Towards a Roadmap to Realize the Physical Internet Vision in the Philippines: Preliminary Results from Stakeholders' Consultation

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Abstract: We present the preliminary results of stakeholders' consultation to contribute to the development of a Physical Internet (PI) roadmap in the Philippines. PI is an open, global logistics system based on the interconnectivity of three layers (physical, digital, and operational). Based on the existing ALICE PI roadmap of the European Union, its basic framework is tested for relevance in the Philippines context by eight members of the Special Interest Group on PI in the Philippines. Presented to eight stakeholders from the logistics industry, key issues and considerations for the PI's possible roll-out in the country based on ALICE PI roadmap's five dimensions (logistics nodes, logistics networks, system of logistics networks, access and adoption, and governance) are identified. The activity and results presented herein are part of a broader effort and set of PI-related activities in the country. Subsequent next steps are also outlined herein. (144 words)

Keywords: Physical Internet, Roadmap, Philippines, Logistics

1. INTRODUCTION

1.1. Background

The Philippine Development Plan 2023-2028 highlights logistics and transport as key components of the national strategies to achieve social and economic outcomes, such as: "Improve industry competitiveness", "Enhance inter-sectoral linkages", and "Achieve seamless and inclusive connectivity".[1] Although there are substantial gains that can be achieved from the realization of these national strategies, they are, at best, only "incremental improvements".

In contrast, the vision of the Physical Internet (PI) for the freight and logistics sector – encapsulation, openness and universal interconnectivity – is far bolder and more ambitious. The Physical Internet (PI) is defined as an "open global logistics system founded on physical, digital, and operational interconnectivity, enabled through modularization, standard interfaces and protocols, with the aim to move, store, produce, supply and use physical objects throughout the world in a manner that is economically, environmentally and socially efficient and sustainable."[2]

The PI can potentially bring about a transition of many orders of magnitude in the sustainability and resilience of supply chains, logistics, and transportation – a transition comparable to the revolution of the Digital Internet. In fact, PI draws inspiration from the digital internet in radically organizing the movement of physical goods across logistics networks (Figure 1). There have been several PI projects (e.g., Ballot *et al*., 2012; Sarraj *et al*, 2014) that led to benefits that would not have been possible with the classical perspective on logistics.

However, how to transform the innovative vision of logistics into real-life implementation in the industry continues to be a challenge (Chen *et al.*, 2022). Recently, the Alliance for Logistics Innovation Through Collaboration (ALICE), supported by the European Union (EU), published its own "Roadmap to the Physical Internet" (2020)[3]. Since then, countries in Europe such as Austria, France, Germany and the Netherlands have made very significant progress in PI implementation.[4] In 2022, Japan also released its own national PI roadmap.[5] We are not aware of any other PI roadmap, besides these roadmaps of the EU and Japan.

Despite the huge potential of PI in radically transforming the logistics sector in the Philippines, the country, to date, has no formal initiative yet related to PI implementation. However, starting in late 2022 when the Special Interest Group on PI in the Philippines (or the PI-PH SIG) was established[6], along with the Department of Science and Technology (DOST) Balik Scientist Program (BSP) Award to Prof Greg Foliente – who was hosted as a visiting professor at the De La Salle University (DLSU) in early 2023 – a range of PI-related activities in the country has commenced. Moreover, the first Physical Internet National Symposium was also organized in

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[1] https://pdp.neda.gov.ph/philippine-development-plan-2023-2028/

[2] http://www.physicalinternetinitiative.org/

[3] https://www.etp-logistics.eu/wp-content/uploads/2022/11/Roadmap-to-Physical-Intenet-Executive-Version_Final-web.pdf

[4] https://www.freightera.com/blog/physical-internet-a-vision-for-sustainable-secure-resilient-supply-chains/

[5] https://www.meti.go.jp/shingikai/mono_info_service/physical_internet/pdf/20220308_1.pdf

[6] The members of the PI-PH SIG are mostly from the academe with specialization in industrial engineering, supply chain, transport and logistics, computer science and information technology. See the SIG website: https://sites.google.com/uap.asia/physicalinternetph/

November 2023, with plenary presentations and track sessions based on the ALICE Roadmap.[7] Additionally, a few members of the SIG have started conducting research on PI within the context of the Philippines as part of their doctoral dissertations.[8] The purpose of this short paper is to present a particular activity by the PI-PH SIG to engage an initial set of stakeholders in the freight and logistics sector to identify the key areas of development of PI in the Philippines.

