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Bridging the Gaps:
Fostering Digital Integration in ASEAN's Supply Chains

Edited by
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Economic Research Institute
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Contents

List of Figures

List of Tables

List of Abbreviations and Acronyms

AANZFTA	ASEAN–Australia–New Zealand Free Trade Agreement
ACDD	ASEAN Customs Declarations Document
ACFS	Agricultural Commodity and Food Standards
ACFTA	ASEAN–China Free Trade Area
AEO	Authorised Economic Operator
AI	Artificial Intelligence
AIS	Automatic Identification System
AJCEP	ASEAN–Japan Comprehensive Economic Partnership
AMS	ASEAN Member States
APEC	Asia-Pacific Economic Cooperation
API	Application Programming Interface
ASEAN	Association of Southeast Asian Nations
ASW	ASEAN Single Window
ASWSC	ASEAN Single Window Steering Committee
ATIGA	ASEAN Trade in Goods Agreement
AWS	Amazon Web Service
B2B	Business to Business
B2G	Business to Government
BCP	Business Continuity Planning
BCR	Binding Corporate Rules
BIR	Bureau of Internal Revenue
BL	Bill of Lading
BOC	Bureau of Customs
BOI	Board of Investment
BOT	Build-Operate-Transfer
BPI	Bureau of Plant Industry
BRS/RSM	Business Requirement Specification/Requirements Specification Mapping
BSSN	Badan Siber dan Sandi Negara
CBPDT	Cross-Border Personal Data Transfer
CBPR	Cross-Border Privacy Rules

CBRAs	Cross-Border Regulatory Agencies
CDTP	Common Data Trust Protocols
CEFACT	Centre for Trade Facilitation and Electronic Business
CEI	Cross-border Electronic Invoicing
CEISA	Customs-Excise Information System and Automation
CERT	Computer Emergency Response Team
CI	Commercial Invoice
CII	Critical Information Infrastructure
CIRT	Incident Response Team
CMA	Communications and Multimedia Act
CMIT	Cai Mep International Terminal
CO	Certificate of Origin
CPTA	Cross-border Paperless Trade Agreement
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
CSA	Cyber Security Agency
CSV	Comma-separated values
CTIP	Cyber Threat Intelligence Program
DEFA	Digital Economy Framework Agreement
DEPA	Digital Economy Promotion Agency
DFFT	Data Free Flow with Trust
DGPS	Differential GPS
DGT	Directorate General of Taxes
DICT	Department of Information and Communications Technology
DJBC	Directorate General of Customs and Excise
DLT	Distributed Ledger Technology
DMF	Data Management Framework
DNB	Digital Nasional Berhad
DOA	Department of Agriculture
DPEA	Digital Platform Economy Act
DX	Digital Transformation
E2M	Electronic-to-Mobile
e-BL	Electronic Bill of Lading

ECS	Electronic Container Seals
EDI	Electronic Data Interchange
e-DO	Electronic Delivery Order
e-EIR	Electronic Equipment Interchange Receipt
EIS	Electronic Invoicing System
e-PCoO	Electronic Preferential Certificates of Origin
ERIA	Economic Research Institute for ASEAN and East Asia
ERP	Enterprise Resource Planning
e-SKA	Electronic Certificate of Origin Service
ESOs	Electronic System Operators
ETA	Estimated Time Arrival
ETDA	Electronic Transactions Development Agency
ETL	Law on E-Transactions
E-TRACC	Electronic Tracking of Containerised Cargo
ETRs	Electronic Transferable Records
EU	European Union
EVFTA	European Union–Vietnam Free Trade Agreement
FAQs	Frequently Asked Questions
FCL	Full Container Load
FDA	Food and Drug Administration
FTAs	Free Trade Agreements
G2B	Government to Business
G2G	Government to Government
GDPR	General Data Protection Regulation
GDT	General Department of Taxation
GPS	Global Positioning System
GST	Goods and Services Tax
GTIN	Global Trade Item Number
HBoL	House Bill of Lading
HS	Commodity Code
ICT	Information and Communication Technology
ICTSI	International Container Terminal Services, Inc.
ID	Indonesia
IK-CEPA	Indonesia-Korea Comprehensive Economic Partnership

	Agreement
IKD	Identitas Kependudukan Digital (Digital Identity)
IMD	Institute for Management Development
IMDA	Infocomm Media Development Authority
INSW	Indonesia National Single Window
IoT	Internet of Things
IPEF	Indo-Pacific Economic Framework for Prosperity
iPORTS	Internet-Based Port Operations and Receipting for Terminals System
IPPC	International Plant Protection Convention
IRAS	Inland Revenue Authority of Singapore
IT	Information and Technology
ITE Law	Law on Electronic Information and Transaction
ITFP	Integrated Trade Facilitation Platform
ITU	International Telecommunication Union
IUAE-CEPA	Indonesia–United Arab Emirates Comprehensive Economic Partnership Agreement
JETRO	Japan External Trade Organization
JIEPA	Japan-Indonesia Economic Partnership Agreement (JIEPA)
JIT	Just-in-Time
JPEPA	Japan-Philippines Economic Partnership Agreement
KOMDIGI	Ministry of Communication and Digital Affairs (Kementerian Komunikasi dan Digital Republik Indonesia)
KPI	Key Performance Indicator
KTDDE	Key Trade Documents and Data Elements
LATAM	Latin America
LiDAR	Light Detection and Ranging
LoA	Levels of Assurance
LPI	Logistic Performance Index
LWG	Legal Working Group
MBoL	Master Bill of Lading
MCC	Model Contract Clauses
MDEC	Malaysia Digital Economy Corporation

MDES	Ministry of Digital Economy and Society
MIC	Ministry of Internal Affairs and Communications
MITI	Ministry of Investment, Trade and Industry
ML	Machine Learning
MLETR	Model Law on Electronic Transferable Records
MMSW	Malaysia Maritime Single Window
MNSW	Malaysia National Single Window
MPA	Maritime and Port Authority of Singapore
MPS	Ministry of Public Security
MY	Malaysia
NCA	National Cyber Security Agency
NCCP	National Cloud Computing Policy
NCII	National Critical Information Infrastructure
NCSC	National Cyber Security Centre
NCSP	National Cybersecurity Strategy
NCSS	National Cyber Security Strategy
NDI	National Digital Identity
NDTP	National Digital Trade Platform
NEA	National Environment Agency
NFCP	National Fiberisation and Connectivity Plan
NLE	National Logistic Ecosystem
NPC	National Privacy Commission
NPPO	National Plant Protection Organization
NSW	National Single Window
NTP	Networked Trade Platform
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
OGA	Other Government Agencies
OJK	Indonesian Financial Services Authority (Otoritas Jasa Keuangan)
PAT	Port Authority of Thailand
PCoO	Preferential Certificates of Origin
PCS	Port Community System
PDP	Personal Data Protection

