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

FMRI Webinar
ITE FAU Student Chapter Lecture Series
2022 March 2nd

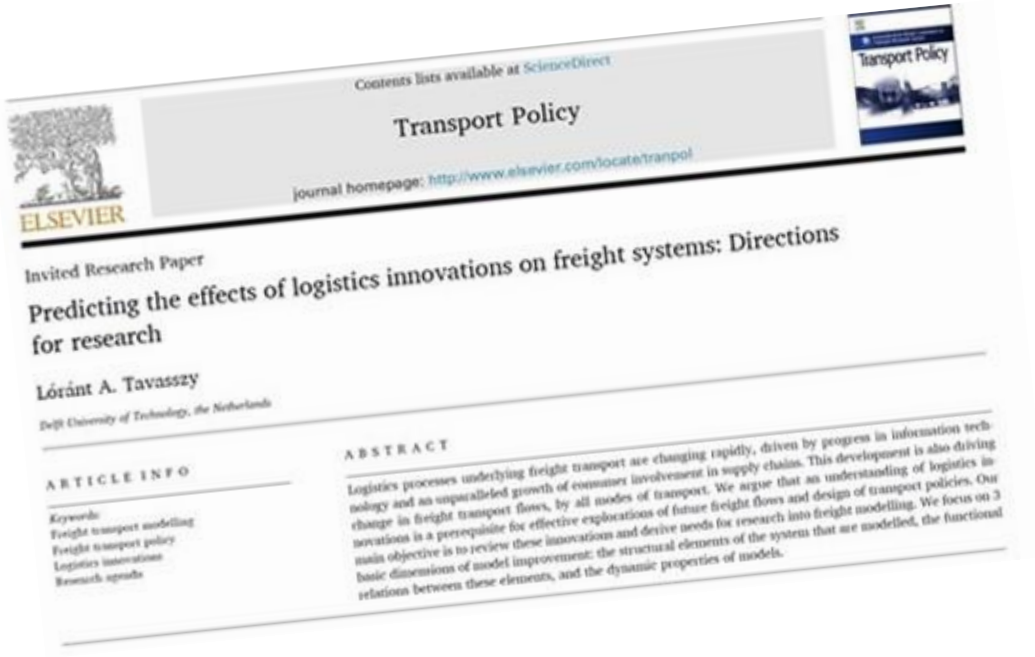
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Lab
Freight and Logistics

Ambition

- Envision logistics system in 2040
- Understand key changes in mechanisms
- Which aspects of freight modeling are essential?



Contents lists available at ScienceDirect

Transport Policy

journal homepage: http://www.elsevier.com/locate/tranpol

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Invited Research Paper

Predicting the effects of logistics innovations on freight systems: Directions for research

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Logistics innovations
Research agenda

ABSTRACT

Logistics processes underlying freight transport are changing rapidly, driven by progress in information technology and an unparalleled growth of consumer involvement in supply chains. This development is also driving change in freight transport flows, by all modes of transport. We argue that an understanding of logistics innovations is a prerequisite for effective explorations of future freight flows and design of transport policies. Our main objective is to review these innovations and derive needs for research into freight modelling. We focus on 3 basic dimensions of model improvement: the structural elements of the system that are modelled, the functional relations between these elements, and the dynamic properties of models.

Innovation in F&L topics

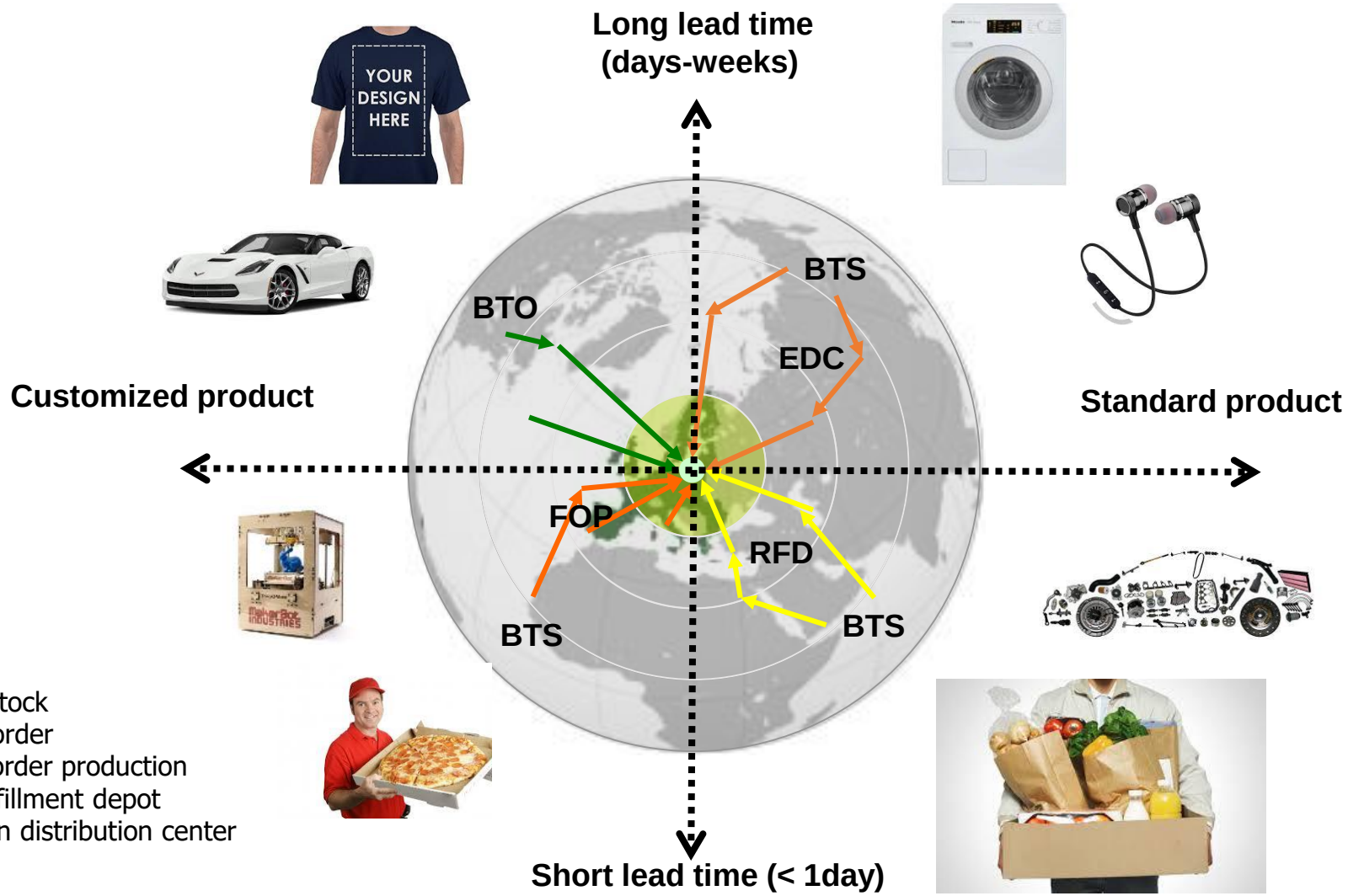
Many many changes…

Overarching vision?

a. Cyber-physical systems
b. Industry 4.0
c. Physical Internet
d. all of the above



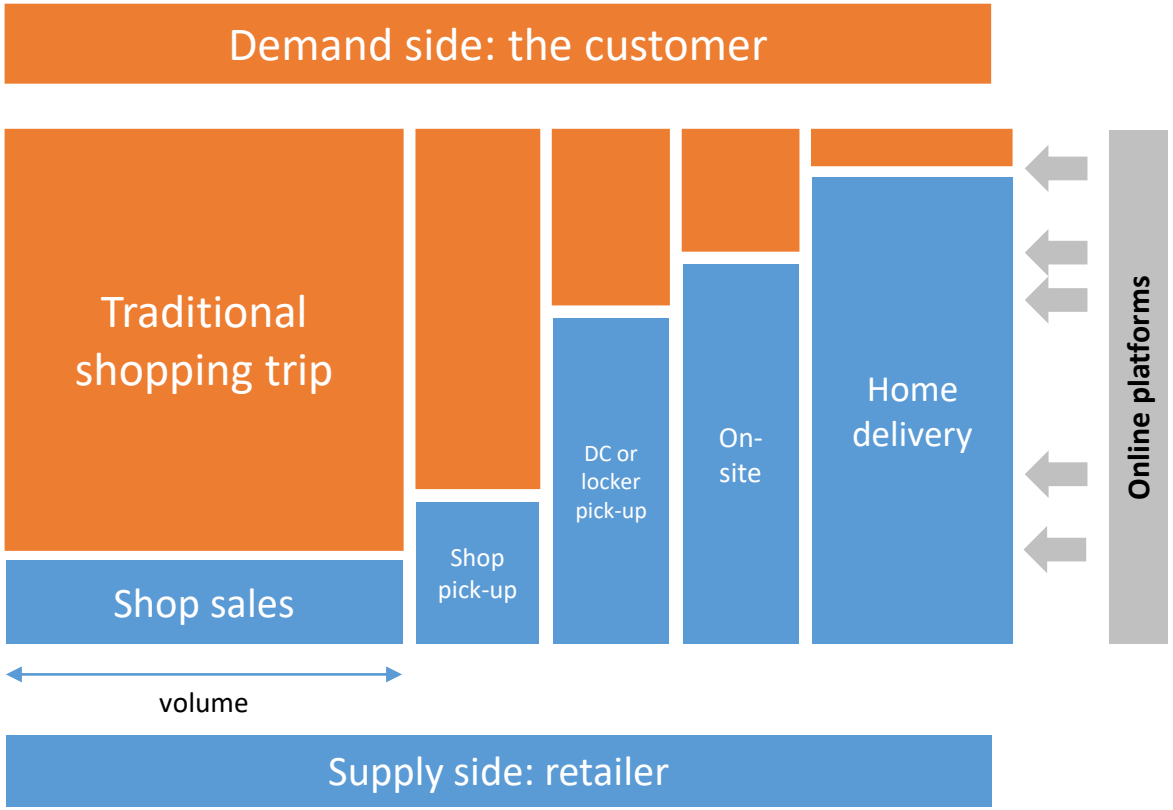
Each product its own supply chain



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

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

now

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

Ton van der Veen, Jumbo CFO on e-delivery
"island of loss in a sea of profit"

upcoming

Cannot balance internally. Pressure to reduce costs remains

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

Cross-chain coordination
- Procurement / Sourcing
- Distribution / Delivery

Co-procurement

LSP Mergers & acquisitions

Crowdshipping

Receiver-led consolidation

Freight markets

Rail transport

Carrier collaboration

"Physical Internet" vision

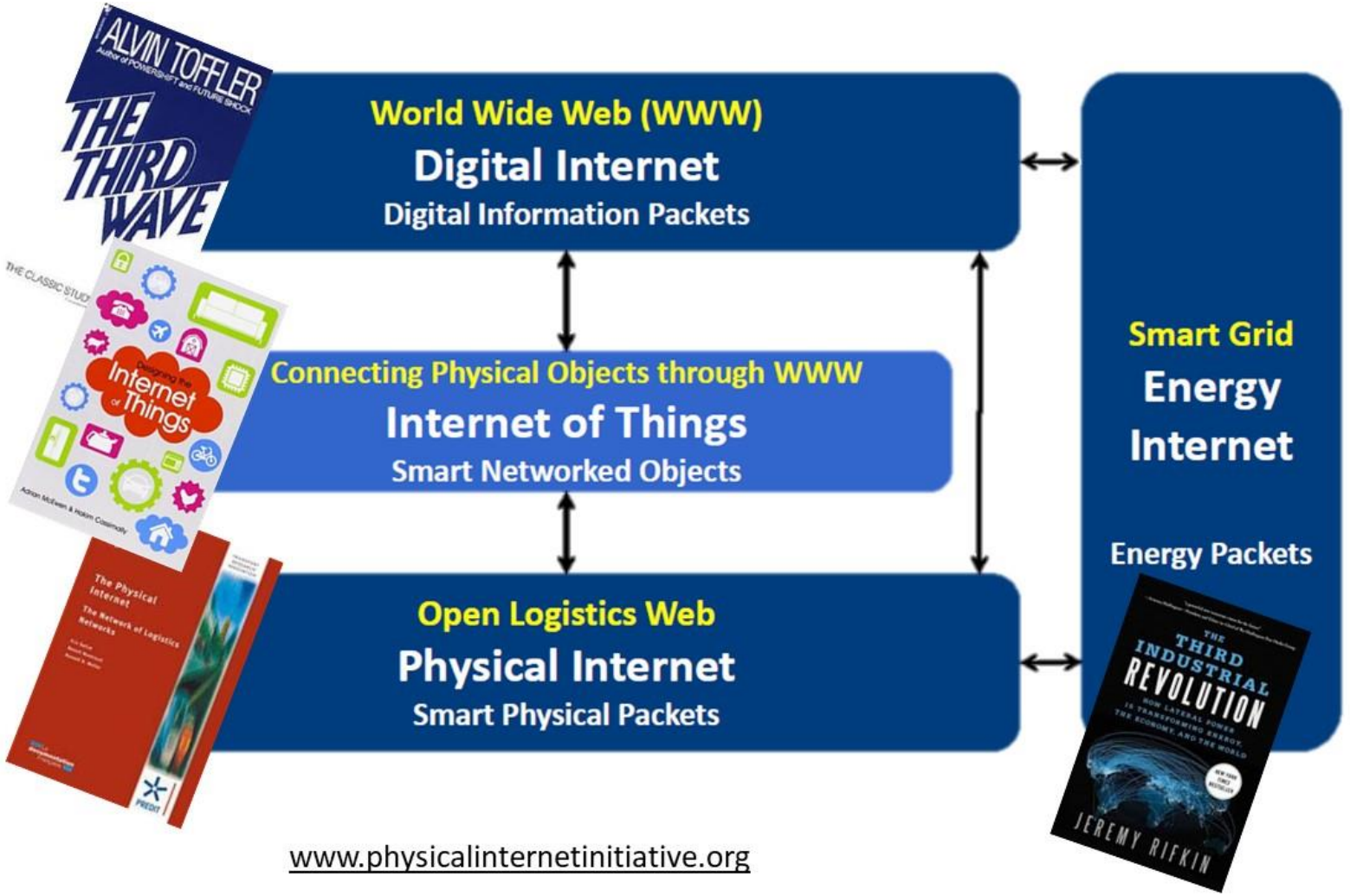
The “Physical internet” (PI)