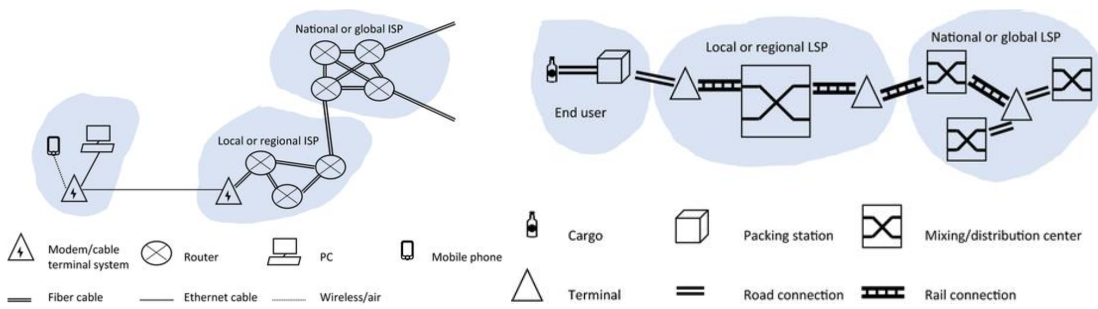

Figure 1. From Digital Internet to Physical Internet (Dong and Franklin, 2021)

1.2. Significance of the Physical Internet in the Philippine Context

The rationale and need to transform our current freight and logistics systems are well-established and have been universally accepted (e.g., Montreuil, 2011). But to make this transformation possible, the key terms are "global" and "standard interfaces and protocols". This means that despite the fast-growing developments in the domain of logistics in North America and Europe, the Global South, in general, and the ASEAN region and the Philippines, in particular, need to be engaged and proactive. The ASEAN region's and our country's priorities and unique contexts and challenges need to be better understood and addressed as part of a global effort (including the development of standard interfaces and protocols) to bring the PI vision to reality. Cambodia, for instance, has initiated PI-related research (for example, Ban et al, 2020). The alternative is to be forced to follow ill-fitting European-based standards or be left out of the benefits of the next generation of economically, environmentally efficient and sustainable freight and logistics sector.

For example, the aforementioned European Union PI roadmap by ALICE has generic five high-level headings which are core to PI implementation (see more below). At least three of the five headings are highly contextual – namely, "system of logistics networks", "access and adoption", and "governance". The barriers and constraints, challenges and opportunities in the Philippines need to be particularly understood and mapped, along with our priority technical needs.

The national PI roadmap will identify priority research and development (R&D), capacity development and implementation needs – by key stakeholder groups such as government, industry, professional bodies and academics/researchers. The potential benefits of a Philippine PI Roadmap will be substantial:

- Positioning the Philippines at the forefront of regional innovation and global PI execution;
- Highlighting strategic policy and investment areas for stakeholders, from the government to industry and entrepreneurs;

[7] https://sites.google.com/uap.asia/physicalinternetph/conference

[8] For example, an ongoing study is being conducted on integrating Physical Internet (PI) in Baguio City.

- Identifying priority and country-unique R&D and education and training needs; and
- Offering pioneering companies a chance to tap into newfound opportunities in a PI-integrated logistics economy.

Regardless of PI's degree of development in the country, pursuing the identified activities in the roadmap will reap sector efficiencies and broader benefits, in addition to supporting a sustained platform for academe-industry collaboration and innovation in the country.

2. EXISTING PHYSICAL INTERNET ROADMAPS

As far as we are aware, there are two known PI roadmaps: one prepared by ALICE for Europe and one for Japan[9].

