International Standardisation Needs for Scaling Up Innovation and Advance Implementation of Physical Internet in Urban Logistics & Beyond

From pilots to large scale implementation

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1. Executive Summary

1.1. Main Findings:

The Physical Internet represents a highly promising approach to improving the efficiency, resilience, and sustainability of logistics systems, yet its implementation remains fragmented across regions, actors, and solutions. Efforts to advance the Physical Internet vision are revealing both the potential and the complexity of transforming global logistics into an open, modular, and interoperable system. While the vision is well established, practical deployment often occurs in isolated initiatives, limiting interoperability and systemic impact.

Urban logistics has emerged as a particularly important opportunity for Physical Internet implementation. Cities are facing growing challenges due to rising e-commerce volumes, increasing last-mile delivery demand, congestion, emissions, and constrained urban space. These pressures create a strong need for innovative logistics models that make better use of shared infrastructure and resources. Physical Internet principles (such as modularity, openness, and asset sharing) are well suited to address these challenges, positioning cities as natural testbeds and early adopters.

As a result, Physical Internet concepts are already being implemented in urban contexts. Shared micro-hubs, parcel lockers accessible to multiple operators, and consolidated freight flows are increasingly deployed to improve last-mile efficiency and reduce environmental impacts. EU-funded research and innovation projects have played a key role in enabling and accelerating these implementations, moving beyond conceptual exploration toward real-world deployment and operational validation.

However, the ability to scale and replicate these urban Physical Internet solutions depends critically on standardisation. Common standards are required to enable interoperability between systems and actors – for example, to allow parcel lockers to be shared across logistics service providers, platforms, and cities. Without harmonised standards for physical infrastructure, digital interfaces, data exchange, and operational rules, urban Physical Internet solutions risk remaining fragmented and location specific.

In this context, ISO has made significant efforts to develop standards relevant to urban logistics and Physical Internet applications. Ongoing work includes standards for parcel locker systems, as well as related initiatives such as unmanned stores and other shared urban logistics infrastructures. These standardisation activities provide an essential foundation for interoperability, safety, and scalability.

While urban logistics has emerged as a prominent entry point for Physical Internet implementation, the relevance of Physical Internet principles extends well beyond the urban context. Applications are expected to expand across other segments of the logistics system, including long-haul transport, intermodal operations, warehousing, and cross-border freight networks. In this regard, urban logistics implementations serve not only as deployment sites but also as learning environments. Lessons derived from urban use cases (such as shared asset governance, interoperability of physical and digital infrastructures, and multi-actor coordination) provide valuable empirical evidence that can inform broader Physical Internet adoption across the logistics chain. Capturing and transferring these best practices will be essential to avoid repeating fragmentation at larger spatial and organisational scales.

Standardisation plays a critical enabling role in this transition. Effective implementation of the Physical Internet depends on interoperability across physical units, digital systems, and organisational processes, which in turn requires close and sustained cooperation among industry stakeholders, research actors, public authorities, and standards development organisations. However, the objective of standardisation should not be to create an entirely new and comprehensive set of standards labelled specifically for the Physical Internet. Given the diversity and complexity of logistics systems, such an approach would be neither feasible nor desirable.

Instead, standard development should be driven by clearly identified needs arising from concrete research and innovation outcomes and real-world technological deployment. Standardisation efforts should focus on specific, high-impact components (interfaces, modular units, data models, and operational procedures) where interoperability gaps are demonstrably constraining implementation. Research and innovation activities can play a crucial role in identifying these gaps, testing solutions, and providing the technical maturity and evidence base required for effective standardisation.

Given the pace of technological development and the evolving nature of logistics business models, it is neither realistic nor necessary for standardisation to attempt to cover all aspects of the Physical Internet simultaneously. A selective, use-case-driven, and iterative approach is more appropriate, allowing standards to evolve in step with technological readiness and operational practice. Close cooperation between R&I projects and international standardisation bodies is therefore essential to ensure that emerging standards remain grounded in practical experience, aligned with market needs, and capable of supporting scalable and interoperable Physical Internet implementation across the logistics system.

1.2. Recommendations:

Prioritise small, targeted standardisation efforts with demonstrable benefits

Standardisation for the Physical Internet should begin with focused, realistic components rather than attempting to cover the entire system. Priority should be given to areas where interoperability gaps are evident and where implementation experience already exists, such as modular containers, inter-hub procedures, or shared urban infrastructure. Early, low-risk standardisation efforts allow solutions to be tested, refined, scaled, or discontinued with minimal disruption. Even incremental progress generates valuable learning, strengthens interoperability, and accelerates readiness for a fully networked Physical Internet. Lessons from urban logistics implementations (shared micro-hubs and parcel lockers) can inform the selection of these priority areas and guide best practices for other parts of the logistics chain.

Strengthen links between projects and national/international standardisation bodies

To maximise the impact of research and innovation efforts, projects should establish early and active engagement with national and international standardisation organisations. This involves integrating mechanisms for consultation, participation, and ongoing feedback throughout the project lifecycle, rather than treating standardisation as a final task. By embedding these connections from the outset, technical solutions and operational insights gained during projects can be translated into recognised standards, directly supporting interoperability and broad adoption of Physical Internet principles.

Begin implementation in parallel with standardisation

Waiting for comprehensive European or international standards risks delaying progress and stalling innovation. Instead, practitioners and projects should initiate implementation using current best practices, pilot protocols, or locally agreed standards, while remaining attuned to the evolution of formal standards. This approach not only accelerates the deployment of new solutions but also generates valuable empirical evidence and operational feedback, which can inform and shape ongoing standardisation processes. The iterative exchange between practice and policy creates a dynamic feedback loop, allowing standards to evolve in response to real-world experience.

Continuously monitor R&I activities and standardisation progress

Maintaining ongoing surveillance of research, innovation, and standardisation activities is vital to ensure that lessons are systematically captured, gaps are promptly identified, and efforts remain responsive to changing needs. Regular engagement with relevant stakeholders—including standardisation bodies, industry associations, and research networks—enables the iterative development of focused, evidence-based standards. This continual monitoring supports the timely transfer of best practices and helps align standardisation efforts across logistics domains and geographic regions.

2. Assessing the State of the Physical Internet

The Physical Internet (PI) represents an ambitious vision for the seamless, efficient, and sustainable flow of goods across open, interconnected logistics networks, inspired by how data moves through the digital Internet. Achieving this vision depends on harmonised standards across multiple dimensions, including modular containers, data protocols, operational processes, and governance frameworks. While research and pilot projects (such as URBANE and DISCO in urban logistics) have advanced the concept, no globally recognised set of standards currently exists. Divergent approaches across industries, regions, and actors risk fragmentation, inefficiency, and incompatibility, limiting the scalability and impact of PI innovations. Newly launched projects like Shift2Zero and IKIGAI aim to further explore digitalisation and PI implementation to decarbonise and optimise logistics operations.

The Physical Internet promises unprecedented gains in efficiency, interoperability, automation, and the seamless movement of goods across global supply chains. Yet these benefits come with meaningful risks, including new forms of operational dependency, systemic vulnerabilities, and potential disruptions that extend beyond traditional logistics failures. Such risks stem not only from technical breakdowns or unexpected emergent behaviours within interconnected networks, but also from a deeper misalignment between digitally driven, hyper-connected logistics architectures and governance frameworks built for slower, more siloed systems. As its name implies, the Physical Internet transforms logistics into a shared, networked ecosystem with rules and logics distinct from legacy transport and warehousing models. Implementing it without robust risk assessment and updated governance mechanisms may undermine resilience and trust, both of which are essential for the long-term success of the Physical Internet.

2.1. The concept of Physical Internet (PI)

The Physical Internet Initiative promoted research efforts around 2011 by Benoit Montreuil who organised a project called the Physical Internet Initiative at the University Laval in Canada. It applied concepts from internet data transfer to real-world shipping processes to bring the efficiency, modularity and interoperability of the digital internet to physical logistics: i.e. to treat freight, warehousing, and transport networks as interconnected, shared systems rather than isolated supply-chains. On a European scale, ALICE, since 2013, has been working as a key platform to promote the concept, coordinate research, innovation and market deployment for PI. ALICE published its official "Roadmap to the Physical Internet"[1] in 2020, marking an important milestone: the roadmap outlines a vision and concrete pathway towards a fully operational, open logistics network by mid-21st century, supported by shared infrastructure, standardised modular load units and interoperable logistics nodes.