PDPA	Personal Data Protection Act
PDPC	Personal Data Protection Commission
Pelindo	PT Pelabuhan Indonesia
PH	Philippines
PIB	*Pemberitahuan Impor Barang*
PIC	Person in Charge
PINT	Peppol International Invoice
PKI	Public Key Infrastructure
PKKA	Foreign Vessel Operating License
PL	Packing List
PNPKI	Philippines National Key Infrastructure
PO	Purchase Order
PoC	Proof of Concept
PPP	Public Private Partnership
PRP	Privacy Recognition for Processors
PSA	Port of Singapore Authority
PTFC	Philippine Trade Facilitation Committee
PTV	Pre-border Technical Verification
QR	Quick Responses
RCEP	Regional Comprehensive Economic Partnership
RFID	Radio Frequency Identification
RFP	Request for Proposal
RMCD	Malaysia Customs
SCC	Standard Contractual Clauses
SDO	Shipping Delivery Order
SG	Singapore
SGD	Singaporean Dollar
SI	Shipping Information
SINSW	Single Submission System
SLA	Service Level Agreement
SLC	Smart Logistics Complex
SME	Small and Medium-sized Enterprise
SNP	Saigon Newport Corporation
SOP	Standard Operating Procedures

SPOF	Single Point of Failure
SSCC	Serial Shipping Container Code
SSm	Single Submission
SSO	Single Sign-On
TFA	Trade Facilitation Agreement
TH	Thailand
TISI	Thai Industrial Standard Institute
TNSW	Thailand National Single Window
TOS	Terminal Operating Systems
TRGAs	Trade-related Government Agencies
UN	United Nations
UNESCAP	United Nations Economic and Social Commission
UNICITRAL	United Nations Commission on International Trade Law
UNTDED	United Nations Trade Data Element Directory
VASP	Value-Added Service Providers
VASSCM	Viet Nam Automated System for Seaport Customs Management
VCCI	Viet Nam Chamber of Commerce and Industry
VN	Viet Nam
VNACCS/VCIS	Viet Nam Automated Cargo Clearance System / Customs Information System
VNeID	Viet Nam Electronic Identification
VNPT	Vietnam Posts and Telecommunications Group
VNSW	Viet Nam National Single Window
VNTR	Viet Nam National Trade Repository
WCO	World Customs Organization
WTO	World Trade Organization

Executive Summary

Efficient and resilient supply chains are fundamental to sustaining trade and economic growth in today's interconnected economy. For ASEAN, where high volumes of cross-border movements underpin regional integration, persistent inefficiencies continue to hinder progress. Three challenges remain central: inconsistent data handling across supply chain processes, fragmented systems that cannot interoperate, and complex shipment procedures that slow documentation, verification, and multi-party collaboration. These issues result in limited visibility, higher administrative burdens, and increased exposure to disruptions.

While some processes across the region have been digitalised, many still rely on manual or paper-based workflows, creating uneven levels of automation. Fragmented platforms make it difficult for stakeholders to share information efficiently, and lengthy compliance requirements add procedural friction. In contrast, an integrated digital supply chain enables real-time visibility, granular unit-level tracking, and secure data exchange based on trusted frameworks such as Data Free Flow with Trust (DFFT). This model strengthens operational efficiency, transparency, and resilience – capabilities that are increasingly critical amidst geopolitical uncertainty, pandemic risks, and rapidly shifting customer expectations.

To support this transition, the project employs a dual-track approach combining a Proof of Concept (PoC) with a comprehensive regional survey. The PoC demonstrates the feasibility of end-to-end, unit-level data sharing, while the survey assesses existing policies, systems, and practices across six major ASEAN economies: Singapore, Malaysia, Thailand, Indonesia, the Philippines, and Viet Nam. Together, these activities identify gaps between current operations and the ideal future-state supply chain.

The project focuses on high-value, time-sensitive sectors such as the automobile industry, where precision, visibility, and traceability are essential to production continuity. Across all workstreams, it is anchored on four pillars of ideal supply chain digitalisation: domestic process efficiency; seamless cross-border connectivity and interoperability; end-to-end unit-level traceability and resilience; and trustworthy and secure infrastructure.

The PoC centres on the third pillar, validating the operational benefits of real-time cargo visibility. It demonstrates that integrated data flows can optimise ordering, reduce excess inventory, and improve asset utilisation. However, the increased frequency of orders needed to maintain safety stock places additional burdens on shippers, highlighting the need for balanced operational strategies that support both shippers and consignees.

Building on the insights from the PoC, the key findings for each pillar are as follows:

Pillar 1: Domestic Process Efficiency

ASEAN economies are improving domestic efficiency through stronger digital infrastructure, increased use of digital trade documents, and continued development of National Single Window systems. Expansion of 5G networks, cloud services, and data centres is ongoing, but rural connectivity gaps, low SME adoption, and sustainability concerns related to energy consumption remain significant constraints. Many core

trade documents are now digital; however, incomplete legal recognition of electronic transferable records and continued reliance on paper for supporting documents still limit fully digital workflows. All six countries operate National Single Window platforms, though levels of integration vary, links to logistics and financial services remain limited, and smaller firms face adoption barriers. Moreover, complex exception processes, such as refunds and appeals, largely remain manual. These trends reflect clear progress while underscoring the need for stronger institutional co-ordination, more consistent legal frameworks, and broader cross-sector integration.

Pillar 2: Seamless Cross-Border Connectivity and Interoperability

Countries are increasingly adopting international standards such as the WCO Data Model and expanding the use of API-based integration. However, a persistent semantic gap remains, as legacy systems struggle to map data to newer standards. Governance arrangements under the ASEAN Single Window provide mechanisms for regional co-ordination, although consensus-based decision-making can slow progress, suggesting the potential value of 'Pathfinder' approaches amongst willing and ready countries. Interest in global legal frameworks, including the UNCITRAL Model Law on Electronic Transferable Records, is growing, yet domestic legislative alignment remains partial. Ongoing challenges include fragmented legal regimes, uneven system reliability, limited cross-border exchange of electronic documents, and overlapping institutional mandates. Advancing interoperability will depend on harmonising standards and legal frameworks, strengthening governance mechanisms, improving system reliability, and supporting private sector and SME participation.