2.1.ALICE with funding support from the European Union

The European Commission (EC) established ALICE, a European Technology Platform (ETP) to "develop a comprehensive strategy for research, innovation and market deployment of logistics and supply chain management innovation in Europe"[10]. One of the projects coordinated by ALICE is "SENSE: Accelerating the Path Towards the Physical Internet"[11]. One of the main aims of SENSE is to develop an industry-driven roadmap towards physical internet realization. Figure 2 presents an overview of the ALICE roadmap, consisting of five areas of PI development:

1. Logistics nodes,
2. Logistics networks,
3. System of logistics networks,
4. Access and adoption, and
5. Governance.

Each area of development consists of five generations leading to a full transition to PI by 2040 (e.g., autonomous PI nodes, fully autonomous PI network services and operations, complete PI functionality and network interconnectivity, everyone can access PI, and stable PI rules and models).

[9] Apart from these industry roadmaps, there are also roadmaps at the academic level, e.g. by Fahim *et al* (2021) on the evolution of maritime ports towards PI. Here we only consider the industry roadmaps.
[10] https://www.etp-logistics.eu/
[11] https://www.etp-logistics.eu/sense-project-accelerating-the-path-towards-physical-internet-kicked-off/

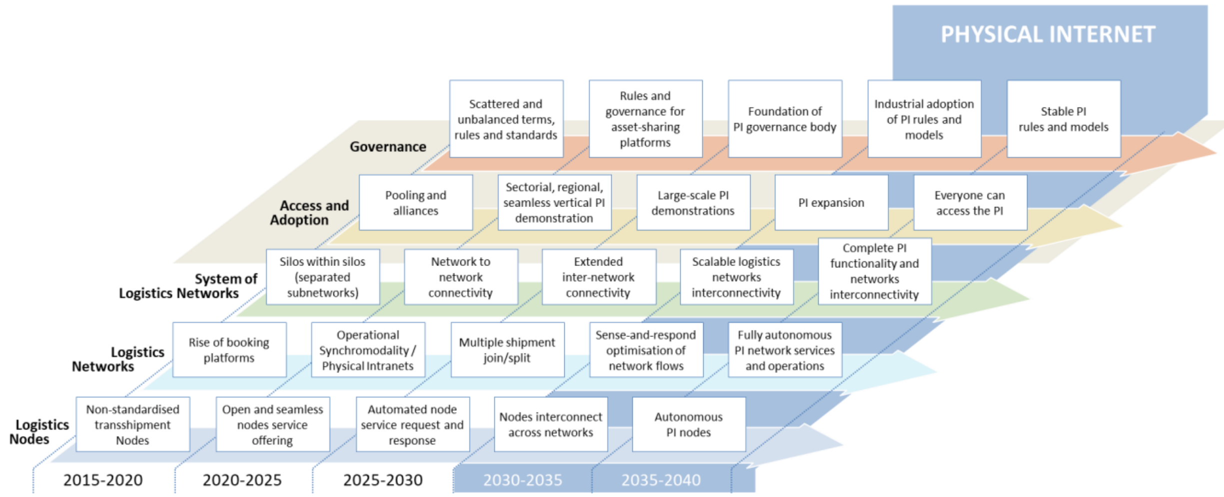

Figure 2. The ALICE PI roadmap

2.2. Japan

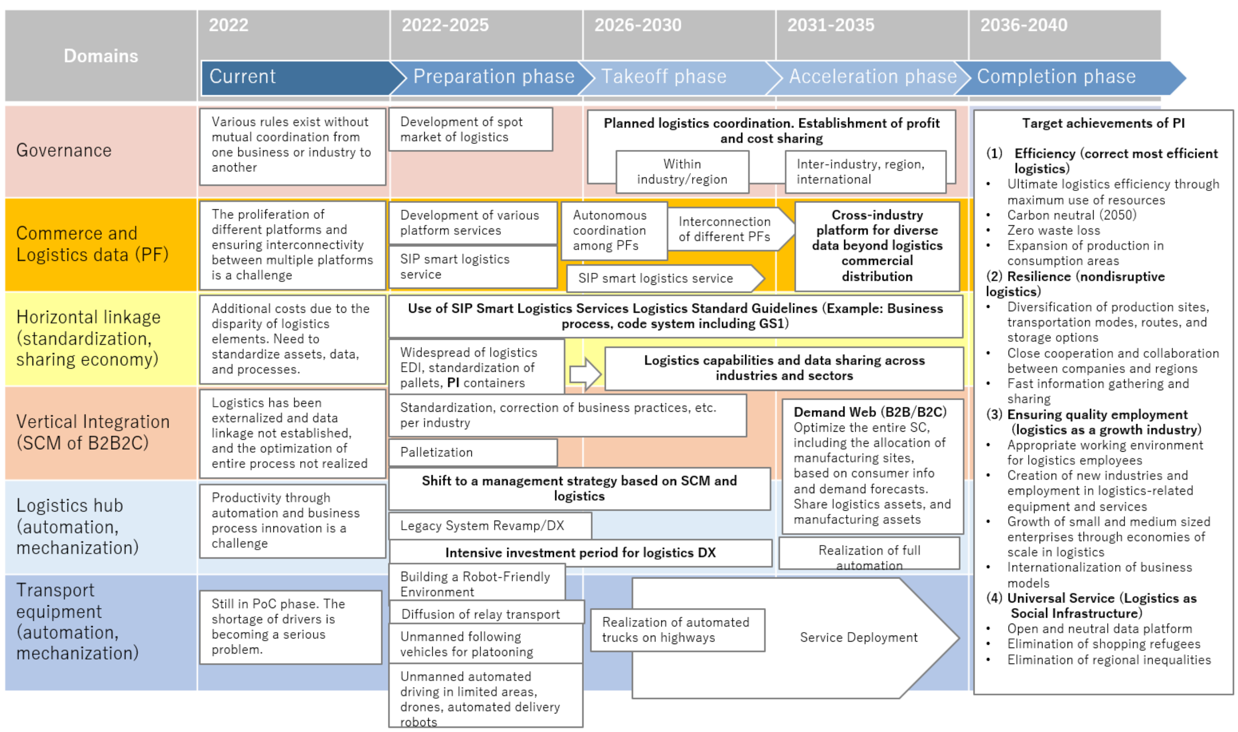

Figure 3. Japan PI roadmap (*Source*: METI, 2022 (Original in Japanese); English translation by Assoc Prof E. Hirata, Kobe University, via personal communication, Nov 2023)

Japan has also developed and released in 2022 an industry roadmap for the development of PI, also by 2040.[12] Figure 3 presents the roadmap.[13] There are six areas of development:

1. Governance,

[12] https://www.meti.go.jp/press/2021/03/20220304005/20220304005.html

[13] The English translation of the Japan roadmap is provided by Assoc Prof E. Hirata of Kobe University.

2. Commerce and Logistics data platform (PF),