Benoit Montreuil
Georgia Tech



Eric Ballot
Mines Tech Paris

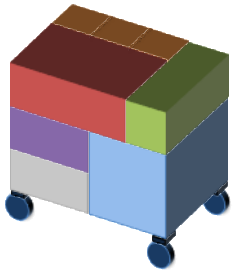


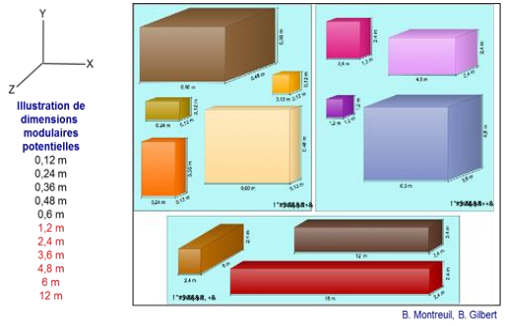
www.physicalinternetinitiative.org

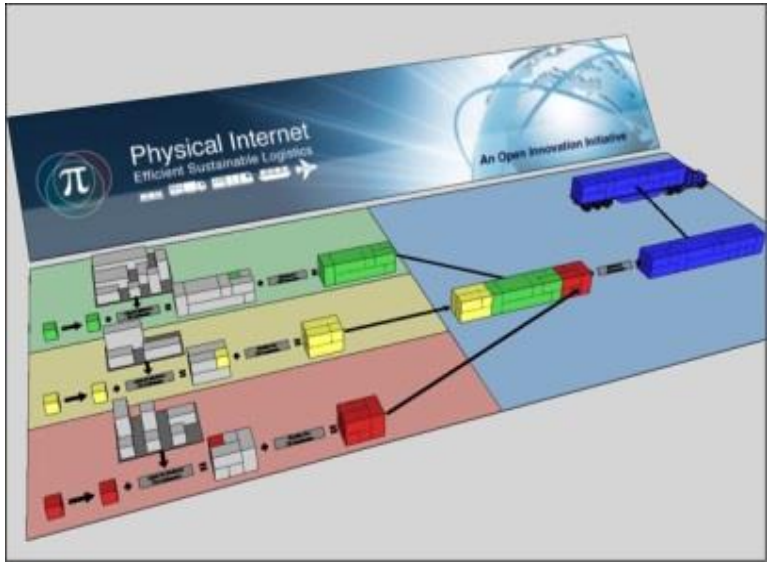
PI: Continuous system-level optimization

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

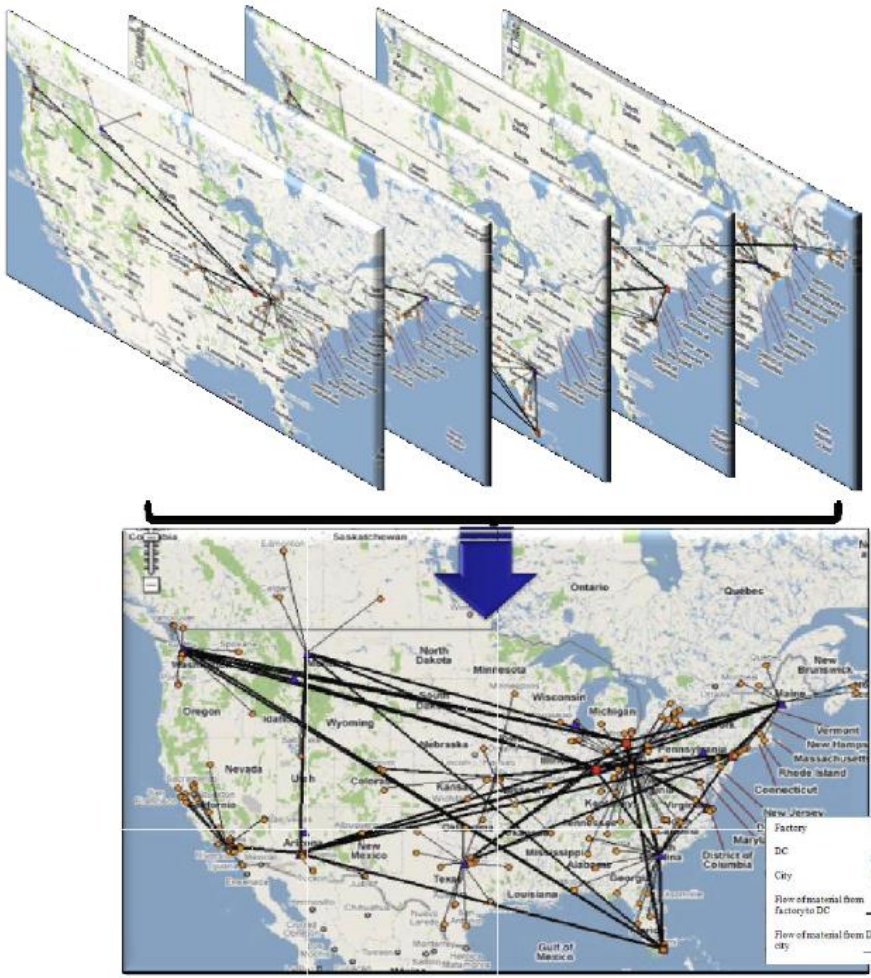
Activate and exploit an Open Global Distribution Web

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

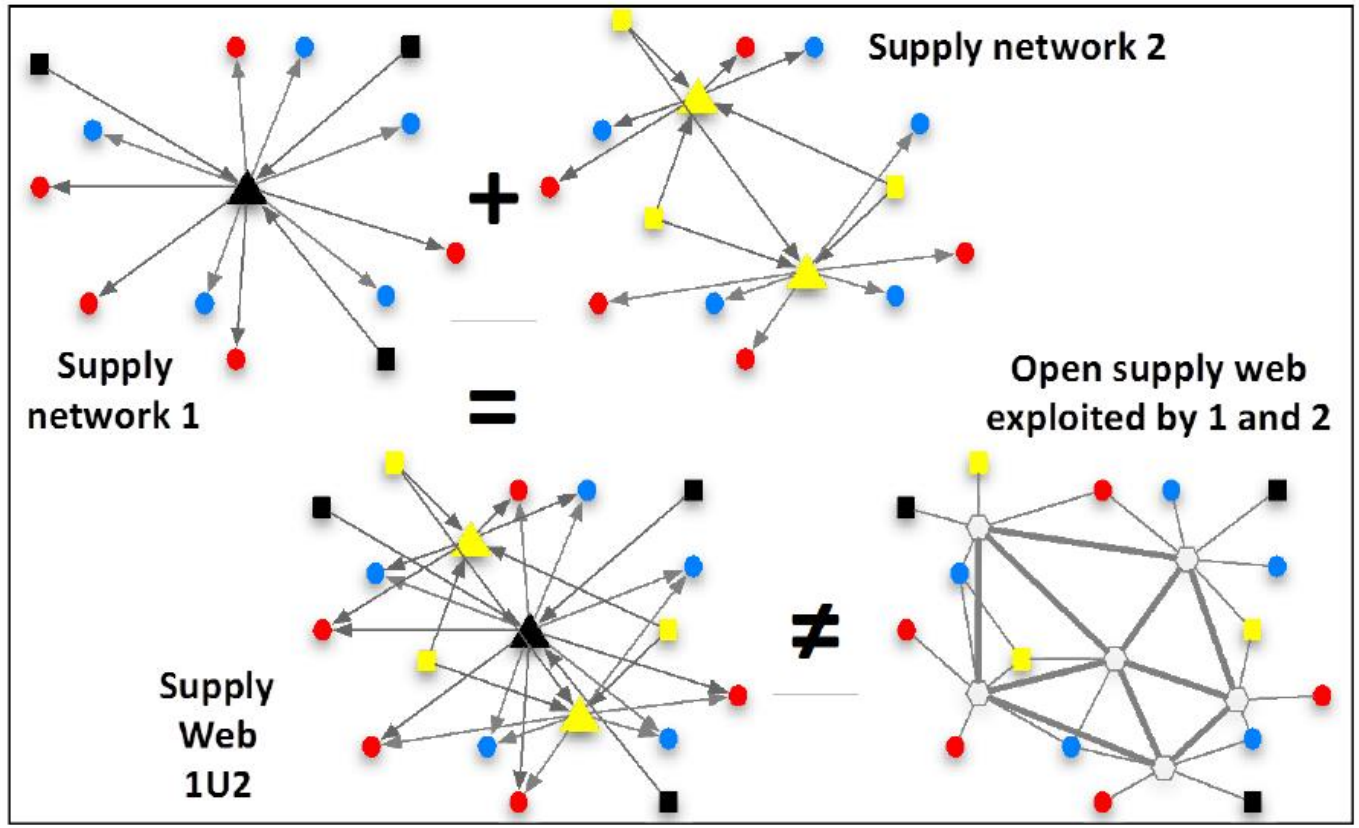
Most of them are used by a single company
Most companies use often a single DC and generally less than 20 DCs

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



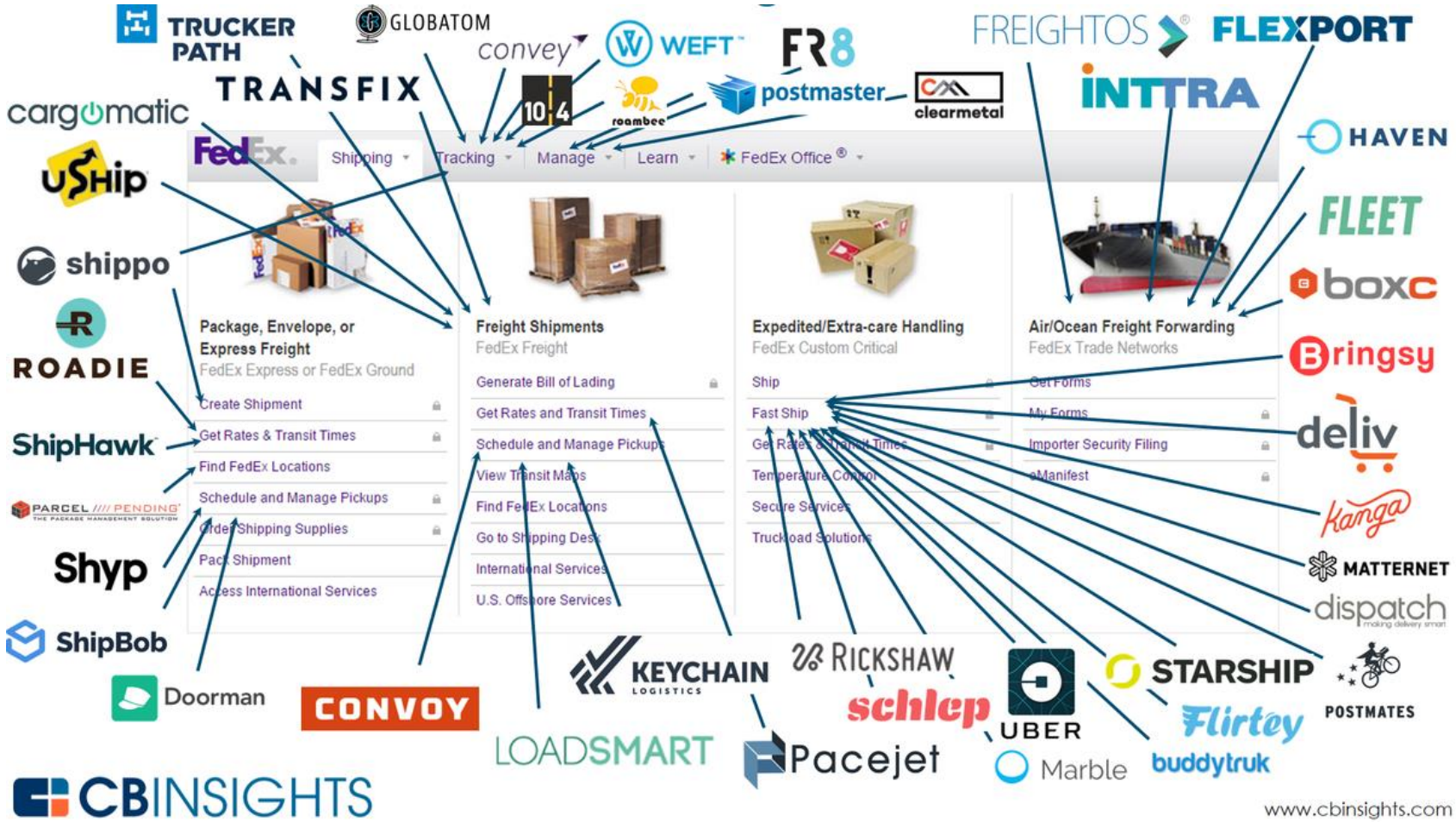
Montreuil and Sohrabi, From Private Supply Networks to Open Supply Webs, IERC 2010