[1] Roadmap to the Physical Internet" — Executive version (ALICE, 2020)

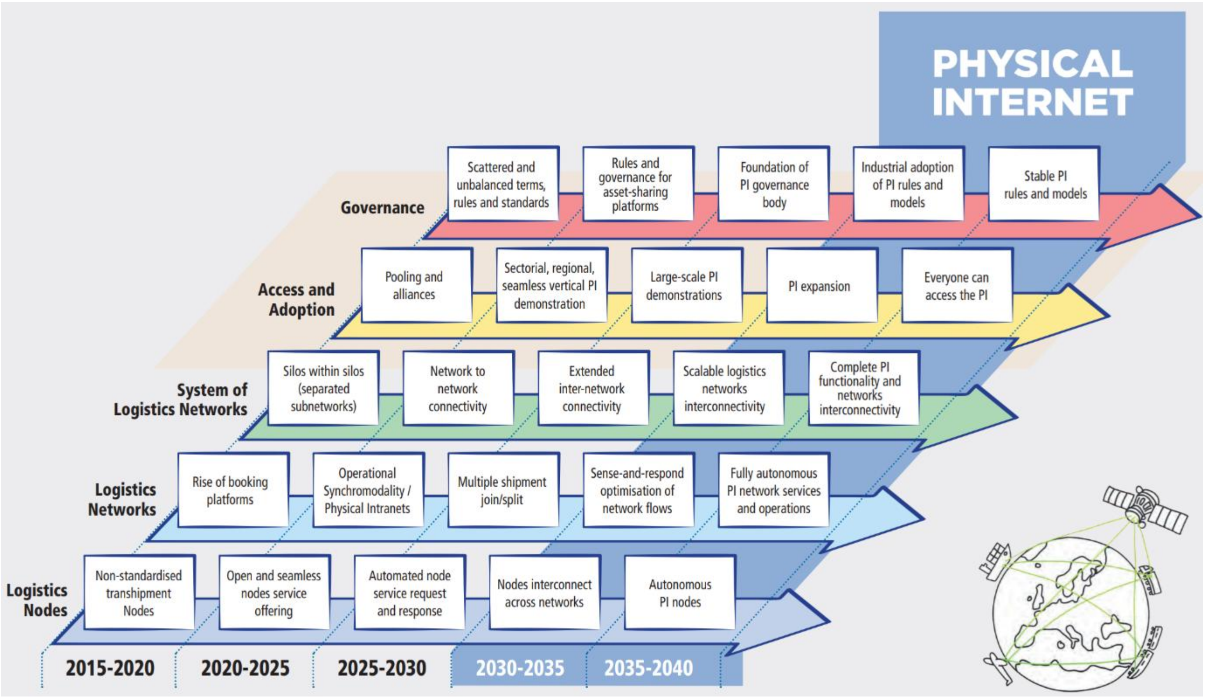

Figure 1 Roadmap to Physical Internet from ALICE

2.2. Physical Internet in Research and Innovation Projects in Europe

Since then, the roadmap has guided multiple European and regional research and pilot efforts, with PI gradually shifting from conceptual vision to practical experiments and implementations. Research and innovation projects funded by Horizon 2020 (H2020) and Horizon Europe (HE) that contributed to the PI implementation have been summarised by the BOOSTLOG Deliverable (published 2023) 2.8 Cloud Report (V) Physical Internet including Modularisation and Transhipment technologies[2]. Research and innovation projects continue to evolve in response to the challenges facing the logistics sector, and their contributions to Physical Internet (PI) implementation are increasingly evident. Whether intentional or not, these initiatives have laid important foundations for the development of a PI-enabled logistics network.

The following tables provide examples of research and innovation projects funded by Horizon 2020 and Horizon Europe that have contributed to transition from logistics nodes to PI nodes.

[2] https://www.etp-logistics.eu/wp-content/uploads/2023/06/BOOSTLOG_D2.8-Cloud-Report_Physical-Internet_v2.1.pdf

Table 1 EU funded Research and Innovation Projects that have contributed to transition from logistics notes to PI nodes

PI Roadmap	Research and innovation projects	
	Initiated in 2015 - 2020[3]	Initiated in 2020 – 2025[4]
Transition from logistics nodes to PI nodes	Clusters 2.0 LESS THAN WAGON LOAD ePIcenter	PIONEERS Stargate within EU Green Deal MAGPIE SMART GREEN PORTS MultiRELOAD PORT SOLUTIONS FOR SUSTAINABLE MOBILITY FOR FREIGHT

[3] **Cluster 2.0**, funded by H2020 in 2018; Grant agreement ID: 723265
LessThanWagonLoad, funded by H2020 in 2017; Grant agreement ID: 723274.
ePIcenter (Enhanced Physical Internet-Compatible Earth-frieNdly freight Transportation answER), funded by H2020 in 2020; Grant agreement ID: 861584.

[4] **PIONEERS**, funded by H2020 in 2021; Grant agreement ID: 101037564
STARGATE (SusTainable AiRports, the Green heArT of Europe), funded byH2020 in 2021; Grant agreement ID: 101037053
MAGPIE (sMArt Green Ports as Integrated Efficient multimodal hubs), funded by H2020 in 2021; Grant agreement ID: 101036594
MultiRELOAD, funded by Horizon Europe in 2022; Grant agreement ID: 101069796
FOR-FREIGHT (Flexible, multi-modal and Robust FREIGHt Transport), funded by Horizon Europe in 2022; Grant agreement ID: 101069731.

Collectively, these projects illustrate key dimensions of the transition from legacy logistics nodes to PI-nodes:

- Modal shift & consolidation: projects like LessThanWagonLoad and MultiRELOAD enable inclusion of small shipments and inland waterways/rail into shared node frameworks, increasing intermodality and reducing road reliance. LessThanWagonLoad demonstrates how legacy freight (especially small shipments) can be aggregated into a hub-and-rail framework, increasing intermodal use, reducing road-dependency, and boosting network resilience, which are all essential features of a PI-node.
- Digital & collaborative infrastructure: ePIcenter and FOR-FREIGHT build crucial elements for a “soft layer” overlaying the physical network, such as the software backbone, data sharing, real-time tracking, decision support and network visibility. ePIcenter addresses one of the main enablers of PI: shared digital infrastructure and interoperability among diverse actors, making classical nodes more connected, flexible, and PI-ready. FOR-FREIGHT’s scope and tools contribute significantly to demonstrating how different kinds of nodes (sea, air, rail, inland) can be orchestrated in a unified and interoperable network, moving away from fragmented, mode-specific infrastructures toward a PI-style system.
- Modern, multimodal hubs: MAGPIE and MultiRELOAD reimagine ports, inland terminals, and inland ports as green, automated, multimodal hubs. These physical PI-nodes that can handle π-containers, cross-dock, handle transshipment, and integrate different transport modes under shared standards. MAGPIE illustrates how port infrastructure (a crucial node type) can evolve into PI-compatible hubs combining sustainability, automation, and multimodal connectivity. MultiRELOAD’s emphasis on multimodal inland nodes, digital coordination, and modal shift makes it a practical stepping stone from siloed terminals toward a network of interoperable, shared nodes, which increases the feasibility of the Physical Internet.
- Experimentation & real-world validation: all projects deploy pilots or demonstrators to test PI-oriented concepts in actual logistics settings. This is essential to bridge the gap between theoretical PI visions and practical, scalable implementation.

These efforts together lay much of the foundation for a PI-enabled logistics network: shared infrastructure and services, interoperable nodes and corridors, digital coordination, greener multimodal transport, and more efficient resource use. While full PI adoption remains a long-term goal, these projects show that Europe is progressively building the architecture, physical and digital, to make PI-nodes a reality.

Table 2 EU funded Research and Innovation Projects that have contributed to transition from logistics networks to Systems of logistics networks

PI Roadmap	Research and innovation projects	
	Initiated in 2015 - 2020[5]	Initiated in 2020 – 2025[6]
Transition from logistics networks to Systems of logistics networks	ICONET planet COG LO LOGISTAR Synchro-NET	ADMIRAL TRACE inTegration & haRmonizAtion of logistiCs opErations

Together, these projects represent vital building blocks toward a future logistics ecosystem structured not as a set of separate supply-chains, but as a network-of-networks (interconnected hubs, dynamic flows, shared digital infrastructure, multimodal integration and collaborative governance, etc.). They show how incremental innovations (in ICT, optimisation, governance, mode integration) can gradually transform existing logistics nodes and chains into a system aligned with the vision of the Physical Internet.

Across these projects, some common patterns emerge, which illustrate the shift from traditional, siloed logistics nodes to networked systems:

- **Digital backbone & interoperability:** projects like ICONET, COG-LO, PLANET and TRACE build ICT/IoT architectures, common protocols, platforms, and digital marketplaces

[5] ICONET, funded by H2020 in 2018; Grant agreement ID: 769119
PLANET, funded by H2020 in 2020; Grant agreement ID: 860274
COG-LO (COGnitive Logistics Operations), funded by H2020 in 2018; Grant agreement ID: 769141
SYNCHRO-NET, funded by H2020 in 2015; Grant agreement ID: 63635
[4] TRACE, funded by HE in 2023; Grant agreement ID: 101104278
ADMIRAL, funded by HE in 2023; Grant agreement ID: 101104163

which enable different actors, modes, and hubs to communicate, coordinate, and share resources.