3. Horizontal linkage,
4. Vertical integration,
5. Logistics hub, and
6. Transport equipment.

While the ALICE PI roadmap was initiated by a consortium of industry and academia/experts, the Japan PI roadmap was largely coordinated by the national government with the cooperation of the logistics industry and business organizations.

3. METHOD

3.1. Roadmap Architecture

A roadmap can be structured as having three elements: a vision, key dimensions of development, and generations (or a set of progressive milestones toward the vision, e.g., see the ALICE roadmap) (Fahim *et al*, 2021). Herein, we adopt this approach instead of the one used by the Japan roadmap, where strategies, and not generations, are used, although these are very closely related. That is, generations could be seen as descriptions of desired outcomes at certain stages of development, while strategies could be viewed as the decisions and actions needed to achieve target outcomes at specified stages of development. Either way, any national roadmap should take into account the unique context of a country's broader governance and socio-economic settings, in general, and its freight and logistics sector, in particular, while still maintaining the general direction of development for PI.

3.2. Framework of the ALICE PI Roadmap

In developing a roadmap for the Philippines, we aim to adopt a combination of top-down and bottom-up approaches. In this paper, a top-down approach means that we begin from existing roadmaps (e.g., EU ALICE and Japan) and then, based on consultations with stakeholders from the logistics industry, validate and adapt these roadmaps for the local context. A bottom-up approach, on the other hand, begins with a "tabula rasa"; through consultations, the inputs from stakeholders are obtained and prepared into a roadmap. Typically, a bottom-up approach requires more effort and resources over a period for implementation. Due to time and resource constraints, and as a preliminary or exploratory effort, this study adopts a top-down approach based on the EU ALICE Roadmap framework.