Open Supply Web

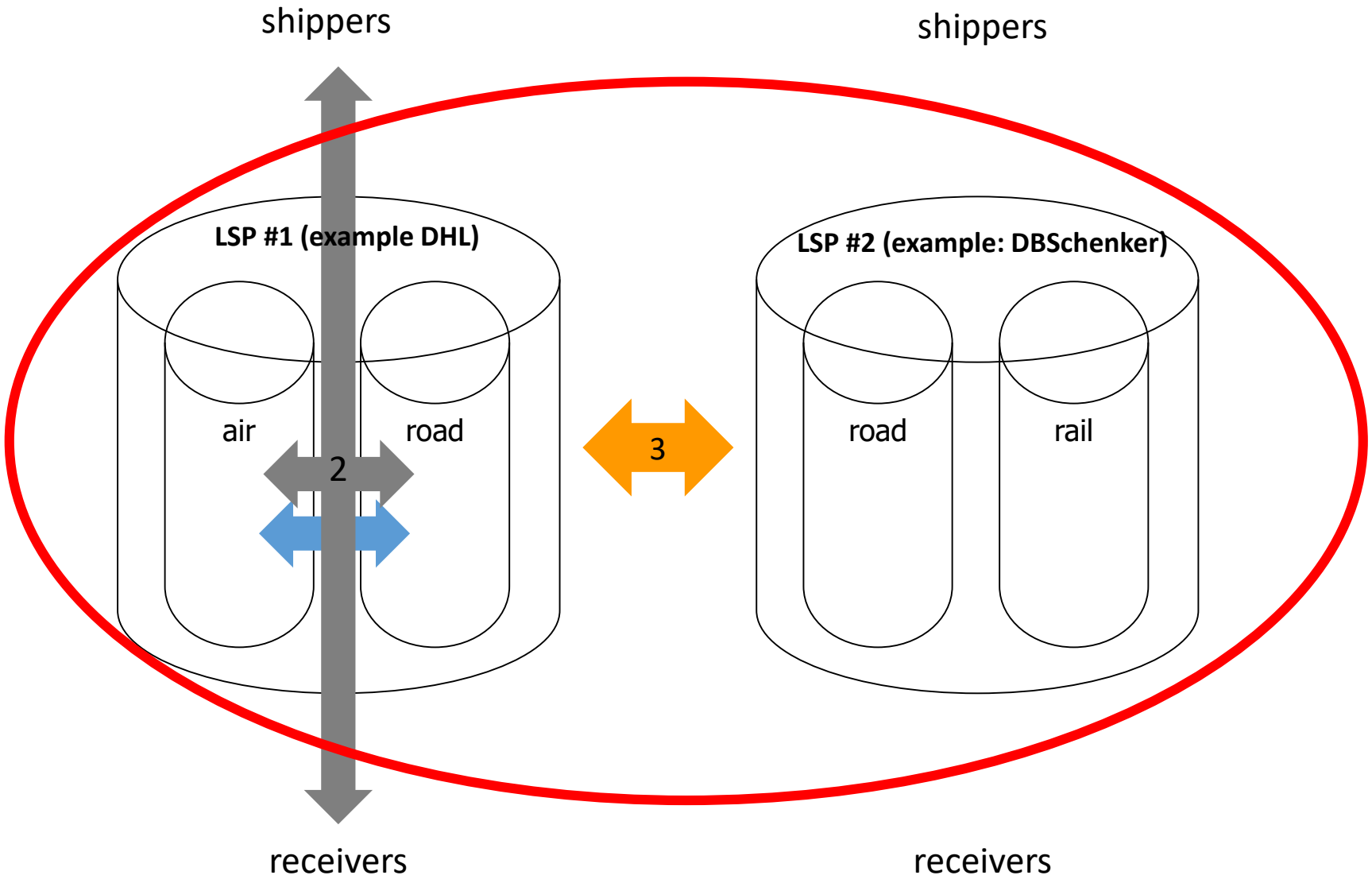


Source: Ballot E., O. Guodet & B. Montreuil (2011), Physical Internet enabled open hub network design for distributed networked operations, Proc. of SOHOMA 2011

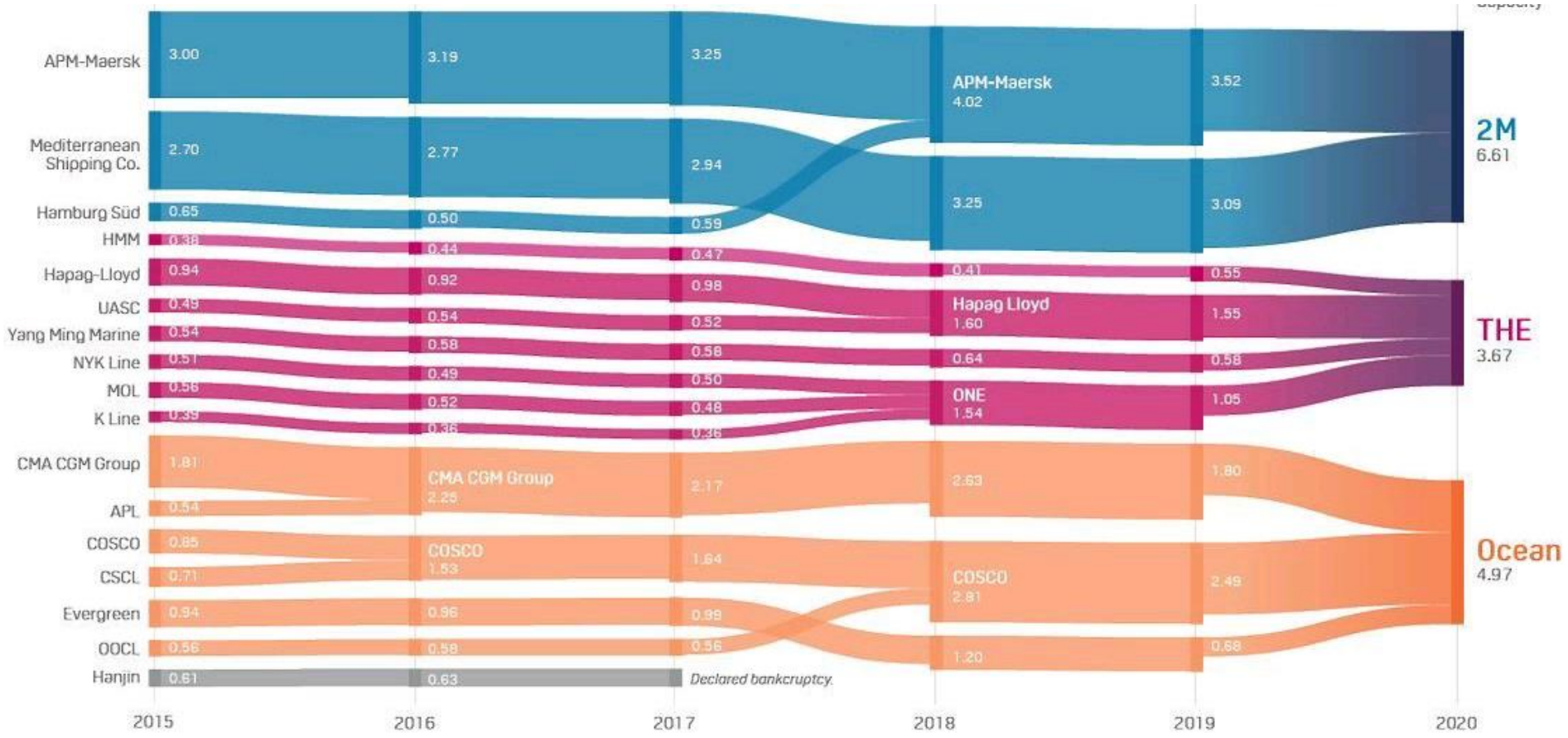
First signs: platform economy



Logistics Service Providers (LSP) roadmap: from intranets to internet



Capacity of maritime alliances (mTEU)



FIATA Bill of Lading: Taking back control through digitalization



More than 350,000 Negotiable FIATA Multimodal Bills of Lading are distributed every year by FIATA's Head
National Associations.

In conformity with the UNCTAD/ICC Rules for Multimodal Transport Documents, the FIATA Bill of Lading
trade document, recognized by banks. However, the current multiplication of trade document version
importance of this standard.

Many see the digitalization of the FBL per se as the ultimate goal to be achieved, but in reality, this i
challenge lies. Digital versions of bills of lading already exist and have proved to work well. Creatin
can be easily achieved, but what is crucial to address is the strengthening of control over its distri
compliance checks. This can be facilitated through the digitalization process and will be one of th
digital strategy.

Tacking back control

FIATA's solution to digitize its FBL will focus on the restauration and development of the doc
will this work in practice?

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China's State Planner Imposed Regulatory Rules On Online Food Ordering Platform

er Staples | Author: Sasha Chen | Feb 23, 2022 11:54 PM (GMT+8)

ebruary 18, 2022, China's National Development and
orm Commission (NDRC), issued a set of rules to help
uggling restaurants to recover from the pandemic. The online
od delivery platforms have been hammered and over-reacted
n response to lower service fees of restaurants.

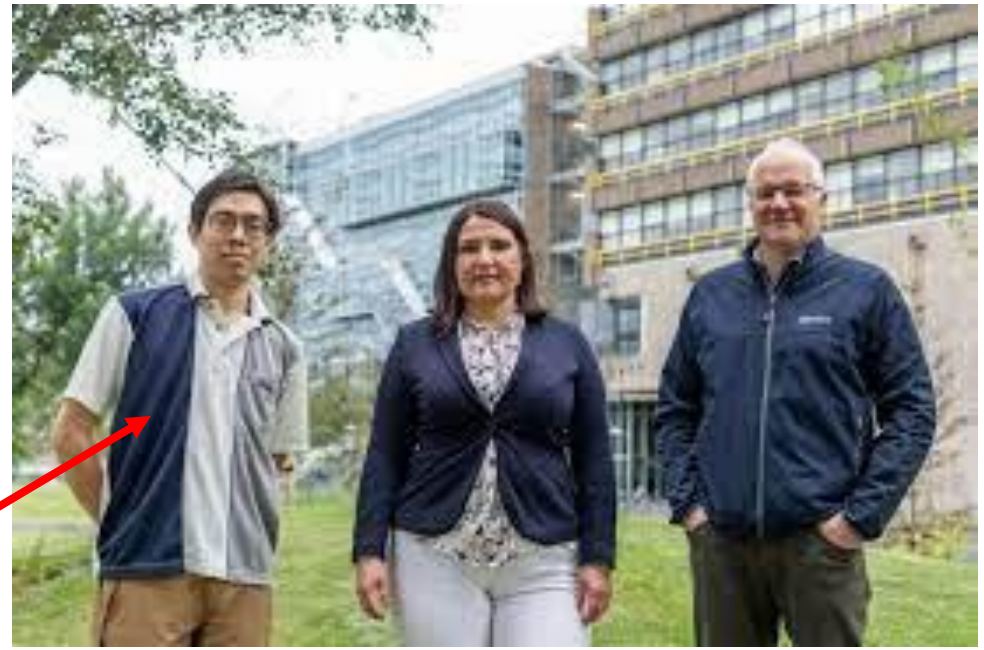


Questions

- 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 megalomanic??