- **Dynamic, adaptive operations:** rather than fixed transport chains, systems become flexible. These use dynamic routing, real-time re-scheduling, load consolidation, ad-hoc collaborations, and adaptation to demand or disruption as promoted by COG-LO, TRACE, SYNCHRO-NET.
- **Multimodality and modal integration:** through synchromodality (SYNCHRO-NET), global corridor integration (PLANET), and marketplace logic (ADMIRAL), these projects enable a truly networked logistics system by shifting between transport modes (road, rail, sea, inland waterways), integrating ports, terminals, hinterland.
- **Shared infrastructure and services:** warehousing-as-a-service, synchromodal routing, shared platforms for contracting and planning (ICONET, ADMIRAL) offer a major building block of a Physical Internet through collective approach, rather than company-specific infrastructure.
- **Sustainability and efficiency goals:** modal shift, load consolidation, and optimised routing all contribute to reduced emissions, fewer empty runs, better asset utilisation, which fits the broader aim of a green, resilient logistics network.
- **New governance / collaboration models:** through federated networks (PLANET), shared marketplaces (ADMIRAL), and collaborative, ad-hoc networks (COG-LO), the projects explore new business models and governance structures needed to manage logistics as a network rather than isolated supply-chains.

2.3. PI Implementation in Japan: The Physical Internet Maturity Model (PIMM)

The Japan Physical Internet Centre has developed the Physical Internet Maturity Model (PIMM) as a systematic framework for assessing the implementation of Physical Internet (PI) principles. The PIMM provides objective criteria for evaluating PI-related achievements, establishes a common conceptual language linking macro-level roadmap objectives with micro-level operational practices, and enables continuous improvement as well as comparative assessment across organisations and contexts. A central contribution of the PIMM is its explicit alignment of PI roadmap objectives with measurable, organisation-level evaluation criteria. While PI roadmaps define desired target states (such as collaborative governance structures, standardised and digitised data platforms, horizontal and vertical integration, and automated logistics hubs), the PIMM operationalises these ambitions through a structured set of evaluation dimensions that capture how PI principles are realised in practice.

Governance-related objectives are addressed through the Ecosystem Formation dimension, which evaluates the presence and effectiveness of governance structures, the articulation of shared goals, mechanisms for performance evaluation, and the equitable distribution of responsibilities and benefits among stakeholders. The objective of establishing standardised and digitised logistics and commercial data platforms is operationalised in the Data and Digitalisation dimension, which assesses the extent of data standardisation, interoperability, and digital connectivity across organisational boundaries. Objectives related to horizontal collaboration, logistics hubs, and automation of transport equipment are captured by the Synchronisation of Space (Assets) dimension, which measures the degree of standardisation, openness, and shared use of physical assets and infrastructure across actors.

Finally, objectives concerning end-to-end supply chain integration, encompassing both B2B and B2C flows, are reflected in the Synchronisation of Time (Processes) dimension. This dimension evaluates the coordination, standardisation, and digital integration of business processes across organisational and functional boundaries. Through these four dimensions, the PIMM provides a rigorous, multidimensional framework for evaluating PI implementation, bridging strategic ambitions with operational realities, and supporting both comparative benchmarking and the continuous refinement of PI practices across diverse logistics contexts.

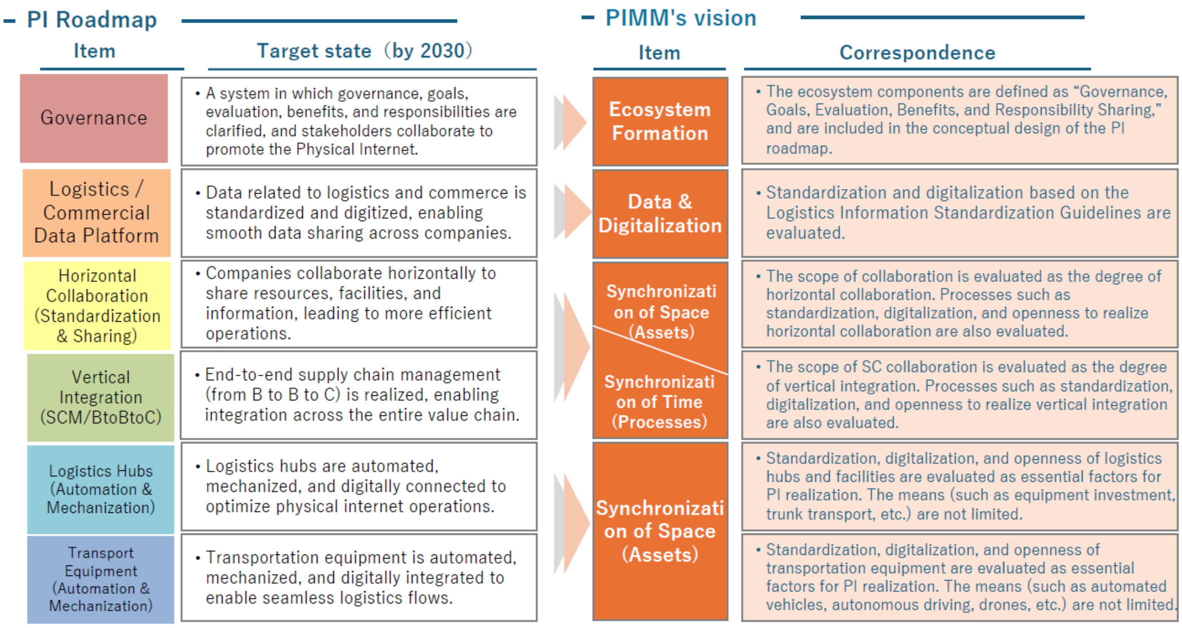

Figure 2. Mapping between Physical Internet Roadmap Targets and PIMM Evaluation Dimensions, by Prof. Takayuki Mori

Maturity Levels and Evaluation Framework

The PIMM evaluation framework is organised around four PI dimensions that together capture the transformation required for Physical Internet implementation: asset sharing, process synchronisation, data and digital utilisation, and ecosystem formation. Each logistics component, such as containers, transportation processes, or warehouse operations, is assessed through one or more PI perspectives (standardisation, openness, collaboration, and digitalisation), ensuring that both technical and organisational aspects are considered.

The model defines five maturity levels, representing a progression from isolated logistics operations to a fully realised Physical Internet ecosystem.

At **Level 1**, PI-related practices are largely absent, with company-specific assets, closed data, and minimal coordination.

At **Level 2**, organisations focus on internal optimisation, introducing standardisation or digitalisation within company boundaries but without interoperability.

At **Level 3**, initial collaboration emerges, with selective sharing of assets, data, or processes, often within a single industry.

At **Level 4**, PI principles are applied at a network or industry level, enabling broader interoperability, coordinated operations, and shared optimisation.

At **Level 5**, a mature PI ecosystem is achieved, characterised by fully standardised, open, and collaboratively managed assets, processes, and data across multiple industries, supported by stable governance mechanisms.

PI components	Components of logistics	PI's perspective	Level1	Level2	Level3	Level4	Level5
Asset sharing	Container	Standardization	Undeveloped	Individual optimization	Individual collaboration	Single-level	Multi-level
		Openness	Closed	—	Partially open	—	completely open
		Collaboration	Independent operation	—	limited collaboration	Partial collaboration	Complete collaboration
	In-warehouse equipment	Standardization	Undeveloped	Individual optimization	Individual collaboration	Single-level	Multi-level
		Openness	Closed	—	Partially open	—	completely open
		Collaboration	Independent operation	—	Partial collaboration	—	Complete collaboration
Process synchronization	Business process (transportation)	Standardization	Undeveloped	Individual optimization	Collaboration with other companies	Single industry	Multiple industries
		Openness	Closed	—	Partially open	—	completely open
		Collaboration (Horizontal)	Independent operation	—	Single industry/one company	Single industry/multiple companies	Multiple industries
		Collaboration (Vertical)	Independent operation	—	Partial collaboration	Small business partners	Multiple business partners
	Business process (warehouse operations)	Standardization	Undeveloped	Individual optimization	Collaboration with other companies	Single industry	Multiple industries
		Openness	Closed	—	Partially open	—	completely open
		Collaboration	Independent operation	—	Single industry/one company	Single industry/multiple companies	Multiple industries
Data and digital utilization	Container	Digitalization	Analog	Data conversion	System Integration	Visualization/Analysis/ Improvement	Overall optimization
	In-warehouse equipment		Analog	Data conversion	System Integration	Visualization/Analysis/ Improvement	Overall optimization
	Transportation equipment		Analog	Data conversion	System Integration	Visualization/Analysis/ Improvement	Overall optimization
	Business process (transportation)		Analog	Data conversion	System Integration	Visualization/Analysis/ Improvement	Overall optimization
	Business process (transportation)		Analog	Data conversion	System Integration	Visualization/Analysis/ Improvement	Overall optimization
Ecosystem creation	Ecosystem Components		Level1	Level2	Level3	Level4	Level5
	Governance		Undeveloped	—	Maintenance & Operation	—	Maintenance & Operation
	Goals and Evaluation		Undeveloped	—	Maintenance & Operation	—	Maintenance & Operation
	Profit/responsibility distribution		Undeveloped	—	Maintenance & Operation	—	Maintenance & Operation

Figure 3. Physical Internet Maturity Model (PIMM): Evaluation Framework Across Components and Maturity Levels, by Prof. Takayuki Mori

A key strength of the PIMM lies in its component-based evaluation logic. Rather than producing a single maturity score, organisations assess their maturity across individual components and dimensions, allowing uneven development to be identified and targeted improvement actions to be prioritised. In this way, the PIMM does not prescribe how PI must be implemented; it provides a structured framework to understand where organisations stand, what is missing, and how far they are from a fully interoperable Physical Internet ecosystem.