Pillar 3: End-to-End Unit-Level Traceability and Resilience

Regional efforts are gradually expanding real-time tracking capabilities through digitalised port and warehouse operations, GPS-enabled electronic seals for inland transport, and integrated platforms linking customs authorities, logistics operators, ports, and financial institutions. However, tracking data often remains disconnected from digital documentation, and event-data standards are not harmonised. Infrastructure disparities limit visibility beyond major hubs, while inconsistencies in unit-level data fields reduce interoperability. SMEs face both financial and technical barriers to adopting advanced tracking solutions. More broadly, the region faces resilience challenges arising from high geographic and industrial concentration, underscoring the need for digital strategies that support supply chain diversification. Achieving consistent, region-wide capability will require shared event vocabularies, common API specifications, stronger integration between Port Community Systems and National Single Windows, continued infrastructure investment, and targeted SME support.

Pillar 4: Trustworthy and Secure Infrastructure

ASEAN economies have enacted cybersecurity laws, data protection regimes, and digital identity frameworks; however, inconsistencies in implementation and enforcement result in uneven protections and uncertainty surrounding cross-border data exchange. Rules on personal data protection, incident reporting, and cross-border transfers vary widely across countries. Governance responsibilities are often fragmented amongst multiple agencies, while inconsistent definitions of Critical Information Infrastructure (CII) generate overlapping and redundant compliance burdens. Digital identities and electronic signatures are increasingly used in trade processes, but mutual recognition remains limited and consent mechanisms are not

aligned. SMEs also face higher barriers to adopting secure digital technologies. Strengthening regional trust and security will require more consistent standards for critical infrastructure protection, aligned incident reporting frameworks, improved inter-agency co-ordination, clear identity assurance levels, and broader capacity-building initiatives.

Through this combined approach, the project delivers actionable insights at both national and regional levels to address existing challenges and accelerate digital transformation in ASEAN supply chains, ultimately supporting sustainable trade ecosystems, reducing systemic risks, and fostering long-term economic growth.

The study underscores the need for ASEAN to move from high-level dialogue toward more practical and actionable co-operation on digital supply chain integration. While frameworks such as DFFT provide important guiding principles, stronger national digital foundations are required before deeper cross-border interoperability can be realised. Recommended actions include strengthening National Single Window ecosystems, expanding rural and SME digital capabilities, updating legal frameworks, harmonising data standards, advancing unit-level traceability, and enhancing cybersecurity and digital identity systems.

Pilot projects should be scaled up as a pragmatic means of testing cross-border interoperability, assessing risks, and building confidence amongst both public and private stakeholders. By aligning domestic reforms with focused regional co-operation, ASEAN can progress toward a trusted, seamless, and resilient digital supply chain that enhances long-term competitiveness and reduces vulnerability to future disruptions.

Chapter 1
Overview of the Project

1. Background and Purpose

In today's highly interconnected global economy, efficient and resilient supply chains are essential to facilitating trade and ensuring sustainable economic growth. Within the ASEAN region, where cross-border trade plays a vital role in regional integration and development, persistent inefficiencies continue to hamper progress. Key challenges include 1) inconsistent data handling, 2) fragmented and non-interoperable systems, and 3) complex shipment processes. These issues limit the ability of ASEAN Member States to streamline trade procedures, cut costs and time, and respond effectively to disruptions.

First, inconsistent data handling reflects the uneven adoption of digitalisation: while some processes still rely on physical paperwork, others have transitioned to electronic formats. Even amongst digital solutions, certain steps require human intervention, whereas others enable machine-to-machine processing. Second, fragmentation and lack of interoperability amongst systems further restrict seamless information exchange, often confining data sharing to bilateral relationships rather than enabling multi-party collaboration. Lastly, shipment processes involving multiple layers of documentation and compliance checks impose significant administrative burdens, slowing trade and reducing transparency.

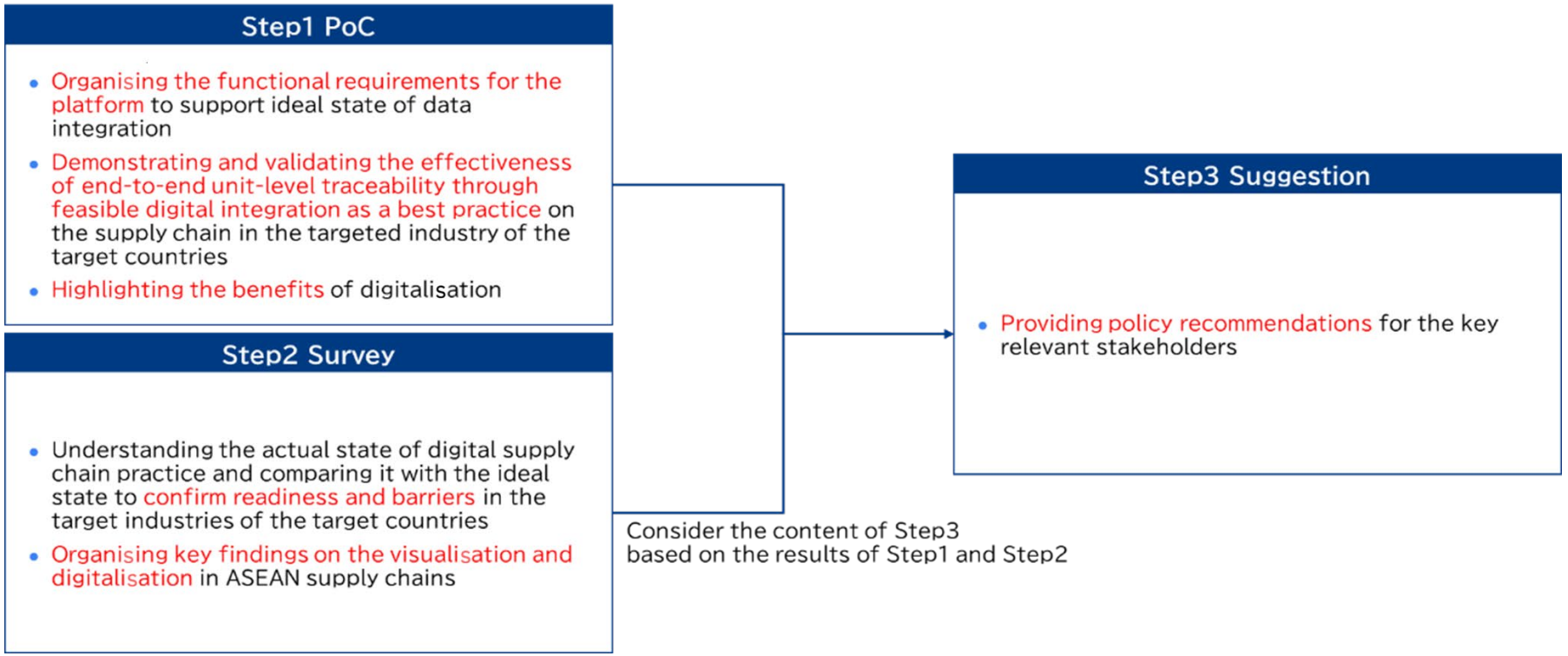
By contrast, a fully digitalised international order and delivery flow can seamlessly connect key stakeholders across inland and maritime supply chains, enabling end-to-end shipment tracking with unit-level data. This smooth and trusted exchange of information is underpinned by Data Free Flow with Trust (DFFT) principle and driven by the ongoing digital transformation of supply chains in ASEAN nations. Achieving this vision is critical for enhancing efficiency, resilience, and trust in regional trade networks.