The DOST-BSP and DLSU seminar-workshop[14] on PI-based Freight and Logistics Future held at the end of May 2023 is an example activity that generated bottom-up perspectives on PI vision, priority gaps and strategies (Foliente and Ilao, 2023). With funding availability in the future, this can be complemented with other data collection efforts, and then combined or integrated with the results from a top-down approach, in order for the roadmap to be more comprehensively developed.

[14] https://journal.com.ph/la-salle-drives-ph-logistics-transformation-roadmap

Since the ALICE PI roadmap is the first PI roadmap formulated, which has been widely disseminated globally through the annual International Physical Internet Conferences (IPIC)[15], we decided to take the ALICE PI roadmap as the starting point. Is its basic framework relevant in the Philippines context?

The PI-PH SIG developed an initial survey tool which assessed the relevance of the vision and generations of the ALICE Roadmap (here we already assumed that the key PI dimensions are the same as the ALICE's). Eight (8) members of the SIG gave a rating on a 5-point Likert scale from "Not at all relevant" (score=1), "Slightly relevant" (score=2), "Somewhat relevant" (score=3), "Very relevant" (score=4) "Extremely relevant" (score=5).

As can be seen in Table 1, the SIG, in general, found the ALICE PI Roadmap to be at least "very relevant" (average score of at least 4).

Table 1. * = not rated (because we are only interested on how Generation 1 / Current may evolve to Generation 5 / Full PI). Ratings are given by N=8 members of the PI-PH SIG

	PI Dimensions				
	Logistics nodes	Logistics networks	System of logistics networks	Access and Adoption	Governance
Generation 1 (Current State)	*	*	*	*	*
Generation 2	4.4	4.4	4.3	4.8	4.5
Generation 3	4.5	4.5	4.5	4.4	4.6
Generation 4	4.3	4.3	4.5	4.5	4.8
Generation 5 (Full PI state)	*	*	*	*	*

3.3. Stakeholders' perspectives

We then obtained inputs from a very limited sample of industry stakeholders.

- Shippers and retail (L'Oréal[16]), representing the dimension of logistics nodes
- Logistics Service Provider (Transportify[17] and Borzo[18]), representing the dimension of logistics networks
- Information and Communication Technology (EACOMM[19]) and Research and technology centers (DOST-ASTI[20]), representing the dimension of system of logistics networks
- National government agencies (Department of Transportation[21]), representing the dimension of governance

[15] https://www.pi.events/
[16] https://www.lorealparis.com.ph/
[17] https://www.transportify.com.ph/
[18] https://borzodelivery.com/ph
[19] https://www.eacomm.com/
[20] https://asti.dost.gov.ph/
[21] https://dotr.gov.ph/

- Since we have no respondent from the sector representing the dimension of access and adoption, two members of the SIG provide perspectives on this particular dimension. The two members have a background in industrial engineering and transport.

The process of stakeholder consultation proceeded as follows:

- The interviewer explains the vision, key dimensions, and generations of the ALICE PI Roadmap using an interview protocol: https://forms.gle/fp7EG7hNYB8wLCDe8
- Among the five dimensions of PI, respondents choose only one dimension they have primary expertise/domain knowledge in
- After choosing, the generations belonging to the chosen area of development are shown
- Respondents then do the following:
    - Validate the (non)relevance of the generations, and revise (if needed)
    - Describe the key achievements/milestones per generation

Note again that the above is a preliminary or exploratory study with a highly simplified (or constrained) methodology and stakeholder engagement or consultations.

4. RESULTS AND DISCUSSION

4.1. Vision

The pandemic has seen many enterprises shift to e-commerce and omnichannel fulfillment not only to survive but also to explore new opportunities and markets. The proliferation of e-commerce has fundamentally altered demand characteristics and order profiles: the handlings units are smaller, the delivery locations are more dispersed, and the customers expect faster, low-cost or free deliveries. E-commerce is seen to grow more in the coming years. Furthermore, there are expectations, in pursuit of sustainability, to reduce carbon emissions and energy consumption, while at the same time, earning more profits and delivering higher customer satisfaction.

To achieve this, first, there must be *flow consolidation or bundling of shipments*. Traditionally, with the B2B model, the flow of goods is much simpler; but with the emergence of e-commerce, B2C is the norm, and thus, it is critical to find ways to be more efficient through consolidation.

