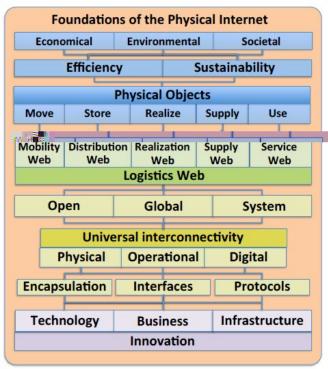


Physical Internet (PI) & PORTS



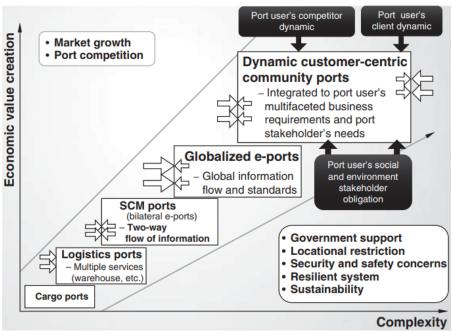
Montreuil, B., Meller, R.D., & Ballot, E. (2013). Physical internet foundations. In: Service Orientation in Holonic and Multi Agent Manufacturing and Robotics.

Springer, Berlin, Heidelberg, pp. 151–166.

Main RQ:

How can maritime ports effectively anticipate on the expected developments towards the PI?





Lee, P. T. W., & Lam, J. S. L. (2016). Developing the fifth generation ports model. In *Dynamic shipping and port development in the globalized economy* (pp. 186-210). Palgrave Macmillan, London.

Research Questions & Design Cycles

RQ1:

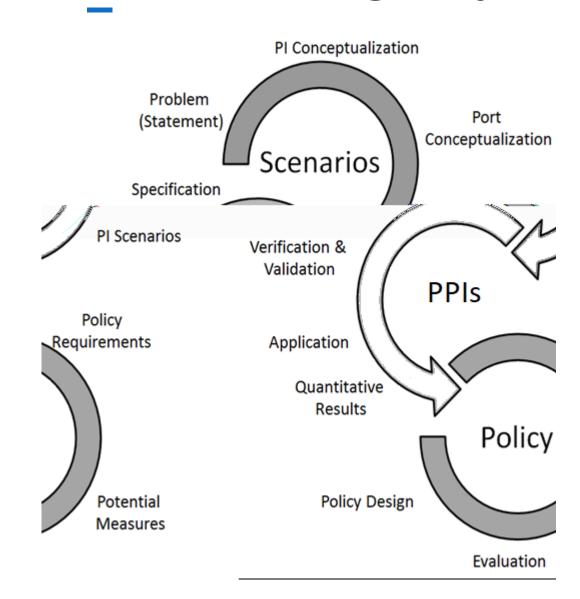
What are the scenarios for the development of ports towards the PI?

RQ2:

How will port users in the PI evaluate port performance and select the most suitable port?

RQ3:

Which policy recommendations can be made to ports?