This report aims to outline the current state and challenges of supply chain digitalisation in ASEAN and to assess the potential impact of achieving end-to-end information integration. By identifying existing gaps and evaluating the benefits of comprehensive digital integration, the study seeks to provide policy recommendations for strengthening supply chain resilience and accelerating regional trade facilitation.

2. Approach

This project adopts a dual-track approach that simultaneously combines practical validation with comprehensive research to address the digitalisation issues of supply chains in the ASEAN region. The validation component involves conducting a **Proof of Concept (PoC)** to demonstrate feasible digital solutions, while the **research (Survey)** component complements it by analysing the current systems, policies, and practices to derive broader policy insights, which will ultimately inform **policy recommendations** for ASEAN and its member states. This parallel approach ensures that the findings are not only evidence-based but also grounded in practical feasibility for accelerating digital transformation across ASEAN supply chains.

Figure 1.1. Approach of the Project



Source: Author, 2025.

2.1. Scope and Focus

The study focuses on **time-sensitive and detail-oriented industries** (such as automobiles, electronics, etc.) rather than commoditised sectors (such as apparel/textiles, food/beverage, agriculture etc.). These industries have stronger need to reduce supply chain disruption risks through digitalisation-driven visibility, given their reliance on precision and the high cost of shipping delays.

Amongst such industries in ASEAN, the **automobile industry** stands out as a representative example as it is characterised by highly synchronised just-in-time (JIT) production systems. Under JIT operations, even minor delays in procurement or logistics can disrupt production, making real-time visibility of both inventory and transport status essential. At the same time, maintaining production continuity requires precise unit-level traceability to quickly identify and address disruptions in the supply chain. Because of these characteristics, initiatives in the automotive industry serve as a valuable benchmark for other manufacturing sectors, offering practical insights and lessons for advancing digital transformation. The geographic scope of this study covers six ASEAN countries that serve as major trade and manufacturing hubs: Singapore, Malaysia, Thailand, Indonesia, the Philippines, and Viet Nam.

2.2. Analytical Framework: Four Pillars of Ideal Digitalisation

To achieve seamless cross-border connection, enable end-to-end unit-level traceability, and ensure trusted data exchanged underpinned by DFFT, this report is based on an ideal state of supply chain digitalisation (To-be), which is structured around these four key pillars (each pillar is broken down into three criteria for analysis; further details are described in the Survey chapter):

- PILLAR 1: Domestic process efficiency

  Fully digitalised and automated domestic procedures to reduce time and eliminate manual intervention.

- PILLAR 2: Seamless cross-border connectivity and interoperability

  Facilitation of smooth cross-border data exchange and information sharing amongst stakeholders (suppliers, customers, and regulatory authority), where different systems can communicate through common standards.

- PILLAR 3: End-to-end unit-level traceability and resilience

  Real-time tracking of products and components supported by robust data streams (e.g. Global Positioning System or GPS) and adaptable logistics systems to further enhance the resilience in responding to the sudden disruptions.

- PILLAR 4: Trustworthy and secure infrastructure

  Cybersecurity and data governance frameworks ensure the reliability and integrity of digital platforms.

As described above, the distinctive feature of this project lies in envisioning an ideal future state of supply chains through a PoC conducted to establish data integration platform. The PoC will incorporate elements from all four pillars but will primarily

focus on Pillar 3: End-to-end unit-level traceability and resilience, demonstrating how real-time visibility can enhance operational efficiency. Additionally, the PoC aims to show not only the technical feasibility but also the tangible benefits of achieving this ideal state.

Building on the insights from the PoC, the survey part of this project will systematically assess the current state of digitalisation across the six target ASEAN countries and perform a gap analysis against the four pillars of ideal digitalisation (To-be), identifying where each country stands relative to the envisioned ideal state.

3. Contribution to Regional Digital Integration

By advancing these four pillars, the project does not only address operational challenges but also strengthens the foundation for trusted, interoperable, and resilient trade digital ecosystems in the region.

The next chapter will delve into the Proof of Concept, focusing on how Pillar 3: End-to-End Unit-Level Traceability and Resilience can be realised and what benefits it can deliver.

Chapter 2
The Proof of Concept (PoC)

1. Overview

In Chapter 1, it was emphasised that end-to-end unit-level traceability and resilience are essential pillars of an ideal supply chain. To achieve this, data integration is necessary. Therefore, the proof of concept (PoC) aims **to demonstrate the technical specifications and effect of data integration to the regional automotive supply chain management**, specifically between Japan and ASEAN countries, given their strong trade bond.

The PoC targeted the automobile industry as an example for other industries due to the following reasons:

- Advanced DX reforms and history over the past decades.
- End-to-end information management by product unit.

The PoC process consists of the following four items:

1) **Design hypotheses through discussions with experts in the automobile industry**

   Before approaching automobile industry stakeholders, hypotheses for the ideal form of supply chain management were designed.

2) **Verify hypotheses through short consultations with automotive industry stakeholders and search for the PoC partners**

   The hypotheses were verified through consultations with automobile industry stakeholders and key issues to address were identified. PoC partners were also sought for collaboration in the implementation process and for reviewing the results.

3) **Development of the PoC plan and prototype system**

   Based on the PoC partners' needs and actual transactions, prerequisites and evaluation metrics were established. Additionally, prototype system for the PoC was developed.

4) **The PoC results and review from automobile industry stakeholders**

   Changes in transaction data resulting from the PoC was calculated and evaluation KPIs were derived. The evaluation results were reviewed by automobile industry stakeholders.