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/

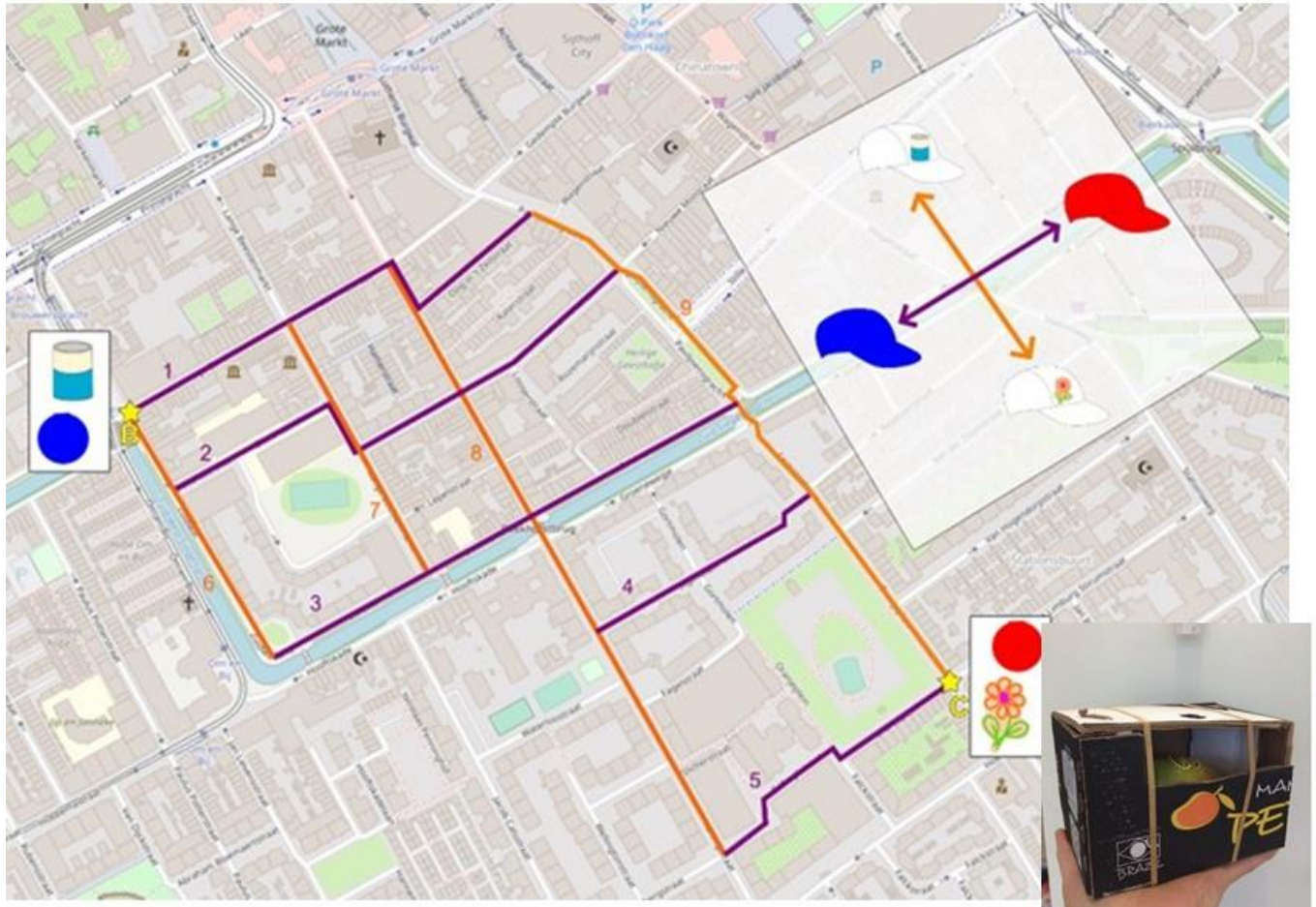
Installation 1: Moving a potato mountain (350kg) by Deliveroo





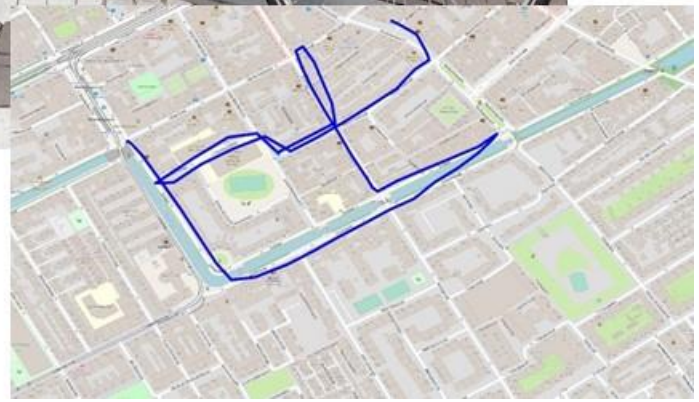


Installation 2: the contingent cycle courier (grid-based P2P delivery relay network)

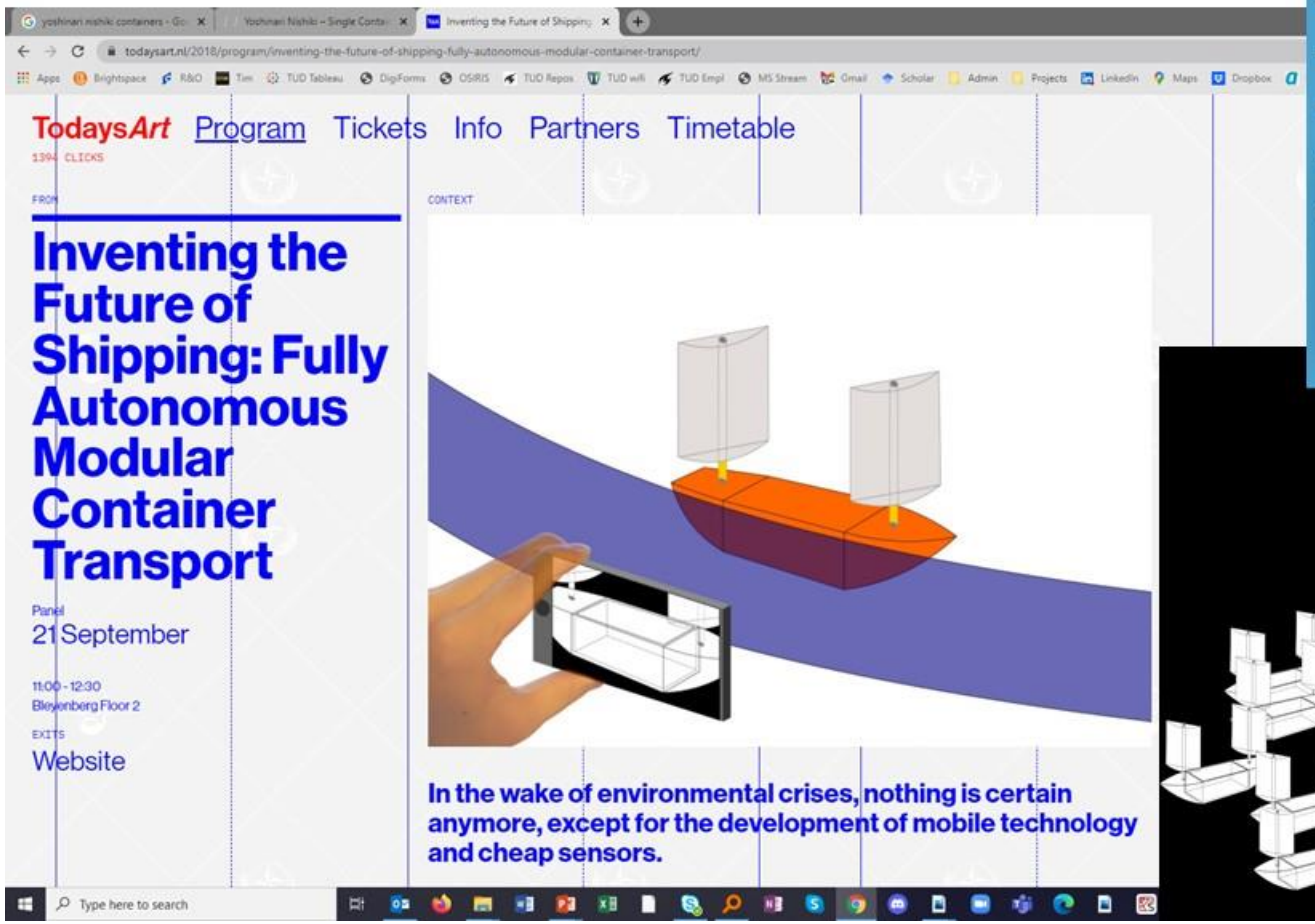


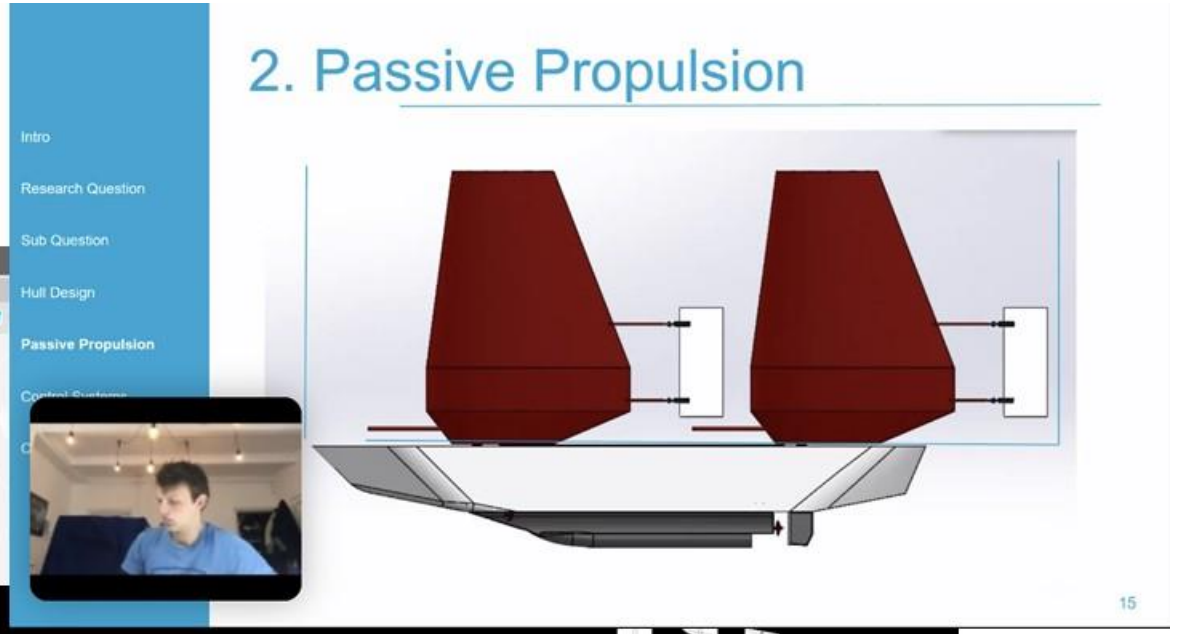


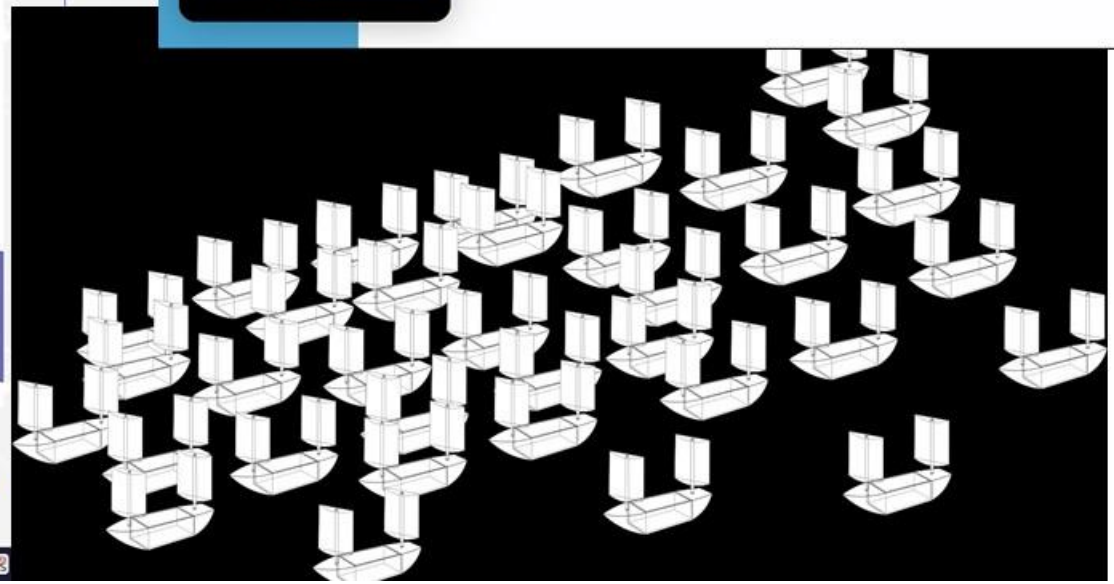




Installation 3: the single container ship (ridiculing scale in container liner shipping)





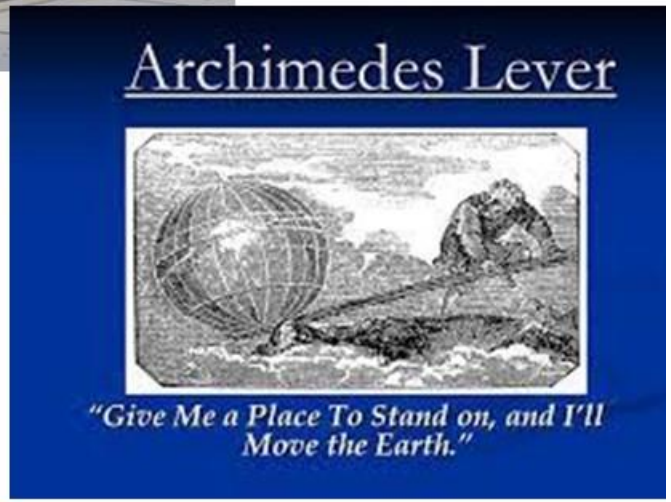


Installation 4: the human dimension of a container (ridiculing scale pt 2)