Second, there must be a shift from the current logistics paradigm and organization, where the dominant models are either private supply networks or shared supply webs. In the former, producers have their own independent private supply networks; in the latter, these producers may collaborate and enter a partnership with other producers/suppliers to enable them to jointly exploit a shared supply web (Montreuil, 2011). These arrangements can be executed by the firms themselves and their partners, or outsourced to third-party logistics providers. Nonetheless, in the long run, these arrangements are unsustainable. What is desirable is a shift "from private supply networks to an Open Global Supply Web enabling the physical equivalents of Intranets, Virtual Private Networks, Cloud Computing and Cloud Storage" (Montreuil, 2011). This evolution from the "physical intranet" to the "physical internet" can be likened to a transition from the virtual intranet into the digital internet. Upon achieving this goal, the overall logistics network would allow for high levels of efficiency, leading to benefits not just for the producers but for the greater logistics and transportation network in general.

Both of these – flow consolidation and asset sharing – are only possible if there is a seamless, open and universal interconnectivity and interoperability with any logistics stakeholder from around the world.

4.2. Key Dimensions and Generations

Table 2 presents the key dimensions (logistics nodes, logistics networks, system of logistics networks, access and adoption, and governance) and the five generations in the ALICE PI Roadmap.

Table 2. ALICE PI Roadmap

	Generation 1 (Current State)	Generation 2	Generation 3	Generation 4	Generation 5
Logistics Nodes	Non-standardized transshipment nodes	Open and seamless nodes service offering	Automated node service request and response	Nodes interconnect across networks	Autonomous PI nodes
Logistics Networks	Rise of booking platforms	Operational Synchromodality / Physical Intranets	Multiple shipment join / split	Sense-and-respond optimization of network flows	Fully autonomous PI network services and operations
System of Logistics Networks	Silos within silos (separated subnetworks)	Network-to-network connectivity	Extended inter-network connectivity	Scalable logistics networks interconnectivity	Complete PI functionality and networks interconnectivity
Access and Adoption	Pooling and alliances	Sectorial, regional, seamless vertical PI demonstration	Large-scale PI demonstrations	PI expansion	Everyone can access the PI
Governance	Scattered and unbalanced terms, rules and standards	Rules and governance for asset-sharing platforms	Foundation of PI governance body	Industrial adoption of PI rules and models	Stable PI rules and models

4.2.1. From Logistics Nodes to PI Nodes

In Logistics Nodes, goods are consumed, stored, transformed, or transhipped from one transport mode to another. Ports, airports, logistics hubs, terminals, distribution centers, warehouses, and depots are examples of Logistics Nodes.

Although recently we have seen huge efficiency gains in logistics nodes due to the widespread use of standard loading units (pallets and containers), the interactions between different units and transport modes are not yet standardized (Generation 1). Generation 2 focuses on the development of logistics nodes in which the processes, services and operations are standardized and interoperable across nodes and openly accessible to stakeholders, usually made possible through the standardization of containers. In Generation 3, Logistics Nodes will interact with the Logistics Networks (e.g., freight forwarders, shippers and the logistics service providers) by answering service requests (storage space capacity, cargo handling, cargo transport) in an automated manner, creating seamless booking systems backed by smart contracts. Whereas

Generations 2 and 3 define "the "identity card" of a node, Generation 4 aims for the interoperable and seamless access of these logistics nodes in the PI network, made possible by the interconnection of all the nodes belonging to different logistics networks. Finally, Generation 5 aims to bring these nodes, now with full PI functionalities, to full scale, covering and serving the world.

4.2.2. From Logistics Networks to PI Networks

Currently, companies control their own logistics networks, with no or little visibility beyond their own network boundaries. Recently, logistics service providers serving these companies have undertaken digitalization efforts to automate planning, booking and administration processes (Generation 1). In Generation 2, LSPs and freight forwarders create the so-called "physical intranets" through the development of platforms for the interconnection of various internal departments and for the creation of full visibility of capabilities. In Generation 3, multiple shipments can be bundled and de-bundled, creating more opportunities for the increased utilization of transport modes. Generation 4 logistics networks are robust against disruptions and are flexible to changes in demand, primarily because of the send-and-respond capabilities of the network. Generation 5 is a full PI logistics network, characterized by vertical integration which brings together all processes and information which can be shared and are public.