2.4. PI Vision in South Korea: Logistics Alliance for Physical Internet (LAPI) Concept & Practices

In Korea, the concept of LAPI illustrates how logistics assets can be shared across regions and industries. It presents a multi-dimensional view of the logistics network, where different stakeholders (shippers, industrial complexes, domestic operations, overseas operations) interact across product categories such as food and beverages, fashion and cosmetics, industrial goods, and raw materials. Each element of the framework represents a combination of unit loads, nodes, protocols, and movers, showing how interoperability and coordinated asset use can enhance efficiency and connectivity throughout the logistics ecosystem.

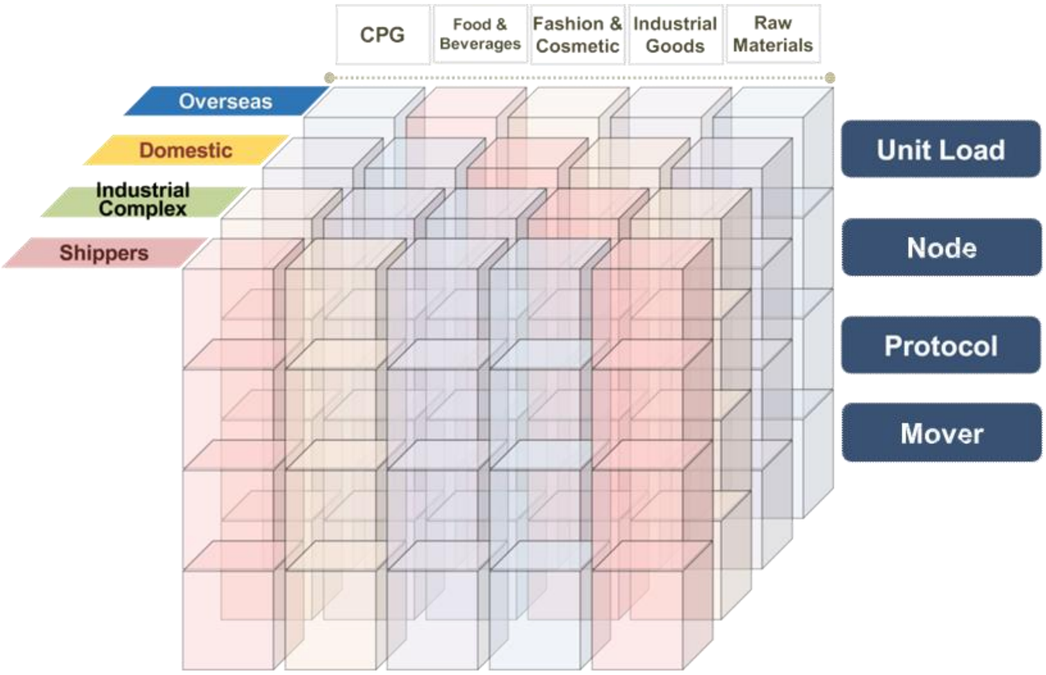

Figure 4. The concept diagram of LAPI, by Heewon Chae

To realise the concept, a roadmap has been developed covering the period from 2024 to 2034. The introduction stage, spanning 2024 to 2026, focuses on piloting reusable unit load systems, establishing initial standards, and building foundational capabilities. From 2027 to 2029, the leap stage aims to accelerate adoption, scale shared logistics models, and strengthen interoperability across the ecosystem. The settlement stage, from 2030 to 2032, emphasises consolidation, operational stabilisation, and refinement of governance mechanisms. Finally, the expansion stage in 2033 and 2034 targets broader deployment, cross-border integration, and further scaling of the LAPI ecosystem.

The LAPI roadmap is structured around three complementary tracks:

1. Standards for unit loads and protocols: establish common standards and operational protocols to ensure interoperability, traceability, and efficiency across the entire logistics ecosystem. This track provides the technical foundation for seamless integration of reusable unit load systems across companies and borders.

2. Models for shared and efficient logistics operations: develop frameworks for the collaborative use of physical logistics infrastructure (nodes) and transportation assets (movers). By enabling pooling and optimised deployment, this track maximises asset utilisation, reduces costs, and improves operational efficiency.

3. Governance for sustainable ecosystem growth: implement governance mechanisms that support stable, long-term operation of the LAPI ecosystem. This includes transparent cost–benefit allocation, consensus-building among stakeholders, and policies that foster trust, compliance, and sustainable growth.

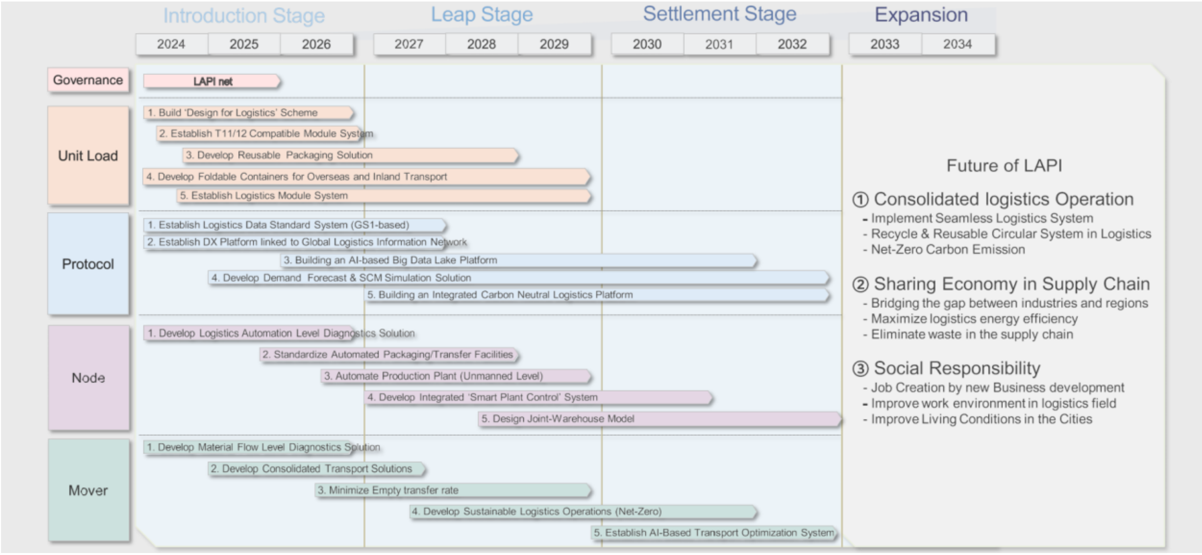

Figure 10. The roadmap of LAPI, by Heewon Chae

Unit load solutions include several concrete examples that illustrate how reusable unit load systems are already being implemented in Korea and internationally. RRPP (Reusable and Returnable Plastic Pallet) is an eco-friendly pallet made from recyclable and reusable materials and designed to be highly hybrid and interoperable. Equipped with RFID and tag-based identification, it enables tracking and asset management across logistics networks and has already been adopted in multiple countries, demonstrating strong potential for international scalability.

RRCC (Reusable and Returnable Collapsible Container) is intended to replace single-use cardboard boxes with multi-use, collapsible containers. Pilot tests conducted with seven companies in Korea, supported by ongoing collaboration with a food industry client, demonstrate how these containers can be integrated into existing logistics operations while reducing packaging waste and overall costs.

CoCon (Cold Container) addresses cold-chain requirements in last-mile delivery by providing insulated cooling and incorporating antibacterial materials to ensure hygiene. After delivery, containers are collected, washed, serviced, and restored to their original condition. Smart tracking technologies enable continuous monitoring of location and content conditions throughout the container lifecycle.

Foldcon (Foldable Container) offers a highly flexible solution that can be folded using a forklift and two workers. When folded, its volume is reduced to one quarter of its original size, allowing four times more empty containers to be transported simultaneously. This significantly reduces storage and transportation costs while improving handling efficiency across logistics hubs.

3. Urban Logistics: Advanced PI Implementation

Urban logistics systems are facing increasing structural pressure. Rapid growth in e-commerce has led to a sharp rise in delivery volumes and delivery frequency, while available urban space for logistics activities continues to shrink due to competing uses and urban densification. At the same time, cities are under growing pressure to meet climate and environmental objectives, including reductions in emissions, noise, congestion, and safety risks. These combined challenges expose the limits of traditional, vehicle-centric and operator-specific last-mile logistics models. In response, innovation efforts have increasingly focused on shared assets, more efficient use of urban space, and flow consolidation mechanisms. Solutions such as micro-hubs, nearby delivery areas, shared lockers, and modular loading units represent direct implementations of Physical Internet principles in urban contexts, demonstrating how shared infrastructure and coordinated operations can reduce externalities while maintaining or improving service quality.