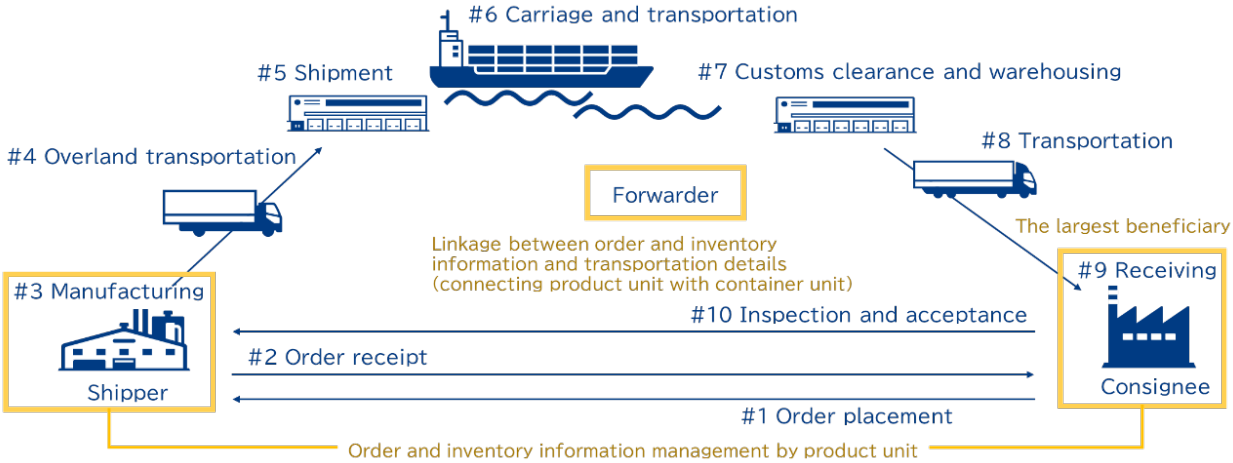
2. Hypothesis Design

Upon discussion with experts in the automobile industry, it is assumed that feasible data keyers for the digital platform would be **a consignee, a shipper and a forwarder**. This is because a consignee is the origin point for issuing order information, while a

shipper is the origin point for issuing shipment information. Furthermore, a forwarder serves to link order information with transportation information. Currently, order information is only shared between a consignee and a shipper, while transportation information is only shared between forwarder and consignee.

Therefore, overall business process surrounding order placement, order receipt, and goods delivery, along with the relationships between players, can be organised as shown in the figures below (data entry keyers are enclosed in the square boxes):

Figure 2.1. Assumed Data Entry Keyers and Business Flow



Source: Authors, 2025.

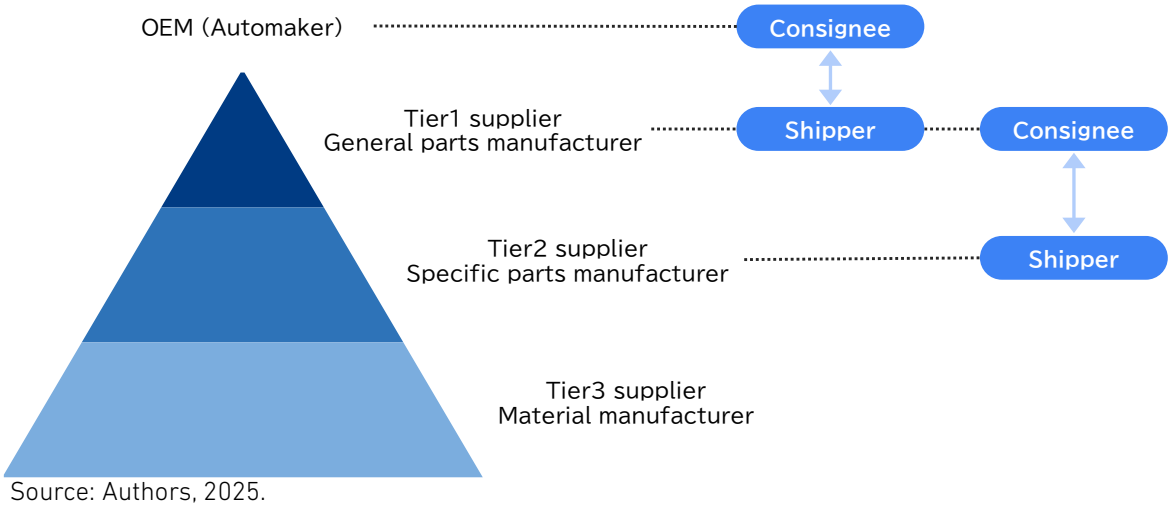
The PoC examines how integrating order information with logistics and transportation data, including customs inspection status as shown in Figure 2.1, **can improve coordination when shared amongst the three participating entities.** Since the consignee controls order quantities, it becomes the largest beneficiary with **significant expected gains in in-house inventory management** through the prototype system.

Moreover, analysing the structure of the automobile industry is essential for designing its overall architecture. The industry is organised as follows: at the top are the OEMs (Original Equipment Manufacturers or automakers), followed by general parts manufacturers (Tier 1 suppliers), specific parts manufacturers (Tier 2 suppliers), and materials manufacturers (Tier 3 suppliers).

In the automobile sector, commercial practices dictate that lower-tier suppliers must adhere to the supply chain arrangements established by the OEMs. Therefore, for the PoC showcase, it is most effective to target either **OEM (consignee)-Tier 1 (shipper) or Tier 1 (consignee)-Tier 2 (shipper)**. Transactions involving Tier 2 and Tier 3 are not included, as enforcing digital exercise on these lower levels of the supply chain can be challenging and their impact is limited.

Lastly, automobiles are commonly produced locally, and cross-border trade in finished vehicles is relatively uncommon. As a result, the targeted products for the PoC demonstration will be **automotive parts**.

Figure 2.2. Assumed Industry Layers and Targeted Transaction Trade Lanes for the PoC



Source: Authors, 2025.

3. Hypothesis Verification

3.1. Approach to Verify Hypotheses

To gain a better understanding of the on-the-ground situations and challenges that will be demonstrated and validated during the PoC execution, as well as to refine the PoC design, the consultation was conducted. This process also aims to identify potential partners for collaboration. The list of advisors is as follows:

- Industry associations
- General parts manufacturers, including members of Study Group for Promotion of Utilization of Trade Platforms by Ministry of Economy, Trade, and Industry of Japan (METI)
- OEM (Automaker)
- Automotive parts trading companies

3.2. Consultation Result

As the result of the consultations, the below priority issues were identified:

1) Upgrading order and inventory data management

While order information is shared between the Shipper and the Consignee, logistics, transportation, and customs inspection data are not shared. Data integration owned by all stakeholders, from the beginning to the end of the shipment chain, will advance order processing and inventory management across the entire supply chain.