Innovation- how to

(from big bangs to living labs)

Linear (1)

Easy context

Naïve

Big bang (2)

“Man on the moon”

Big bucks & full control

Living Lab (3)

Agile & Scrum / Minimum Viable Product

Incremental, consensus based

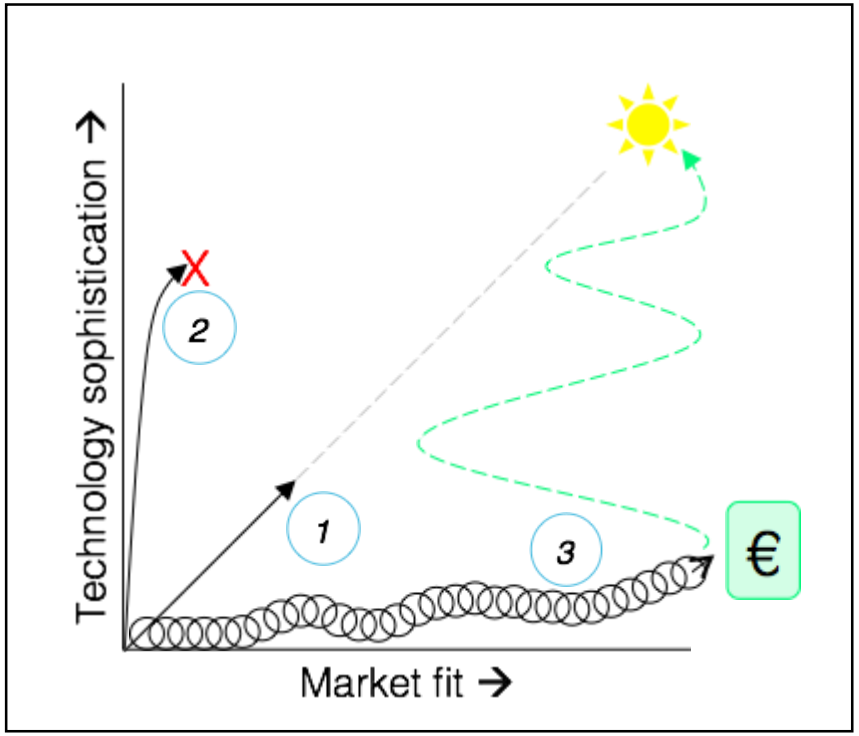
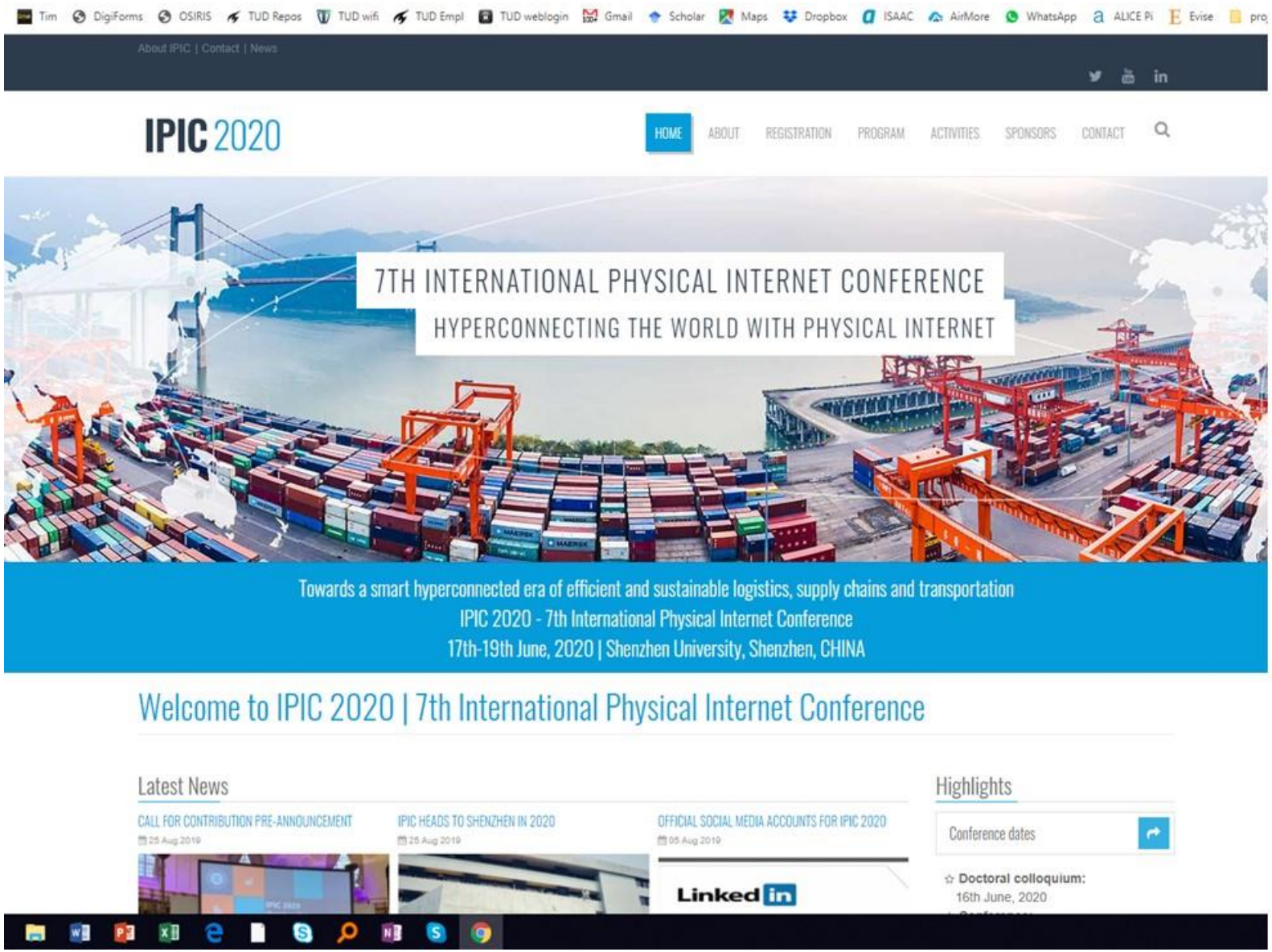
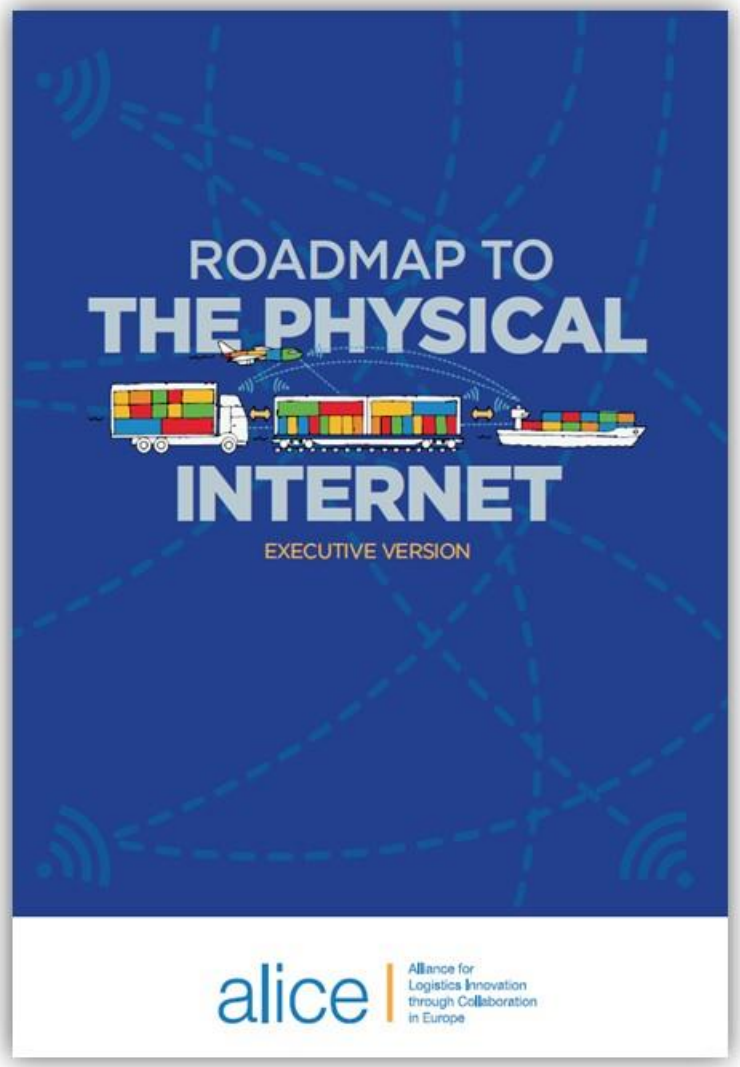


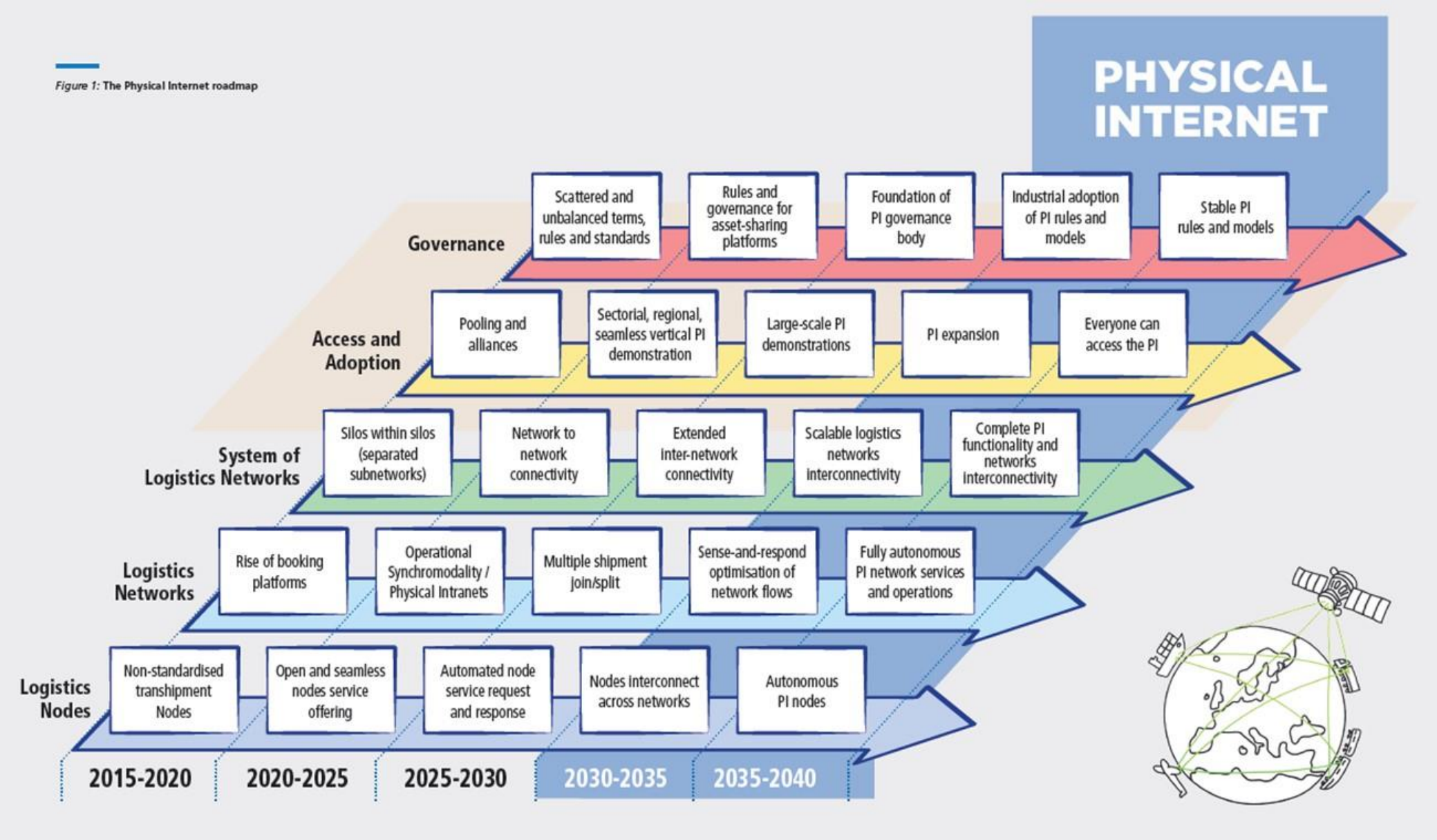
Fig source: A. Wetters (Kimitisik)