3.1. Modular Vehicles, Loading Units, and Right-Sized Urban Distribution

One of the PI implementation achievements in urban logistics is the development of modular, swappable loading units that decouple freight from vehicles. The modular swap box presented in figures 4 and 5 (Paxster Swap Box) embodies key PI principles: modularity, interoperability, and rapid transferability across transport modes and vehicle sizes.

Figure 5. Example of a Modular, Foldable, and Stackable Loading Unit for Urban Distribution – Paxster Swap Box, by Arild Brudeli , Paxster & Dr. Yanying Li (presenting the Shift2Zero Project).

The Paxster Swap Box[7] has been designed to be foldable, stackable, and fully digital, equipped with a smart sensor and a digital locking system. These features enable real-time monitoring of operational status, including door opening, temperature, and movement, while ensuring secure

[7] https://paxster.no/news/paxster-contributes-to-the-future-of-zero-emission-urban-logistics-through-shift2zero/

handling throughout the delivery process. A key achievement lies in the ability to transfer these units in less than one minute from larger electric light commercial vehicles (eLCVs) to smaller last-mile delivery vehicles, allowing rapid and automated redistribution without re-handling individual parcels, which is a foundational principle of the PI.

The integration of modular loading units with right-sized, mission-specific electric vehicles further reinforces this approach. Instead of relying solely on large delivery vehicles entering dense urban areas, the system supports a layered distribution logic in which consolidated shipments are transported by larger eLCVs to micro-depots located near city centres, while smaller electric vehicles collect swap boxes from these locations to perform last-mile delivery. This configuration reduces the presence of large vehicles in constrained urban areas, improves accessibility, and contributes to lower energy consumption and emissions.

Figure 6. Small Electric Vehicles Used for Urban Last-Mile Delivery, by Dr. Yanying Li for Shift2Zero Project.

Digitalisation operates as a transversal enabler of these PI-oriented urban logistics operations. The modular loading units are integrated into digital control and energy management systems, supporting real-time tracking and status monitoring, cold-chain management through multi-temperature cargo bodies, and interaction with vehicle energy systems such as regenerative braking or bidirectional charging. These digital capabilities enable data-driven optimisation of routes, space utilisation, and asset allocation, demonstrating that PI implementation relies on the tight coupling of physical modularity and digital coordination.

3.2. Micro-Hubs, Shared Infrastructure, and Data-Enabled Coordination

A central achievement of PI implementation in urban logistics is the effective use of shared assets to address space constraints in dense cities. Rather than relying on individual, proprietary infrastructure, recent initiatives emphasise facilities and equipment that can be jointly accessed by multiple operators, enabling more efficient use of limited urban space and reducing redundancy.

Micro-hubs and shared parcel lockers exemplify this approach. These assets function as intermediate nodes that consolidate flows, facilitate last-mile distribution, and allow multiple logistics providers to coordinate operations without requiring additional infrastructure. In Bologna, for instance, publicly owned locker infrastructure on municipal land serves as a shared transshipment point, linking conventional freight vehicles with low-impact last-mile modes such as electric tricycles. By enabling multiple actors to use the same facilities, these shared assets increase operational efficiency, reduce urban congestion, and support more sustainable logistics practices.

This focus on shared infrastructure reflects a broader principle of the Physical Internet: that collaborative, multi-actor management of physical assets is essential to optimising logistics in constrained environments. Through shared micro-hubs and parcel lockers, cities can implement modular, flexible, and scalable solutions that maximise the utility of limited space while fostering cooperation among diverse stakeholders.

Figure 7. Urban Parcel-lockers implemented in Bologna by Lorenzo Cello for the URBANE Project.

The URBANE and DISCO projects have established shared micro-hubs in city centres, providing a practical demonstration of Physical Internet principles in urban logistics. These hubs serve as intermediate nodes for the consolidation and deconsolidation of flows close to final demand, supporting low- or zero-emission vehicles and reducing the need for large freight vehicles to enter dense urban areas. By enabling multiple logistics operators to use the same infrastructure, coordinated through a common digital platform, the projects have achieved measurable improvements in efficiency, including reductions in travel distances and vehicle kilometres, lower CO_2 emissions, and higher first-attempt delivery success rates.

These experiences highlight that micro-hubs are more than technical installations; they constitute urban logistics infrastructure that requires public ownership, regulatory support, and integration into city planning instruments such as Sustainable Urban Mobility Plans. The digital platform layer is a critical enabler, orchestrating parcel assignments, monitoring real-time availability, and facilitating coordination across conventional carriers, last-mile operators, and end users while maintaining data privacy and commercial confidentiality.

While the pilots demonstrate the feasibility and benefits of shared assets, they also reveal operational and institutional limitations, such as capacity constraints, locker size restrictions, additional costs for operators, and the need for regulatory updates. These findings indicate that scaling and replicating shared micro-hubs will require further standardisation, governance alignment, and integration with existing logistics systems, reinforcing the importance of collaborative, multi-actor approaches in Physical Internet implementation.

3.3. The Role of Public Governance in Urban PI Deployment

The active involvement of public authorities is a critical enabler of Physical Internet implementation in urban logistics. In the case of modular loading units and swap-box systems, authorities provide the regulatory and spatial conditions necessary for their effective operation, including access to suitable transshipment areas, authorisation for on-street or near-street exchanges, and alignment with safety, mobility, and environmental regulations. Without such support, the transfer and redistribution of modular units between vehicles would be challenging to implement at scale in dense urban environments.

Local and regional authorities have further facilitated PI deployment by granting access to publicly owned infrastructure and urban space, enabling the installation of shared parcel lockers and micro-hubs on municipal land, and supporting governance arrangements that allow multiple logistics operators to use these assets collaboratively. These experiences demonstrate that successful Physical Internet implementation in cities depends on more than private-sector innovation; public authorities play an essential role in creating the conditions for scalable, efficient, and cooperative logistics networks.

4. Standard Development for Logistics Innovation Related to Urban Logistics & PI

Standardisation plays a central role in enabling innovation within the logistics sector. By establishing shared rules, formats, and technical specifications, standards act as a foundation on which interoperable systems, efficient processes, and new business models can be built. In an increasingly complex and digitalised supply chain landscape, standardisation reduces uncertainty, lowers transaction costs, and accelerates the adoption of innovative solutions across diverse actors and geographies.

4.1 The Roles and Impacts of Standardisation

Standardisation is a driver for several strategic dimensions of logistics transformation:

- **Regulation:** standards help shape and support regulatory frameworks by providing stable, recognised references. They offer a common technical language that public authorities can use to ensure safety, security, and compliance across supply chains.
- **Market Transparency:** harmonised standards increase clarity regarding products, services, processes, and data formats. Transparent markets allow actors to compare offerings, reduce information asymmetry, and foster fair competition.
- **Interoperability and Competitiveness: i**nteroperability is essential in logistics, where numerous actors, modes, and systems interact. Standards ensure technical and operational compatibility, reducing barriers between companies and enabling efficient multimodal and cross-border operations.
- **Market Opening or Protection:** standards can promote open markets by allowing new actors to participate on equal terms. Conversely, proprietary or restrictive standards can protect strategic capabilities at the national or corporate level. The balance between openness and protection is a strategic choice.
- **Service Deployment and Risk Mitigation:** the existence of shared specifications facilitates the rapid deployment of new services. Standardised frameworks reduce risks for adopters, which is particularly important in innovation-led environments.
- **Digitalisation:** the digital transformation of logistics relies heavily on standardised data models, communication protocols, and identifiers. Without these, digital interoperability and automation remain limited.