1a) Data integration at local EDI

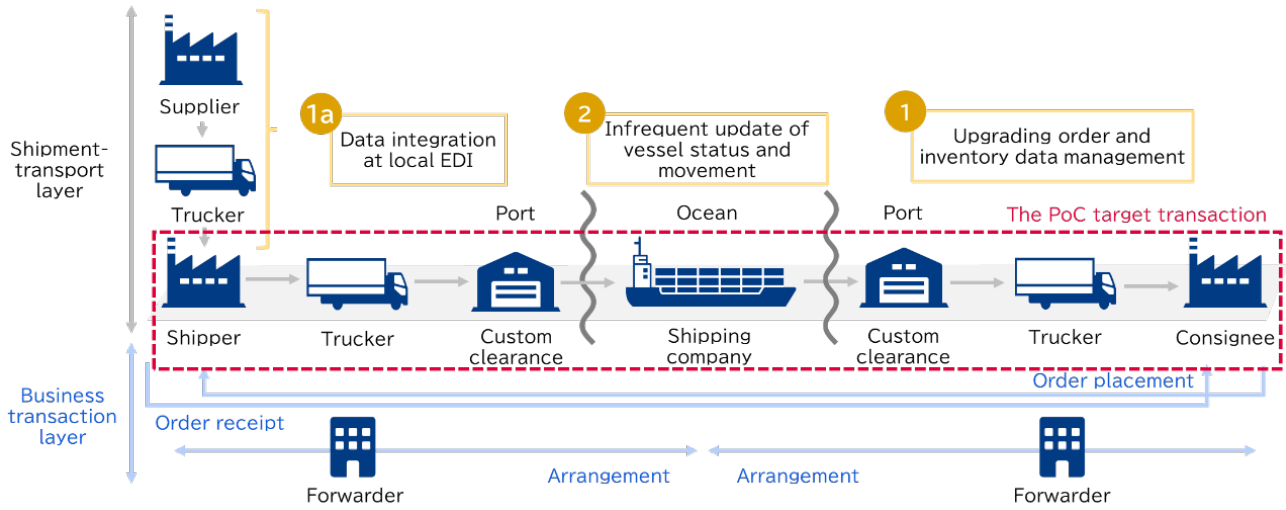
Order, logistics, and transportation details for local arrangements, specifically between production sites and the shipper's warehouse or factory, are not currently integrated into the main platform utilised by the headquarters for cross-border automotive trading. Connecting this local information to the main system will improve visibility and inventory planning for the international consignee.

2) Infrequent update of vessel status and movement

Information on vessel status and movement is updated infrequently, making it **difficult to plan orders considering delays and arrange alternative deliveries**. Increasing the update frequency of vessel-related information enables agile responses to delays.

The purpose of the PoC was to assess how integrating and visualising information amongst a consignee, a shipper and a forwarder can address issues #1 and #2. It focused on **how this data integration enhances in-house consignee's inventory management, especially during disruptions like vessel delays.** Since issue #1a is a derivative of #1, it has been excluded from the PoC.

Figure 2.3. Identified Priority Issues to be Verified in the PoC



Source: Authors, 2025.

The table below shows the correspondence with the issues mentioned by the advisors.

Table 2.1 Summary of the Issues Mentioned by the Advisors

Advisor		Issue		
Type	Name	#1 Upgrading Order and Inventory Data Management	#1a Data Integration at Local EDI	#2 Infrequent Update of Vessel Status and Movement
OEM (Automaker)	A	✓	✓	✓
	B	✓		✓
	C		✓	✓
	D			
General parts manufacturer	E	✓		✓
	F	✓		✓
	G			
Automotive parts trading companies	H			
	I			✓

Source: Authors, 2025.

Details on the consultations are summarised in Appendices 1 Details of the Advisors' Feedback.

4. Development of the PoC Plan and Prototype System

For the issues identified in the previous section, the PoC plan was designed to clarify the potential for resolution through the integration and visualisation of supply chain data. Furthermore, based on the PoC plan, the prototype system was developed that enables the trial integration and visualisation of supply chain data.

4.1. Approach to Develop PoC Plan and Prototype System

The supply chain data of companies is crucial for their business strategies. As a result, many companies are hesitant to share their actual data for the proof of concept (PoC) demonstration, leading to reliance on synthetic data. To better align the PoC plan and prototype with the current automotive supply chain, they were reviewed by real business entities, including one original equipment manufacturer (OEM) and one general parts manufacturer.

4.2. Assumption

To create the synthetic data and develop the prototype system, assumptions regarding the setting, business processes, data list, and key data item were set.

- Setting: Define the setup of this PoC, such as the Product and Shipping Mode (Table 2.2 PoC Setting).
- Business process: Define the processes or flows in one full cycle of international procurement (Table 2.3 PoC Business Process).
    - To realistically simulate Issue #2, vessel delay is assumed to occur with certain possible frequencies and durations.
- Data list (representative): List down all data available throughout an entire trade chain. Each of data items refers to the dictionary developed by UNESCAP and ICC-DSI called Key Trade Documents and Data Elements (KTDDE)[1] to ensure relevance (Table 2.4 PoC Data List (Representative)).
- Key data item: Define only the essential data items in each document that are needed to link and populate all required information (Table 2.5 PoC Key Data Item).

Table 2.2. PoC Setting

Type	Assumption	Note
Consignee	OEM	Since it assumes Japanese OEMs, the results may vary for companies with different business scales.
Shipper	Tier 1 Supplier	
Product	A product suitable for JIT (Just-In-Time) approach	Product with a short lead time from production to consignee arrival, where reducing inventory in the warehouse is essential, and it is cost-effective to regularly ship by air in case of delays.
Country	Between ASEAN and Japan	
Data Keyer(s)	Consignee, Shipper, Forwarder	Data keyers must input the data into the system (either by manual keying or automati connection through API for real-time data update)
Shipping mode	Vessel, Air	
Logistic arrangements	Full Container Load (FCL)	One container and anything inside belonging to same consignee (one destination)
Incoterms	Cost Insurance and Freight (CIF)	
Time span	One year	
Frequency of business operation	Daily (from Monday to Friday)	
Quantity required for production	300 units (per Five business days)	

[1] https://www.digitalizetrade.org/ktdde

Type	Assumption	Note
Order frequency	Once a week (every Monday or Tuesday)	
Warehouse storage	480 units	Since orders are usually placed once a week, the warehouse is assumed to have enough capacity to store 8 business days of production as a buffer.
Initial inventory	300 units	The initial inventory level at the start of the PoC is assumed to be sufficient for 5 business days of production, reflecting the typical weekly ordering cycle.
Safety stock threshold	300 units	Because orders are placed weekly, safety stock is set to cover 5 business days of production to buffer against potential vessel delays. Inventory must stay above this level at the end of each day.