4.2.3. Developing the System of Logistics Networks towards the PI

The aim of this area of development is the full interconnection of individual logistics networks, including their assets, services and resources, into a "system of logistics networks". Currently, there is a high fragmentation in the global logistics industry ("separated subnetworks"): individual organizations develop their own networks or outsource their logistics operations to LSPs. Although there is an increasing effort among LSPs to forge partnerships, still the networks are not as globally interconnected for goods to flow seamlessly across them (Generation 1). The goal of Generation 2 is to develop network-to-network connectivity by developing interconnection protocols for dedicated logistics networks to perform experiments with sharing assets, services and resources with one another or among new partners. Generation 3 aims for a more extended inter-network connectivity, primarily by allowing networks to connect per "on-demand" basis. In Generation 4, more protocols will be developed to allow the scale and scope of interconnectivity to increase (both in terms of geographical and service coverage). In Generation 5, partners and users have seamless access to PI. Plug-and-play connectivity is available for users and providers; new networks can become part of PI or leave PI any time.

4.2.4. Access and adoption

The current status (Generation 1) is characterized by increasing pooling and alliances, but such cooperation is mostly based on existing operational contracts, so stakeholders still act independently from each other with a minimum of information sharing. In Generation 2, PI adoption further expands within the sector, creating sectorial and regional seamless PI-based collaboration. The integration and collaboration between logistics networks further expand to a larger and wider scale (Generation 3). International reach and multisectoral horizontal and vertical integration characterize Generation 4. In Generation 5, PI is fully accessible and widely adopted by everyone.

While current PI research literature revolves primarily around technical aspects of PI implementation, addressing the behavioural aspects of PI access and adoption such as behavioral intentions of adopting PI as well as how PI is communicated in firms to employees or how complex it is to use PI by people and firms could help predict the future widespread adoption of PI across logistics networks. These factors require critical considerations in developing and implementing national PI Roadmaps because of different socio-cultural and regulatory-legal environments in different countries. Pournader *et al* (2023) recently presented a paper aimed at initiating the discourse surrounding behavioural and theoretical aspects of PI access, use and adoption.

4.2.5. Governance

Governance is another topic that is highly dependent on different socio-cultural and regulatory-legal environments in different countries. Thus, this has to be mapped considering a country's unique context.

In the Philippines, there is no harmonized governance framework yet. There is an absence of PI terms, rules, standards and regulations (Generation 1). In Generation 2, a Technical Working Group may be established to take limited initial first steps toward the formulation of rules and governance framework for asset-sharing among various stakeholders. Generation 3 is the foundation of a PI governance body, with a governance structure determined consensually by customers and suppliers. The PI governance body may define and harmonize the terms and rules for vertically integrated synchro-modal logistics networks, including rules for asset-sharing. Generation 4 aims to further extend the governance models to the system of logistics networks so that asset sharing and shipment routing are allowed for logistics nodes belonging to different networks. In Generation 5, a mature PI governance framework and body will have already been developed for the formulation and adoption of stable PI rules and models.

5. SUMMARY AND CONCLUSIONS

In this paper we engaged and consulted an initial set of stakeholders in the freight and logistics sector to identify the key areas of development of PI in the Philippines over five generations or phases considering the five EU ALICE PI Roadmap dimensions: logistics nodes, logistics networks, system of logistics networks, access and adoption, and governance. Although the results are preliminary and the methodology had been simplified, the ALICE Roadmap framework and dimensions are relevant and useful in developing a national PI roadmap in the Philippines.

Consulted stakeholders contributed ideas on how the roll-out of the 5-generation model of the ALICE Roadmap may look like in the Philippines. These preliminary information need to be expanded by reviewing the methodology employed herein, releasing some of the constraints imposed on the current effort, extending stakeholder consultations and engagement, and augmenting these with other visioning and strategic road-mapping approaches. Appropriate level of funding and greater support from key government and industry stakeholders are needed. Furthermore, there is a need to integrate capacity development (including education and training) and collaborative research and development among stakeholder groups. Specific case studies and/or limited trials are needed to see how PI may exactly evolve and develop in the country.

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