Etp-logistics.eu

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

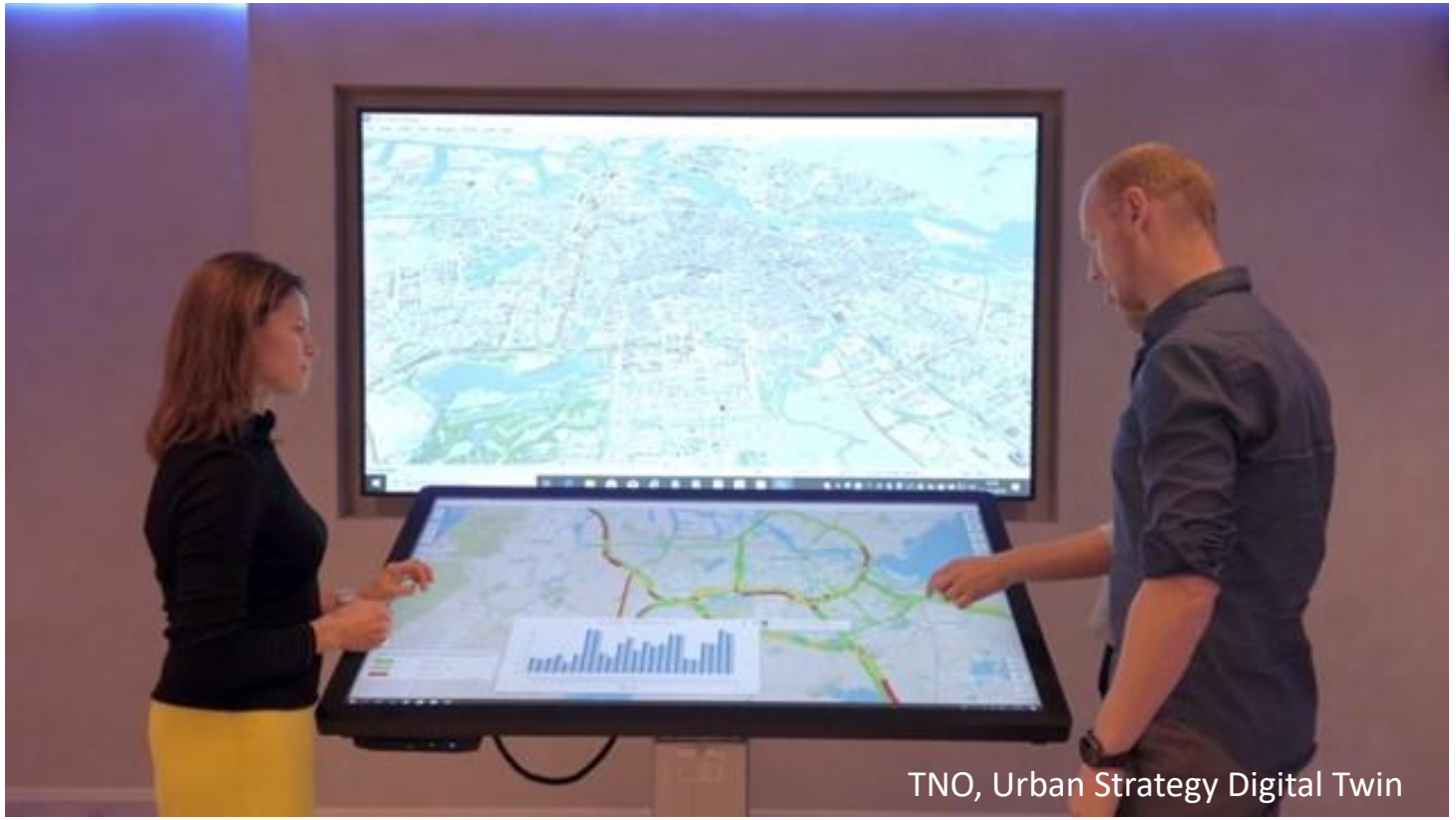
Predict-and-provide --

Experimentation in living labs ++

Decision cycle times --

Trust in data ++

Trust in theory --



TNO, Urban Strategy Digital Twin

2. What system to model?

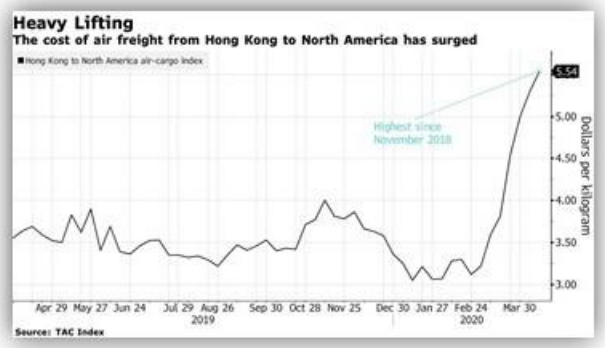
Responsibilities outside transportation (e.g. sustainability)

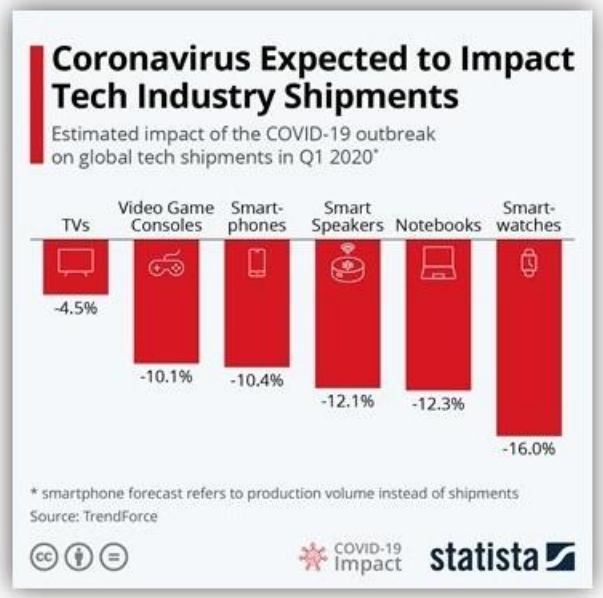
Lasting dependence on major transitions (e.g. energy, ICT)

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?

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

Inventory Management
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

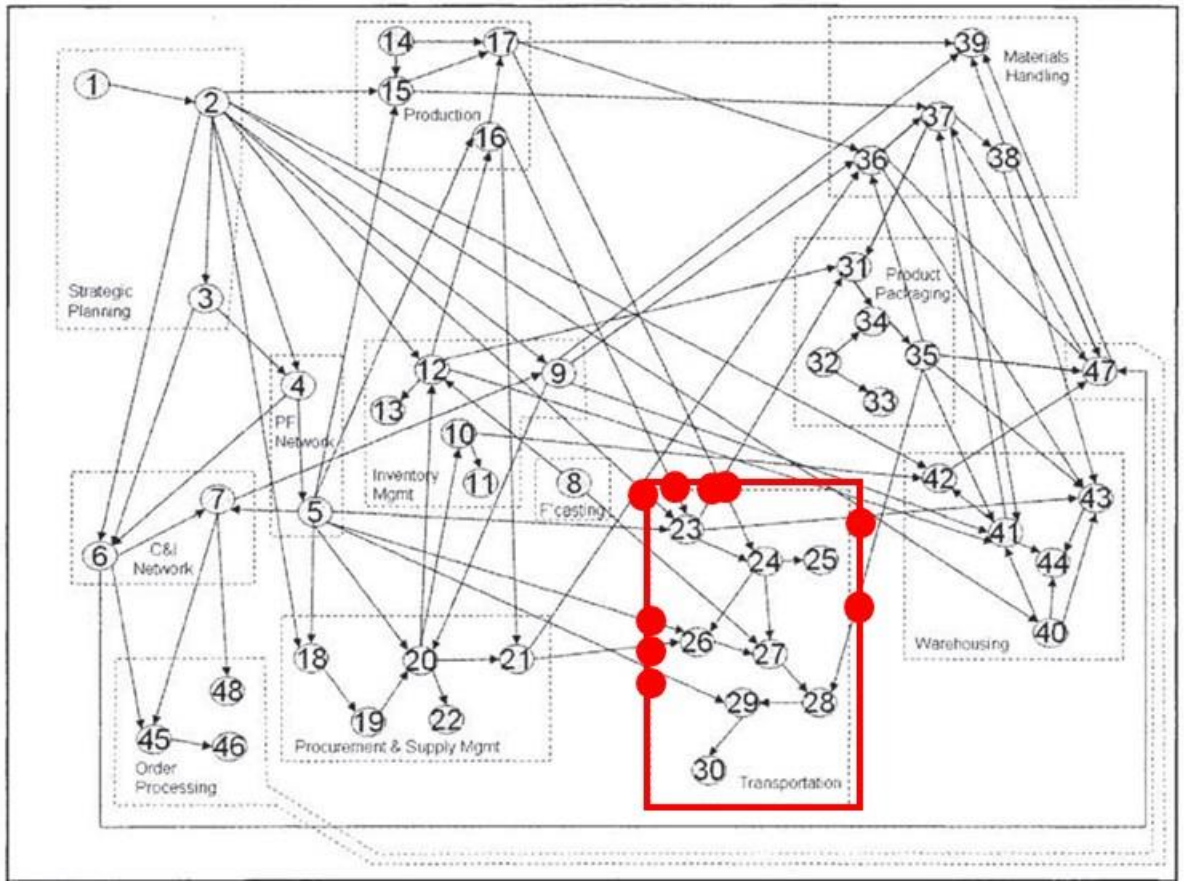
Transportation
23. Transportation modes
24. Types of carriers
25. Carriers
26. Degree of consolidation
27. Transportation fleet mix
28. Assignment of customers to vehicles
29. Vehicle routing and scheduling
30. Vehicle load plans

Product Packaging
31. Level of protection needed
32. Information to be provided with the product
33. Information media
34. Type of packaging
35. Packaging design

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

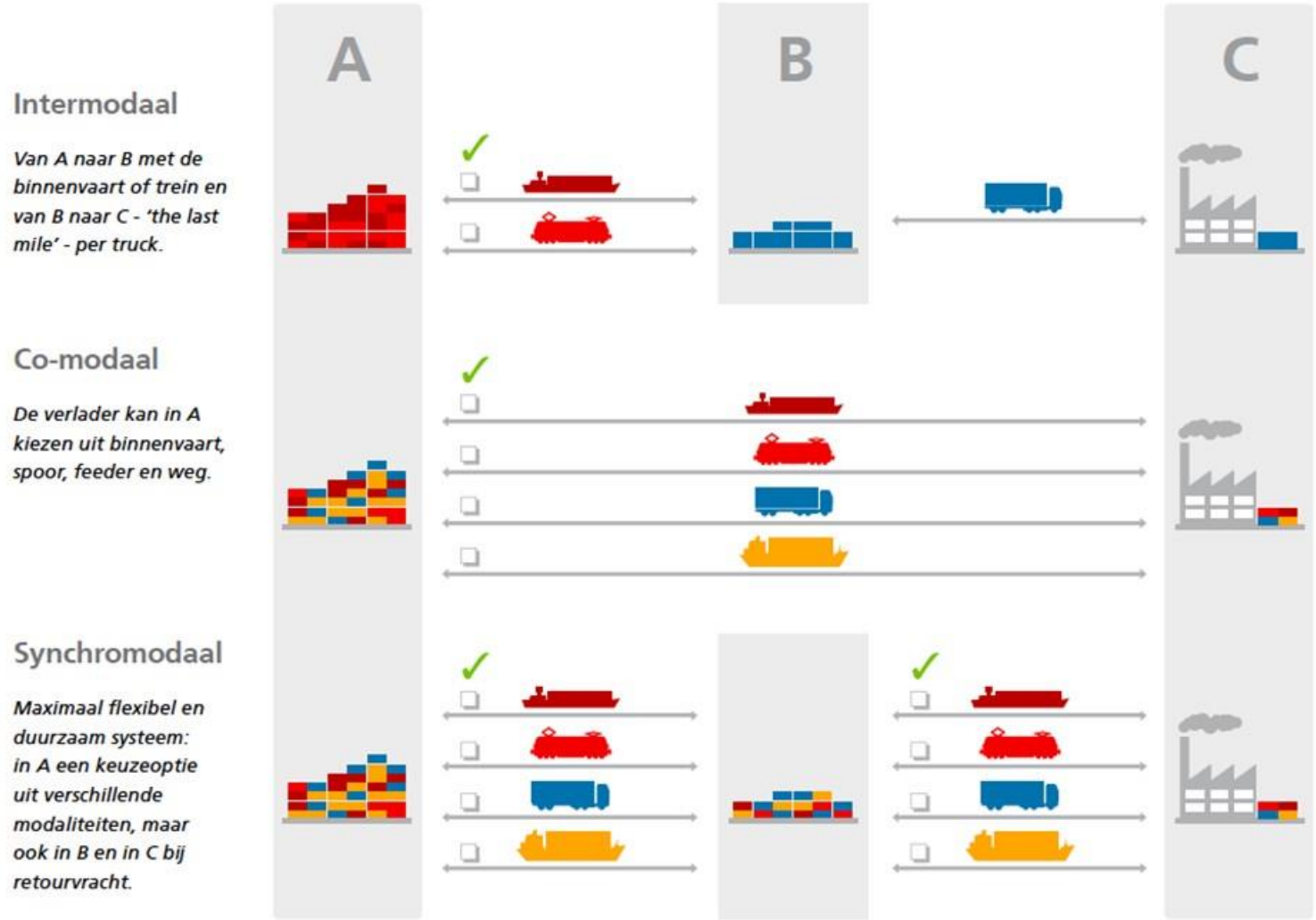


Riopel & Langevin 2005

Recent examples of PI-inspired modelling work

- Dynamic synchromodal freight networks
- Demand side and supply side of hyperconnected networks
- Preference-driven optimization
- Economic of collaborative networks