Source: Author, 2025.

Table 2.3. PoC Business Processes

#	Country	Process	Process Type	Responsible Party	Lead Time (vessel)	Lead Time (air)
1	Importing Country	Market forecast manifested in production plan. *I	Commercial process	Consignee	-	
2		Upon considering inventory left, domestic procurement, buffer items, etc. consignee place order to shipper. *I *II			1 day	1 day
3	Exporting Country	Shipper confirms the order and will send out the goods either once or more or by sending them in batch accumulatively. *I *III		Shipper	3 days *IV	1 day
4		Shipper packs the ordered goods. *I	Transportation process			
5		Shippers dispatch the freight-stuffed truck to the port. *I			1 day	1 day
6		Truck is moving to port. *I		Parties responsible for delivery		
7		Truck arrives at port. *I				
8		Export custom clearance. *I	Regulatory process	Parties responsible for custom clearance	1 day	1 day
9		Container gate-in. *I	Transportation process	Parties responsible for delivery	2 days *IV	
10		Container loading to vessel.				
11	International	Vessel unberth and departure. *V			15 days *V	1 day
12		Vessel is moving to Port of Discharge.				
13		Vessel berth and arrival.				

#	Country	Process	Process Type	Responsible Party	Lead Time (vessel)	Lead Time (air)
14	Importing Country	Container discharged from vessel.	Transportation process	Parties responsible for delivery	1 day	1 day
15		Import custom clearance. *I	Regulatory process	Parties responsible for custom clearance	2 days *IV	
16		Container gate out. *I	Transportation process	Parties responsible for delivery		
17		Truck leaves the port. *I			1 day	1 day
18		Truck is moving to Consignee's door. *I				
19		Freight arrived at the Consignee's door and Consignee confirmed receipt. *I *VI	Commercial process	Consignee		

*I: These business processes are not carried out on weekends; II: Only one kind of product is ordered per order; III: Assume a scenario where two invoices are issued for one order; IV: Vessels are used for regular orders, and these orders are placed well in advance; V: Minor delays (4-6 days) happen twice a month while major delays (8-10 days) happen once every three months; VI: Products that arrive at the warehouse are assumed to be available for use starting from production on the day after their arrival.
Source: Author, 2025.

Table 2.4. PoC Data List (Representative)

#	Country	Process	Data	Representative data item *I
1	Importing Country	Market forecast manifested in production plan.	Production plan *II	·Required date ·Product number ·Required quantity
2		Upon considering inventory left, domestic procurement, buffer items, etc. consignee place order to shipper.	Inventory information	·Inventory confirmation date ·Product number ·Inventory quantity
			Purchase order	·Order date ·Delivery date ·Purchase order number ·Quantity ordered
3	Exporting Country	Shipper confirms the order and will send out the goods either once or more or by sending them in batch accumulatively.	Commercial invoice *III	·Invoice number ·Quantity
4		Shipper packs the ordered goods.	Packing list	·Conveyance reference number ·Quantity
5		Shippers dispatch the freight-stuffed truck to the port.	Shipper's letter of instructions or Shipping instructions	·Date of departure from the exporting port ·Shipping Instruction number ·Number of packages
6		Truck is moving to port.	-	
7		Truck arrives at port.	Shipping Advice or Shipping Notice	·Date of notification ·BL number
8		Export custom clearance.	Customs Declaration	·Date of custom clearance ·Booking reference number ·Number of packages
9		Container gate-in.	Container yard	·Date of departure from the

#	Country	Process	Data	Representative data item *I
			information	container yard ·Booking reference number
10		Container loading to vessel.	Bill of Lading	·Date of departure from the exporting port ·BL number ·Number of packages
			Sea Waybill	·BL number ·Number of packages
			Sea Cargo Manifest	·BL number ·Number of packages
11	International	Vessel unberth and departure.	Shipping Information *IV (vessel or air)	·Estimated time of arrival ·Vessel number
12		Vessel is moving to Port of Discharge.		
13		Vessel berth and arrival.	Arrival Notice *V	·Date of arrival ·Vessel number
14	Importing Country	Import custom clearance.	Customs Declaration	·Date of custom clearance ·Invoice number ·Number of packages
15		Container discharged from vessel.	Bill of Lading	·Date of arrival at the importing port ·Container number ·Goods value
			Sea Waybill	·Container number ·Goods value
			Sea Cargo Manifest	·Container number ·Goods value
16		Container gate-out.	Ship's Delivery Order	·Date of departure from the importing port ·BL number
17		Truck leaves the port.	Shipping Information	·Date of notification

#	Country	Process	Data	Representative data item *I
			(Trucker)	･Vehicle registration number
18		Truck is moving to Consignee's door.	-	
19		Freight arrived at the Consignee's door and Consignee confirms receipt.	Warehouse Receipt	･Issue date ･Purchase order number ･Quantity

*I: All data items are listed in the Appendices 4 PoC Assumption (Data List); II: The procurement plan is created based on the production plan; III: One invoice is issued per purchase order. However, for the PoC target time span, it was also demonstrated a case where two invoices are issued for a single purchase order. In such a case, the ordered quantity is shipped in two separate batches, with the second shipment arriving five days later than the original ETA (Estimated Time Arrival) of the first shipment; IV: In the case of after data integration, the arrival delay at the importing port can be detected immediately after the shipment departs from the exporting port, based on the shipping information. Shipping information can be identified through open data and is assumed to be integrated into the prototype system via API; V: In the case of before data integration, delays can only be detected through the arrival notice, which is issued two days before ETA at the importing port (13 days after departure from the exporting port).
Source: Author, 2025.

Table 2.5. PoC Key Data Item

Document	Key data item										
	Product number	Purchase order number	Invoice number	HS code	Conveyance reference number	Vehicle registration number	Vessel number	Container Number	Booking Reference number	Shipping Instruction number	BL number
Production Plan	✓										
Inventory Information	✓										
Purchase Order	✓	✓									
Commercial Invoice	✓	✓	✓	✓							
Packing List		✓	✓	✓	✓						
Shipper's Letter of Instructions or Shipping Instructions		✓	✓		✓		✓	✓		✓	
Shipping Advice or Shipping Notice						✓				✓	✓
Customs Declaration			✓	✓					✓		
Container Yard Information								✓	✓		
Bill of Lading				✓	✓		✓	✓			✓
Sea Waybill				✓			✓	✓			✓
Sea Cargo Manifest					✓		✓	✓			✓
Shipping Information (vessel or air)							✓				
Arrival Notice							✓				
Ship's Delivery Order	✓							✓			✓
Shipping Information (Trucker)						✓		✓			
Warehouse Receipt	✓	✓	✓								

Source: Author, 2025.