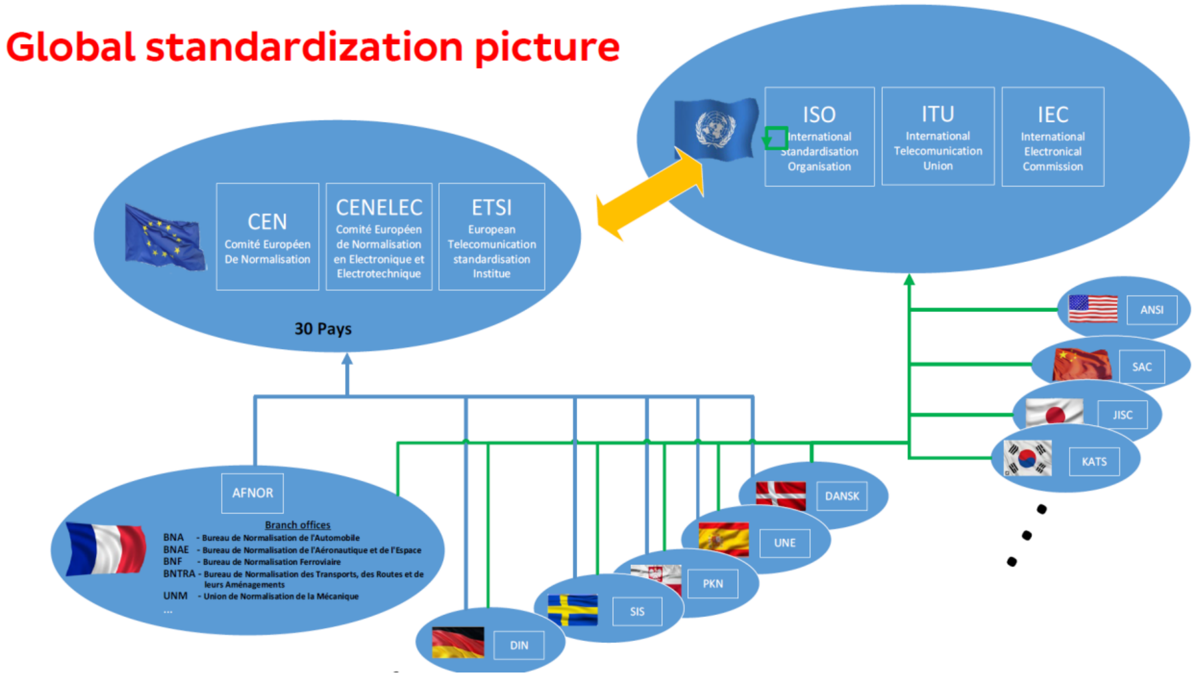

Figure 8 Global standardisation picture; by Bruno Gadal

As logistics moves toward more interconnected, automated, and sustainable models, standardisation becomes a prerequisite for innovation. Whether enabling the Physical Internet paradigm, supporting PI-driven optimisation, or facilitating the deployment of green logistics solutions, standardised frameworks ensure that innovation can scale across the entire ecosystem. Far from being a constraint, standardisation is one of the strongest enablers of logistics transformation.

4.2 ISO Development in Urban Logistics

4.2.1 Overview of ISO Technical Committee 344

ISO Technical Committee 344 (ISO TC 344) was established to address the need for standardisation in innovative logistics, focusing on interoperability and scalability across logistics networks. Its scope concentrates on the distribution of goods from manufacturers and distributors to regional hubs, distribution centres, and urban businesses, rather than on end-to-end supply chains. The committee aims to improve the quality, safety, efficiency, flexibility, and sustainability of logistics operations, reflecting both economic and societal priorities.

ISO TC 344 is organised into two main subcommittees. SC1 (Retail Logistics) focuses on urban and consumer-facing logistics, including parcel lockers, unmanned retail environments, and last-mile delivery, while SC2 (Courier Services) addresses sustainability, courier logistics fundamental and organisational frameworks. Across both subcommittees, there is a strong emphasis on harmonising physical and digital processes, enhancing interoperability, and strengthening system-level resilience.

The committee includes broad international participation and is developing multiple standards covering terminology, ESG frameworks, use cases, and operational requirements. At the committee level, ongoing work includes green logistics use cases, an ESG framework for innovative logistics, and a shared logistics vocabulary to support cross-domain coordination.

SC1 plays a central role by addressing retail and urban logistics, where operational complexity and societal impacts are most pronounced. Retail logistics is defined as the set of processes enabling the efficient flow of goods from suppliers to stores and final consumers, encompassing inventory management, warehousing, distribution, and last-mile delivery across both physical retail and e-commerce. Current standardisation efforts respond to challenges such as rising last-mile costs, labour shortages, supply chain disruptions, and technological fragmentation, with a focus on micro-fulfilment, urban hubs, parcel lockers, unmanned stores, last-mile delivery, and reverse logistics. Examples of retail logistics are:

- Micro-fulfilment
- Consumer logistics
- Self-storage/parcel locker
- Reverse/catering logistics
- Last mile delivery
- Unmanned store/dark store

The following figure shows the business boundary (defined on 12 June 2025):

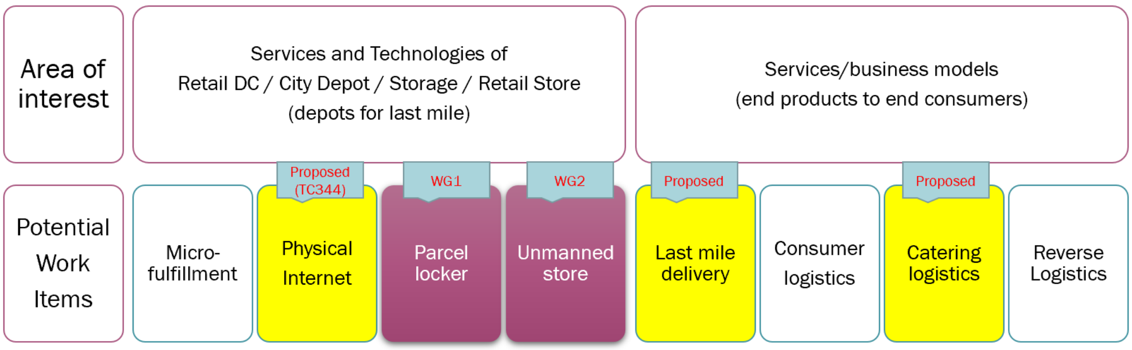

Figure 9 Business boundary of Retail Logistic; by Dr. Jongkyoung Kim

A key ongoing task involves establishing general requirements and quality inspection methods for parcel lockers (ISO/CD 25414), as well as defining the classification (ISO CD 25525-1) and requisite service architecture (ISO CD 25525-2) for unmanned stores.

4.2.2 Standardisation of Unmanned Retail and Last-Mile Delivery Systems

Retail logistics is moving toward the operationalisation of unmanned stores, which require new reference architectures and service definitions extending beyond traditional retail standards. A key concept introduced in this context is **Unmanned Store as a Service (USaaS)**, which frames unmanned retail environments as modular, service-based systems rather than isolated technological deployments described in ISO CD 25525-2. This approach supports scalability, interoperability, and seamless integration with last-mile delivery systems, aligning closely with Physical Internet principles of modularity, service interoperability, and shared infrastructure.

USaaS relies on standardised service architectures that connect unmanned retail spaces, fulfilment and warehouse operations, last-mile service providers, and end consumers. Such architectures are positioned as critical building blocks for PI-aligned retail logistics, enabling shared infrastructures, standardised interfaces, and coordinated service provision across multiple actors.

To illustrate how this can be operationalised, a layered USaaS architecture was presented, structuring unmanned retail logistics as a modular, service-oriented system in which business functions, operational services, applications, data, and physical infrastructure are clearly separated yet interoperable.

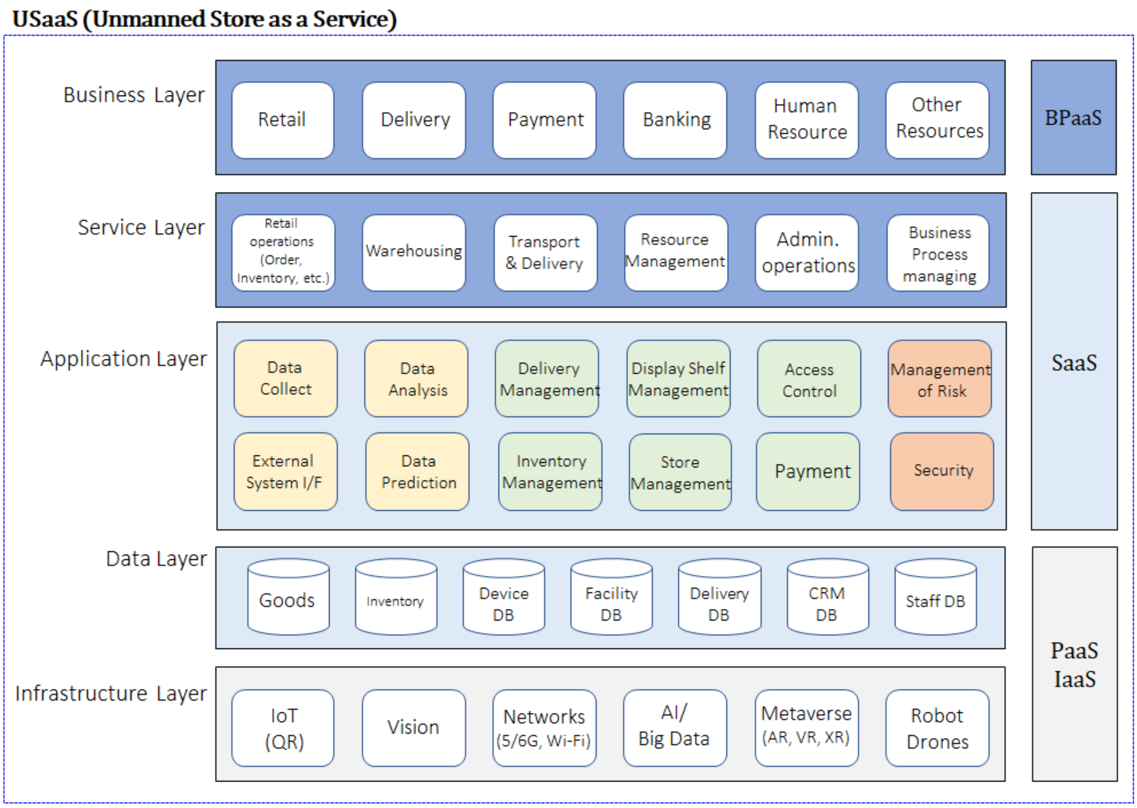

Figure 10. Unmanned Store as a Service (USaaS): Layered Service Architecture for AI-Driven Retail Logistics, by Kerri Ahn

The USaaS architecture is organised into five interrelated layers:

- The **Business Layer** captures high-level retail and enterprise functions, including retail operations, delivery, payment, banking, human resources, and other supporting services. This layer reflects how unmanned stores are embedded within broader commercial and organisational ecosystems. It can be carried out by combining modules from the relevant lower layers in accordance with the corresponding business processes.