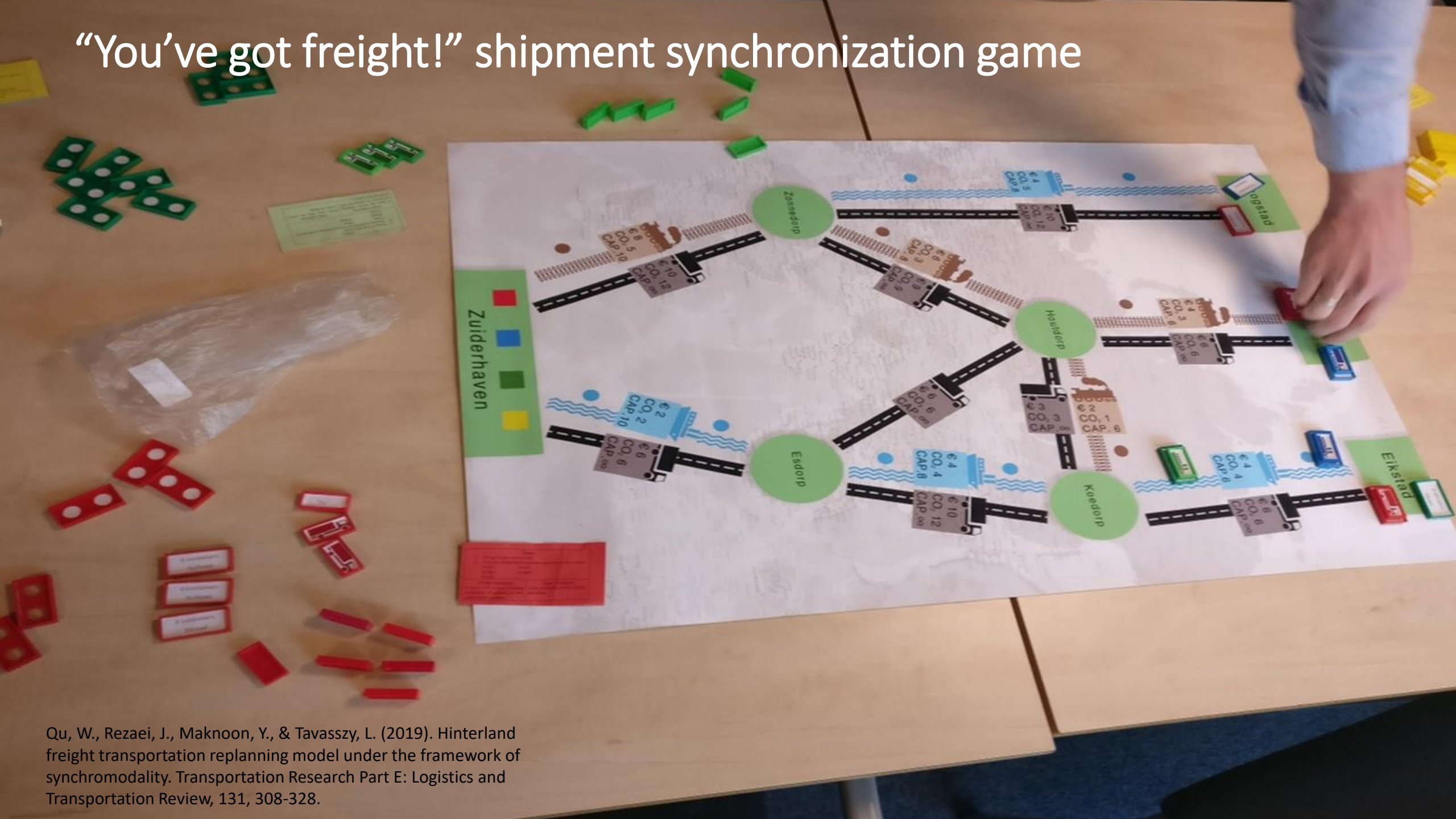
Synchronized intermodality (Synchromodality)





https://www.europeangatewayservices.com/en/about-egs/part-of-ect

“You’ve got freight!” shipment synchronization game



Qu, W., Rezaei, J., Maknoon, Y., & Tavasszy, L. (2019). Hinterland freight transportation replanning model under the framework of synchromodality. Transportation Research Part E: Logistics and Transportation Review, 131, 308-328.

Recent PhD research on synchromodality



Mo Zhang



Hobbs White



Panos Ypsilantis



Bart van Riessen

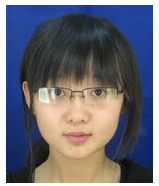
SUPPLY SIDE



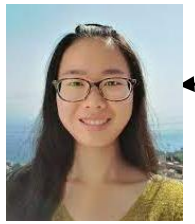
Arturo Rivera Perez



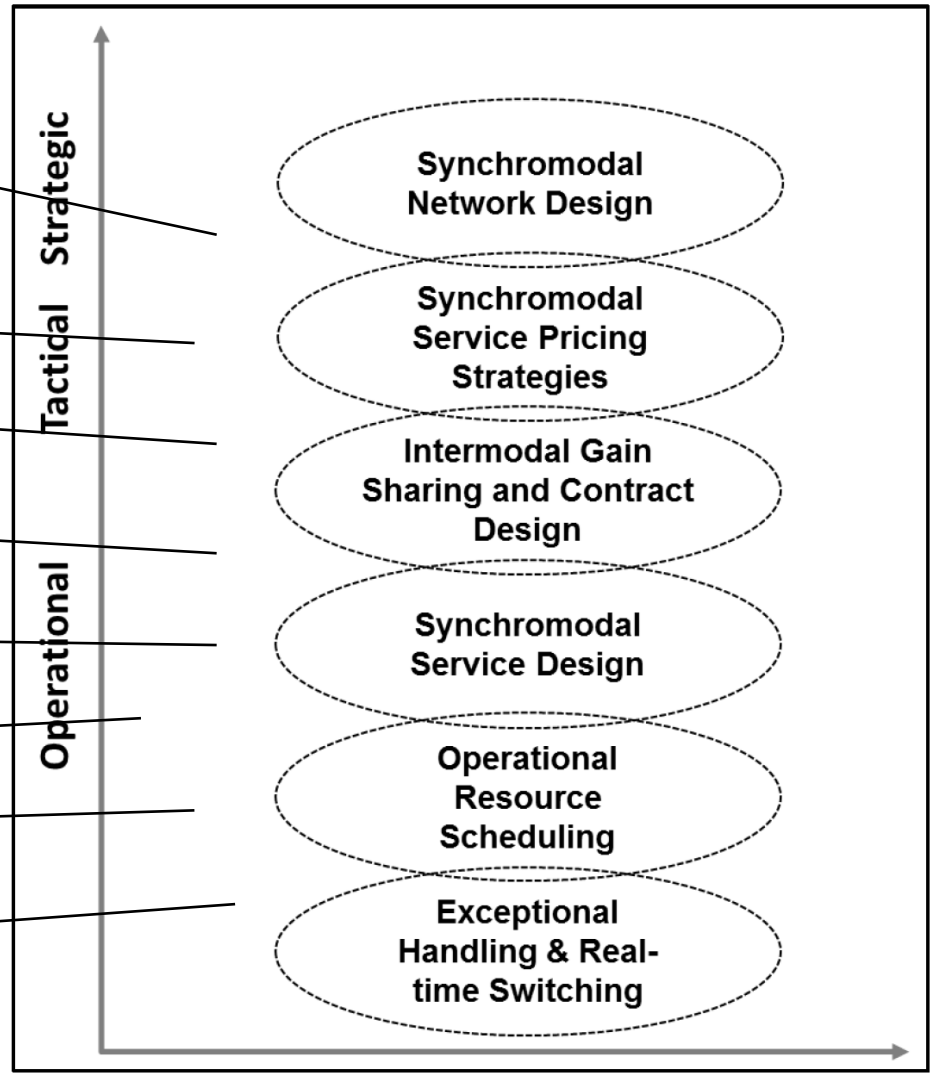
Rie Larsen



Wenhua Qu



Wenjing Guo



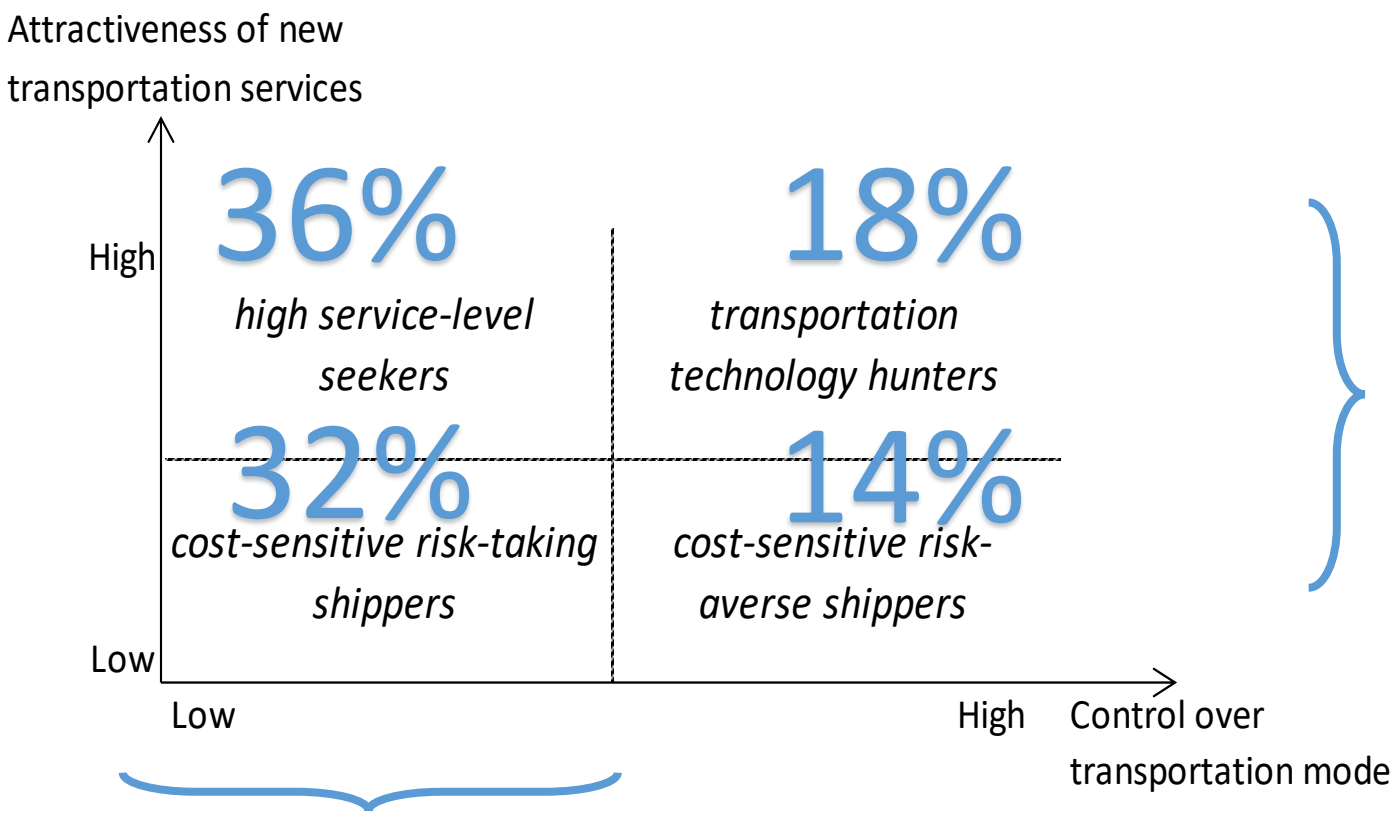
Behdani et al., 2014

DEMAND SIDE



Masoud Khakdaman

What shippers want

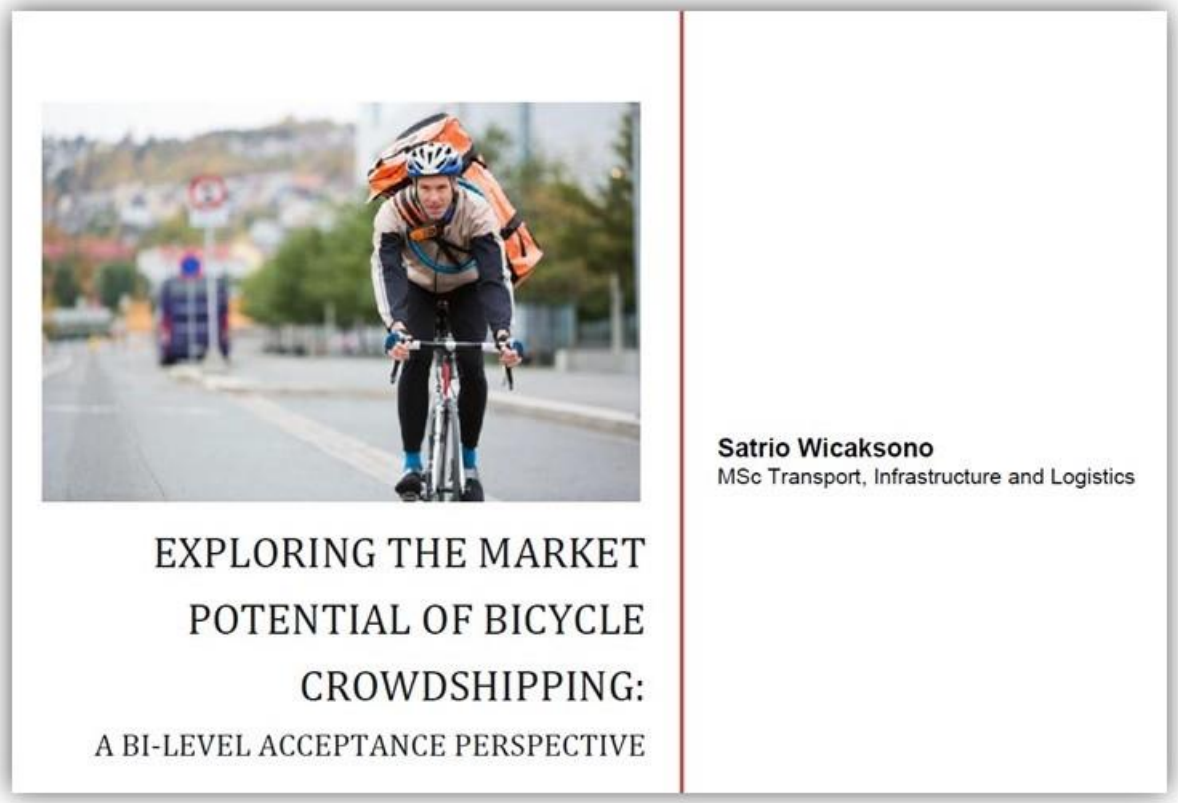


Share of cost and service focused shippers about 50/50 !