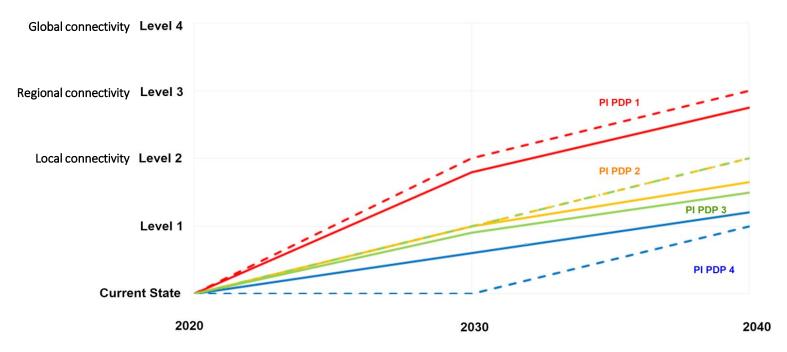
PI Port Framework

	Current State	Level 1	Level 2	Level 3	Level 4	
Port connectivity	Unconnected terminals within ports Unbalanced alliances in maritime shiping lines	Unconnected terminals within ports. Full integration of vertical supply chains by alliances	Horizontal inter- terminal connectivity: 'Physical Intranet' within port	Horizontal inter-port connectivity: Open Ports and networks	Global hub hyperconnectivity	
Governance dimension	Current Incoterms. Unbalanced regulations for asset sharing platforms and CBER	Next Incoterms (Rotterdam rules). Regulations for asset sharing platforms.	Harmonized rules and standards for intra-port connectivity	Harmonized competition rules and standards in horizontally integrated ports	Governance processes and bodies for an open global network	
Operational dimension	(Semi) automation of yard handling operations at terminals	Mode Hinterland synchromodality	Automated crossdocking and reshuffling operations	Automated node service and response across networks	Fully autonomous network operations	
Digital dimension	Tracking systems. Port Community Systems (PCS) at niche level	Full PCS with dedicated connection to hinterland	Digital platform allowing for communication and Decision Making at port	Standardized digital platforms distributed in ports at regional level	Inter-network standardized digital platforms distributed at global level	
	Local connectivity					
				Regional connectivity		
					Global connectivity	
					Clobal collicativity	

Scenario development (RQ1)

	Fast technological development		
Restrictive institutional development	'Technologically driven advancement'	'Big PI'	Progressive institutional development
	'No PI'	'Institutionally driven Advancement'	
		Slow technological development	

PI Port Development Paths (PITD



Continuous lines = Mean Dashed lines = Median

- Online Delphi survey among port experts and the PI community members (ALICE)
- Global connectivity will not be reached by 2040!
- "Worst" scenario, level 1 is not surpassed

Port Performance Indicators (RQ2)

PPIs of PI Ports	Description
Port Operations	Effectiveness of the port operations, including the speed, reliability, flexibility, responsiveness, and quality of operations.
Costs	Costs of port operations for users (port duties, terminal handling charges, cost of services).
Digital Connectivity	Hardware (e.g. sensors) and software (IT systems) to help port users connect to the port and other services allowing seamless digital integration into the supply chains.
Physical Network Connectivity	Physical connectivity of the port to the maritime side and hinterland from a network perspective.

Weights?

→ Determined by using Multi-criteria Decision-analysis (MCDA) / Best-Worst Method (BWM)

Importance of PPIs in scenarios

Scenario KPI	Big PI	J	Technologically driven	No PI
Port Operations	0,20	0,24	0,26	0,30
Costs	0,23	0,25	0,27	0,36
Digital connectivity	0,33	0,24	0,24	0,13
Physical network connectivity	0,24	0,27	0,23	0,21
-	1	1	1	1

Overall:

- (Digital) Connectivity becomes more important towards the PI
- Operations and Costs become less important towards the PI
- Tech and Institutionally driven, balanced importances



Policy Directions (RQ3)

Policy direction	Description
Transport Infrastructure	Invest in port infrastructure to improve its accessibility and enlarge its capacity.
(PI) Standardisation	Contribute to the advancement of administrative, nautical, legal, digital, and functional standardisation.
Advanced Terminal Areas	Develop (PI) container reshuffling of and logistics value added services areas in the port.
ICT Hardware	Invest in the installation and implementation of sensors and wireless communication technologies in the port.
Information systems and information exchange platforms (IS&IEP)	Develop accessible and interoperable information systems and information exchange platforms for the port community for seamless supply chain integration. Improve the smart functionalities of these systems.
Sustainability Management	Monitor and control safety and security, air and water quality, and other nuisances. Comply with environmental and work condition regulations, and traffic measures.

effectiveness of Policy Directions

Scenario	Big Pl	driven	Technologically driven advancement	No PI
Transport Infrastructure	0,15	0,15	0,13	0,23
(PI) Standardization	0,21	0,20	0,23	0,18
Advanced Terminal Areas	0,14	0,15	0,13	0,16
ICT Hardware	0,17	0,18	0,17	0,15
Information systems and Information exchange platforms	0,24	0,24	0,25	0,18
Sustainability Management	0,09	0,08	0,09	0,10
	1	1	1	1

Overall:

- Sustainability Management least effective
- Advanced terminal areas and ICT hardware are similarly effective

Big PI, Institutionally and Tech driven:

 IS&IEP most effective policy, followed by (PI) Standardization, while Transport Infra, ATA and ICT-H similarly effective



Conclusions

- Fully functioning global PI not to be expected by 2040, even in the "best" scenario
- Connectivity PPIs become more important towards the PI, while Costs and Operations become less important
- In the more developed scenarios towards the PI, ports should focus on:
 - the development of Information Systems and Information Exchange Platforms
 - the development of global (PI) standards (protocols and interfaces)

Future research

- Develop dynamic policy roadmap with concrete action plan
- Develop a (global) network design to determine the freight flows in the different scenarios
- Port Community Systems in the PI?