- The **Service Layer** translates these business functions into operational logistics services, such as order and inventory management, warehousing, transport and delivery, resource management, administrative operations, and business process management. This layer supports core logistics services that must be standardized to enable interoperability among providers by performing functionalities that manage workflows for unmanned store business processes.
- The **Application Layer** implements these services through concrete digital functions, including data collection and analysis, delivery and inventory management, shelf and store management, access control, payment, risk management, and security. It also enables predictive capabilities, such as demand forecasting and maintenance planning, which are essential for AI-driven retail logistics. For interoperability, it should refer to loosely coupled, interoperable, and independent components that represent the tasks of unmanned stores through a common, standardized interface.
- The **Data Layer** provides the shared information backbone of the system, integrating data related to goods, inventory, devices, facilities, delivery operations, customer relationships, and staff. This layer is critical for ensuring traceability, transparency, and real-time coordination across unmanned retail and last-mile delivery operations.
- The **Infrastructure Layer** comprises the physical and digital technologies enabling unmanned operations, including IoT devices, vision systems, communication networks (5G, Wi-Fi), AI and big data platforms, immersive technologies (AR/VR/XR), and autonomous robots or drones. It is the area of LaaS that manages resources, including network and storage, in a cloud environment.

From a Physical Internet perspective, these developments underline the necessity of aligning rapid technological innovation with internationally agreed standards. AI-driven unmanned retail and last-mile delivery systems offer clear efficiency and sustainability benefits, but their large-scale deployment depends on standardised service models, interoperable data and AI architectures, and shared safety, performance, and traceability requirements. Last-mile delivery, in particular, is a critical application area for the PI, necessitating the establishment of identification and trusted verifiable credentials to ensure interoperability. The work presented contributes to the operational layer of PI implementation by addressing concrete technologies, services, and processes at the urban and retail interface, while also highlighting a key challenge for standardisation: maintaining sufficient flexibility to accommodate fast-evolving AI technologies while providing the structure needed to support interoperability, trust, and scalability.

4.3 Our View: The Importance of Standards in Enabling PI Implementation in Urban Logistics

Urban logistics provides one of the most concrete contexts in which the importance of standards for PI implementation becomes evident. Cities face increasing pressure from rising e-commerce volumes, limited availability of urban space, and ambitious climate objectives. These constraints make traditional, operator-specific logistics models inefficient and difficult to scale. In response, recent innovations in urban logistics have increasingly relied on shared assets and coordinated use of space, directly reflecting PI principles.

However, the effectiveness of such solutions depends fundamentally on standardisation. Shared urban logistics assets, such as micro-hubs, parcel lockers, and modular loading units, can only function as common resources if they are technically and digitally interoperable. Without standards, these assets remain proprietary, leading to duplicated infrastructures placed side by side, underutilisation of scarce urban space, and fragmented operations. Standardisation transforms these assets from isolated solutions into interoperable components of a shared urban logistics system.

Standards also play a critical role in enabling data-driven coordination. The shared use of urban logistics infrastructure requires real-time information on availability, access, size compatibility, and operational status. Without common data models and interfaces, such coordination depends on bilateral negotiations between operators, which is costly, slow, and incompatible with large-scale deployment. International standards, particularly at ISO level, provide a neutral and scalable foundation that allows assets and digital platforms to connect automatically across organisational boundaries.

From a governance perspective, standardisation is equally essential. Urban logistics infrastructure increasingly occupies public space and must be allocated in a way that avoids monopolisation while ensuring efficient use. Standards allow public authorities to mandate openness and interoperability without favouring specific operators or technologies. In this sense, standardisation supports fair access, competition, and transparency, aligning PI implementation with public-interest objectives in urban planning.

Finally, urban logistics demonstrates that PI implementation does not require the immediate standardisation of entire logistics systems. Instead, focusing on a limited number of high-impact elements, such as reusable loading units, shared lockers, and micro-hubs, can act as effective entry points. These elements serve as practical drivers for PI adoption, allowing standardisation and innovation to progress together while generating tangible operational and environmental benefits.

5. Towards a Physical Internet: A Transformative Vision

5.1. General Recommendations

As the logistics sector increasingly embraces Physical Internet principles, the importance of robust international standardisation becomes paramount. Global standards are essential to ensure interoperability, consistent data exchange, and seamless integration across diverse systems, operators, and geographies. Effective standardisation should address technical specifications, digital documentation, security protocols, and sustainable operational practices.

A critical next step is to focus on specific standardisation areas, particularly in retail and urban logistics. This includes prioritising the development of standards for parcel lockers, unmanned stores, micro-fulfilment centres, and last-mile delivery systems, as seen in ongoing ISO initiatives like ISO/WD 25414 and ISO/WD 25525. Standardised service models, such as Unmanned Store as a Service (USaaS), should be developed to ensure interoperability and scalability across urban logistics networks. Additionally, the adoption of a Physical Internet Maturity Model (PIMM) can provide a structured framework for organisations to assess their progress in implementing PI principles, covering dimensions such as asset sharing, process synchronisation, data utilisation, and ecosystem formation. Certification mechanisms, potentially managed by third-party bodies like the Japan Physical Internet Center (JPIC), can further incentivise adoption and ensure compliance.

Collaboration and governance must also be strengthened through trust-based frameworks, such as offline trustees and matchmaking platforms, to facilitate volume pooling and shared logistics resources. Aligning these efforts with regulatory frameworks, such as the EU Green Freight Package, will help avoid antitrust issues and foster horizontal cooperation. Leveraging digital transformation, including AI-driven automation for demand forecasting, inventory optimisation, and real-time data sharing, will enhance visibility and decision-making. Semantic interoperability should be addressed by developing a common logistics ontology and using AI translation tools to bridge communication gaps between fragmented systems. Sustainability and circular economy principles should be embedded by standardising reusable containers, pallets, and packaging (e.g., RRPP, RRCC, CoCon, Foldcon) and promoting circular logistics models through shared governance. Supporting SMEs and startups with compliance tools, digital platforms, and educational programs will ensure inclusive innovation and broad participation in the PI ecosystem.

Achieving this requires active collaboration among international organisations, industry consortia, and regulatory authorities. Unified frameworks can reduce fragmentation, facilitate cross-border operations, and lower barriers to innovation. In particular, standardising modular infrastructure, digital interfaces, and tracking systems will enable more efficient, transparent, and reliable supply chains that benefit all participants. Standards must remain adaptive to reflect emerging technologies such as AI-driven automation, IoT integration, and new logistics business models. Continuous stakeholder engagement and alignment with evolving best practices will ensure that standardisation supports both operational excellence and sustainability objectives.

To advance the transition toward a globally harmonised and sustainable Physical Internet, it is recommended to strengthen international collaboration through strategic partnerships with standard-setting bodies and industry groups. Prioritising interoperable platforms, digital documentation standards, and modular logistics infrastructure will enable flexibility and future-proof the sector against technological change. Promoting transparent data sharing and open access to best practices will foster trust and accelerate cross-border innovation. Investments in digital transformation (particularly in AI and IoT) should align with evolving global standards to maximise efficiency, resilience, and scalability.

Finally, embedding sustainability as a core objective through reusable assets, eco-efficient operations, and responsible resource management, will position logistics networks for long-term competitiveness and societal benefit. Ongoing education, collaborative learning, and a data-driven culture will be essential to securing leadership in an increasingly interconnected and rapidly evolving logistics landscape.

5.2. The way forwards: actions to take

To accelerate the transition toward a globally harmonised Physical Internet, it is essential to establish a dedicated ISO Technical Committee for PI. This committee would ensure global alignment and interoperability, harmonising frameworks like the PIMM and ALICE roadmaps into a unified standard. Pilot programs and industrial demonstrations, such as ALICE Express, URBANE, and DISCO, should be expanded to test and validate PI concepts in real-world settings, with successful models replicated across regions and sectors. Scaling these innovations requires scalable governance models for shared logistics infrastructure and cross-border collaboration between organisations like ALICE and JPIC. Addressing data and physical standardisation gaps is equally critical: implementing the Electronic Freight Transport Information (EFTI) Regulation will digitalise and standardise freight documentation, while AI-assisted interoperability tools can harmonise data exchange across diverse systems.