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

Khakdaman, M., Rezaei, J., & Tavasszy, L. A. (2020). Shippers' willingness to delegate modal control in freight transportation. Transportation Research Part E: Logistics and Transportation Review, 141, 102027.

What carriers want



Satrio Wicaksono
MSc Transport, Infrastructure and Logistics

EXPLORING THE MARKET POTENTIAL OF BICYCLE CROWDSHIPPING:

A BI-LEVEL ACCEPTANCE PERSPECTIVE

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

Willingness to pay for:	Value	Unit
Increased Delivery Speed (Crowdshipping)	0.25	Euro/hr
	6.00	Euro/day
Adjustable Delivery Time Window	2.29	Euro
CO2 emission reduction	1.00	Euro/kg CO2
Performance rating improvement	0.27	Euro/star rating
Increased Delivery Speed (Traditional Shipping)	0.07	Euro/hr
	1.68	Euro/day

Demand side (shippers)

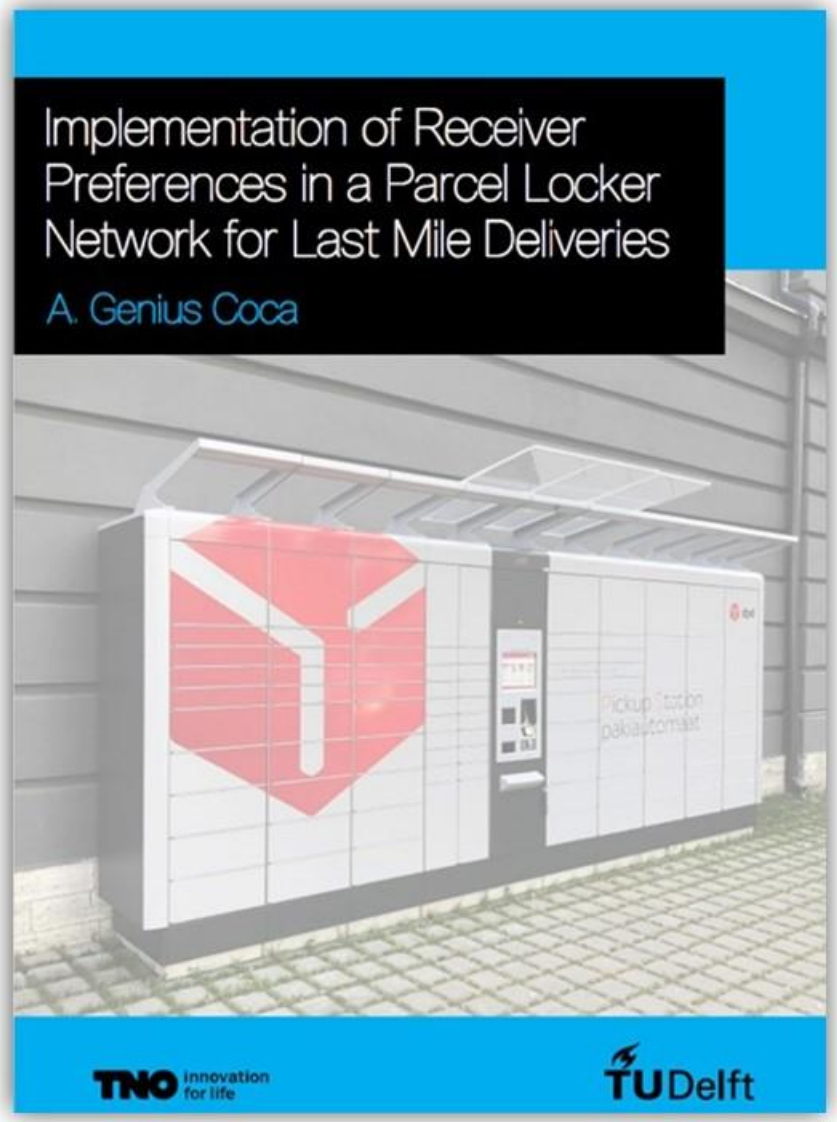
Supply side (“bringers”)

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

Willingness to work for:	Value	Unit
Additional travel time	0.39	Euro/min
	23.76	Euro/hr
Package weight	1.00	Euro/kg

Wicaksono, S., Lin, X., & Tavasszy, L. A. (2021). Market potential of bicycle crowdshipping: A two-sided acceptance analysis. Research in Transportation Business & Management, 100660.

Preference-based network optimization



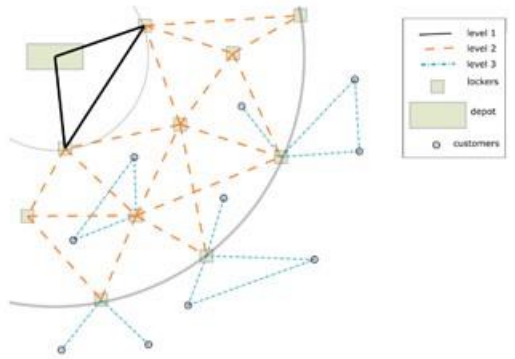
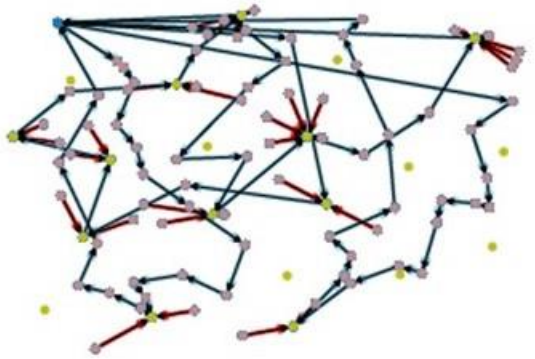
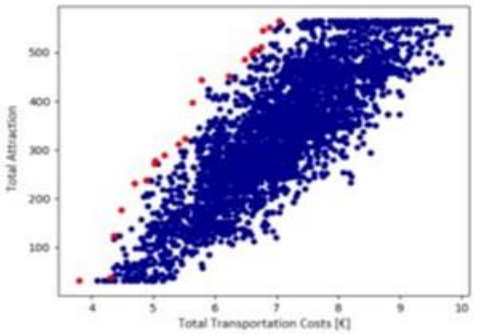


Figure 1.1: Sketch of the system defined, where the different levels of the vehicles are represent





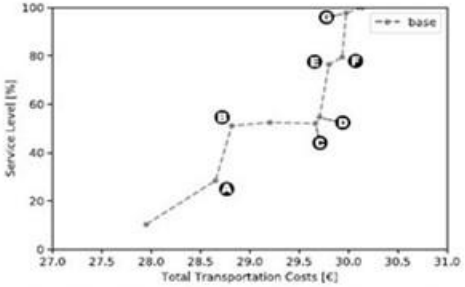


Figure 6.5: Service level vs Total Transportation Costs from the Pareto Frontiers of the base scenario.

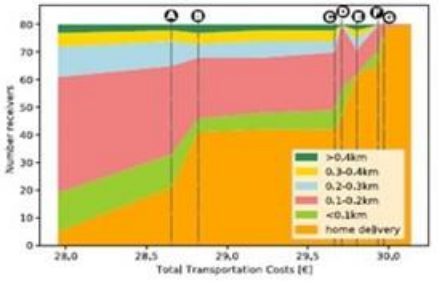


Figure 6.6: Receiver distribution by distance to locker for the Base scenario.

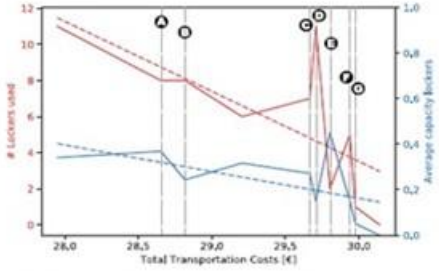
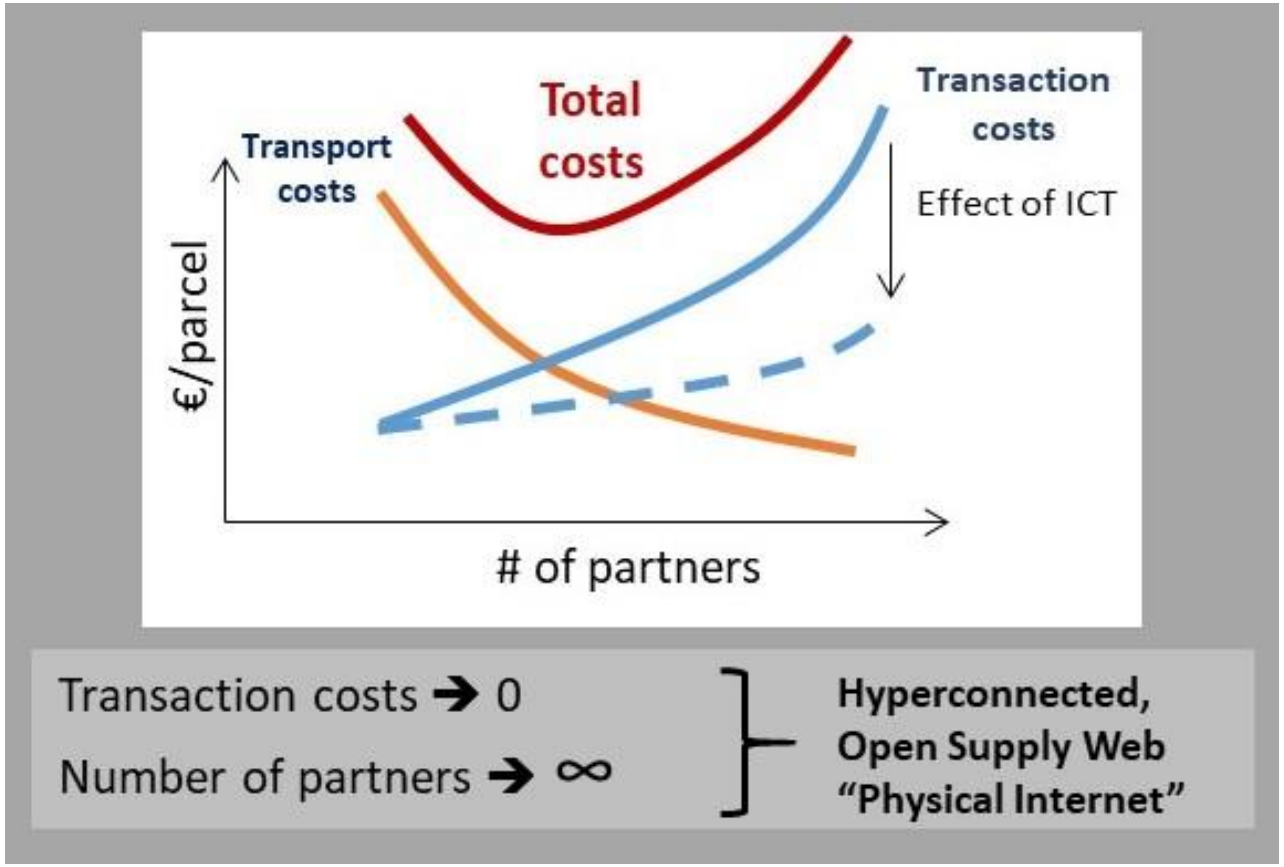


Figure 6.7: Number of lockers used and average capacity usage trends for the base scenario.

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…….

Rezaei, J., Pourmohammadzia, N., Dimitropoulos, C., Tavasszy, L., & Duinkerken, M. (2020). Co-procurement: making the most of collaborative procurement. International Journal of Production Research, 58(15), 4529-4540.

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