Physical standardisation of assets, such as pallets, containers, and loading units, should be prioritised to improve compatibility and efficiency. Incentives, such as PI awards and financial support, can encourage adoption, while performance metrics (e.g., volume feed, emission reductions) should be defined to track progress. Finally, education and awareness initiatives, including workshops, training programs, and public engagement campaigns, will build capacity and highlight the benefits of PI adoption for all stakeholders.

The PI vision relies on deep interoperability at all levels, be it physical, operational, informational, and organisational. However, realising this paradigm shift requires addressing several systemic challenges:

- Harmonising existing data exchange standards, identifiers, and documentation practices across countries and modes.
- Enabling compatibility between established logistics processes and emerging PI-oriented concepts such as smart modular containers, open logistics hubs, and shared transportation resources.

- Ensuring that standards evolve rapidly enough to keep pace with technological innovation, while remaining stable and reliable for global deployment.

To advance toward PI-enabled logistics networks, several priority challenges must be addressed:

- **Identifying existing standards and data models:** mapping the current landscape and understanding overlaps, gaps, and complementarities is a foundational step to avoid duplicating efforts or introducing unnecessary complexity.
- **Agreeing on what to use at this stage of knowledge:** stakeholders must converge on a shared baseline of standards and specifications that are mature, interoperable, and capable of supporting early PI implementations.
- **Studying necessary evolutions:** standards must evolve alongside technological developments, operational innovations, and sustainability requirements. A structured approach is needed to assess which standards require extension, revision, or replacement.
- **Convincing stakeholders to adopt common standards:** adoption is the most difficult step. It requires clear incentives, demonstrated benefits, governance structures, and mechanisms to ensure fair participation across the logistics ecosystem. Without broad adoption, even the best-designed standards remain theoretical.

6. Appendix

6.1. The International Workshop on 22nd October

6.1.1. Agenda

#	Duration	Activity
1	9:15 – 9:30	**Registration and welcome coffee**
2	9:30 - 10:45	**Opening session: Setting the scene**

Chaired by Dr. **Fernando Liesa**, Secretary General, ALICE

Speakers:

- Dr. **Jongkyoung Kim**, Korea Conformity Laboratories/Committee Manager of ISO TC344/SC1 and Chair of ISO TC122/SC4 (Packaging and the Environment); presentation on: "*Overview of ISO TC344 (Innovative Logistics)*"
- Prof. **Takayuki Mori**, Chairman of Japanese Physical Internet Centre: presentation on: "*JPIC's PI Maturity Model*"

Followed by a Q&A session

#	Duration	Activity
3	10:45 – 11:15	**Coffee Break**
4	11:15 – 12:45	**Physical Internet & research innovation**

Chaired by **Raffaele Vergnani**, POLIS

Speakers:

- **Heewon Chae**, LOGISALL Consulting, presentation on: "*LAPI concepts and practices, including examples of reusable containers*"
- **Paola Cossu**, CEO of FIT and coordinator of IKIGAI, presentation on: "*IKIGAI – Our vision with PI*"
- **Yanying Li**, ALICE, presentation on: "*Shift2Zero – Physical Internet in vehicle design and loading unit*"

Followed by a Q&A session

#	Duration	Activity
5	12:45 – 13:45	**Lunch break**
6	13:45 – 14:15	**Last mile delivery & urban logistics**

Chaired by **Yanying Li**, ALICE

Speakers:

- **Ioanna Fergadiotou**, Head of Inlecom Athens Office, presentation on: "*Urban Logistics Projects to implement PI*"
- **Kerri Ahn**, Logistics Information Expert, ISO TC344/SC1/WG2 Project Leader, The K Consulting, Korea, presentation on: "*Standardisation aiming for innovative Retail Logistics regarding unmanned store, last mile delivery, and AI Transformation for ISO TC344/SC1*"
- **Lorenzo Cello**, ITL, *"Innovation Projects in Bologna, Italy"*

7	14:15 – 15:00	**Break-out Session 1** **Room 1 - Digital interoperability:** data format, eFTI, data exchange, trust building etc **Room 2 - Physical interoperability assets:** from container, pallet, package to item
8	15:00 – 15:30	**Coffee Break**
9	15:30 – 16:15	**Break-out Session 2** **Room 1 - Physical interoperability assets:** from container, pallet, package to item **Room 2 - Digital interoperability:** data format, eFTI, data exchange, trust building etc
10	16:15 – 16:30	**Key outcomes of the Breakout sessions**
11	16:30 – 17:00	**Summary of the workshop and closing remarks by** *Claudia, Ribeiro*, POLIS

6.1.2. List of Participants

First Name	Last Name	Current Employer
Michael	Archer	Woking
Eric	Ballot	Mines Paris
Harrie	Bastiaansen	Groningen
Amalia	Bozinaki	Frontier Innovations
Lorenzo	Cello	Institute for Transport and Logistics Foundation
Paola	Chiarini	EC DG MOVE
Steve	Corens	VIL
Marion	Cottet	ALICE
Liz	Cristaldo	ALICE
Jean-Christophe	Deprez	Charleroi
Rod	Franklin	Kuehne Logistics University gGmbH
Bruno	Gadal	GeoPost
Jongkyoung	Kim	KCL
Suhyun	Kim	LOGISALL
Janne	Lausvaara	Kaarina
Francois-Regis	Le Tourneau	Paris
Alfonso	Molina Rico	citylogin
Takayuki	Mori	Japan Physical Internet Center (JPIC)
Wiebke	Mueller	Copenhagen
Gero	Niemann	Kühne Logistics University
Attallah Sabri M	Qweider	VUB

Claudia	Ribeiro	POLIS
Pierre	Roberts	ALICE
Pablo	Segura	ALICE
François	Tainturier	DGITM
Orestis	Tsolakis	Thessaloniki
Katsuhiko	Umetsu	Yamato Transport Co.Ltd
Eveline	van Hooijdonk	City of Ghent
Raffaele	Vergnani	POLIS
Fernando	Liesa	ALICE
Heewon	Chae	LOGISALL Consulting
Paola	Cossu	FIT Consulting
Yanying	Li	ALICE
Ioanna	Fergadiotou	INLECOM
Kerri	Ahn	The K consulting
Thato	Motloung	Breda University of Applied Sciences

6.2. Plenary Session of PI and Standard at ALICE Summit

Plenary Session 2 - Physical Internet and standardisation Global Forum

Session Organizers: Fernando Liesa & Yanying Li (ALICE)

Moderated by Eric Ballot, Prof. MINES Paris

Speakers:

- Bruno Gadal, Director Standardization, Geopost - *The importance of global standardization in logistics innovation*
- Jongkyoung Kim, Head, Center for Packaging Research and Testing, Korea Conformity Laboratories/ Committee Manager of ISO TC344/SC1 and Chair of ISO TC122/SC4 (Packaging and the Environment) - *Overview of ISO TC344 (Innovative Logistics)*
- Professor Takayuki Mori, Chairman, Japan Physical Internet Centre - JPIC's PI Maturity Model

- Fernando Liesa, Secretary General, ALICE - PI, standardization and scalable innovations in logistics

<u>Executive Summary</u>

The Physical Internet offers a transformative vision for global logistics, connecting transport, warehousing, and supply chain networks through standardised, modular, and efficient systems that enable seamless access and use to resources and capabilities to build sustainable, competitive and resilient supply chains.

The Physical Internet (PI) is gaining momentum worldwide, with Asia leading in innovation and implementation. From addressing capacity constraints in Japan to boosting competitiveness in Korea and enhancing efficiency in China, PI is shaping the future of logistics. Additionally, COP 30 has emphasized the complexity of addressing decarbonization in affordable and economic way. In essence, the reasons to move forward to PI included in the ALICE Zero Emissions Roadmap and PI Roadmaps are becoming increasingly solid as we advance the journey.

This session highlights these regional experiences and examines how international standardisation, particularly through ISO technical committees, underpins innovation and interoperability. Key logistics service providers and standardisation leaders discussed how global frameworks are being shaped, the opportunities they create for cross-border collaboration, and their impact on the development of PI worldwide.

The session showed how Physical Internet is becoming a reality through global, coordinated standardization. Europe, Japan, and South Korea all pointed to the same needs: shared terminology, interoperable data, harmonized container and node interfaces, and clear governance models. Asia is advancing quickly within ISO, while Europe risks falling behind unless it strengthens its participation and channels R&I results into standards.

Japan’s new PI Maturity Model offers a concrete tool to operationalize PI at company level, and international cooperation is essential to make it globally coherent. Overall, the session made clear that standardization is a clear and solid pathway for scaling PI from promising pilots to a functioning global network, and that Europe must act decisively to remain a leading actor in shaping this future.