4.3. Synthetic Data Creation Method

For the creation of synthetic data, the data consistency is ensured by following the three steps outlined below:

- Determine fixed values based on the assumption (e.g. Origin: ASEAN/Japan, Incoterms: CIF).
- Determine naming rules for the key items (e.g. Invoice number: 'INV'+'4-digit random number).
- Set formulas to automatically generate items that can be calculated using logic (e.g. Quantity ordered: Calculated by the simulation execution function)

The synthetic data creation methods for all data items are detailed in the Appendices 4 PoC Assumption (Data List).

4.4. Specifications of the Prototype System

The prototype system has been set to enable the creation, integration, and visualisation of synthetic data within the supply chain. Additionally, it allows for the simulation of order management operations conducted by the consignee. The system has the following three functions:

- Simulation Settings Registration Function

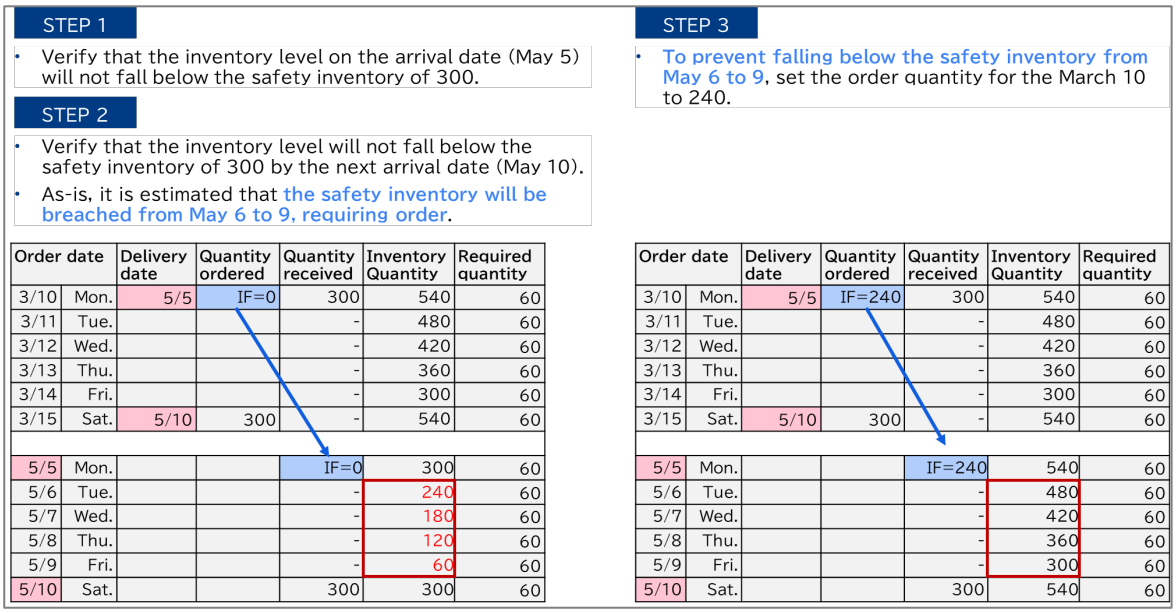
  The Simulation Settings Registration Function is a feature designed to allow Excel file uploading that sets the assumption and scenario for the simulation. Additionally, it also permits multiple adjustments to input different value of vessel delay days and safety stock levels.

- Simulation Execution Function

  It enables the simulation of order management operations conducted by the consignee. As a premise, regular orders for shipment by vessel are placed every week, and products are ordered to cover the quantity shortage for production until the vessel arrives (order quantity considers total vessel lead time)[2]. However, if a delay occurs with the vessel shipment, an emergency order for shipment by air is considered, ensuring that the products can arrive by the initial ETA (Estimated Time Arrival) specified in the purchase order. Additionally, the order quantity for emergency shipment only covers the period of production shortages until the delayed vessel arrives. If a delay occurs in the vessel shipment but does not affect production, no emergency order for shipment by air will be placed. Afterwards, next batch of order quantity will be adjusted. For detail formula and calculation please refer to Table 2.6.

[2] Refer to Figure 2-4

Figure 2.4. Method for Setting Order Quantities



Order date		Delivery date	Quantity ordered	Quantity received	Inventory Quantity	Required quantity
3/10	Mon.	5/5	IF=0	300	540	60
3/11	Tue.			-	480	60
3/12	Wed.			-	420	60
3/13	Thu.			-	360	60
3/14	Fri.			-	300	60
3/15	Sat.	5/10	300	-	540	60
5/5	Mon.			IF=0	300	60
5/6	Tue.			-	240	60
5/7	Wed.			-	180	60
5/8	Thu.			-	120	60
5/9	Fri.			-	60	60
5/10	Sat.			300	300	60

Order date		Delivery date	Quantity ordered	Quantity received	Inventory Quantity	Required quantity
3/10	Mon.	5/5	IF=240	300	540	60
3/11	Tue.			-	480	60
3/12	Wed.			-	420	60
3/13	Thu.			-	360	60
3/14	Fri.			-	300	60
3/15	Sat.	5/10	300	-	540	60
5/5	Mon.			IF=240	540	60
5/6	Tue.			-	480	60
5/7	Wed.			-	420	60
5/8	Thu.			-	360	60
5/9	Fri.			-	300	60
5/10	Sat.			300	540	60

Source: Authors, 2025.

- Result Output Function

Result output function is possible to verify the order quantity and inventory levels across the supply chain. By changing the data verification date, the data as of that specific point in time will be displayed. If a delay occurs, an alert will be displayed.

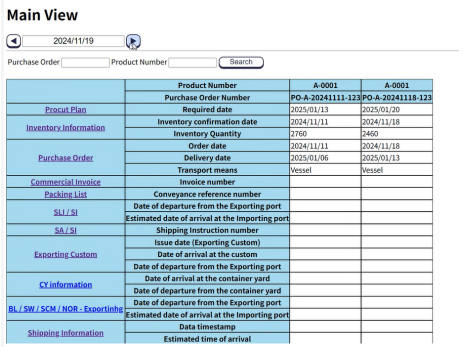
Figure 2.5. Three Functions of the Prototype System

1. Simulation settings registration function

The system can reflect the settings by importing a file that contains the simulation configurations

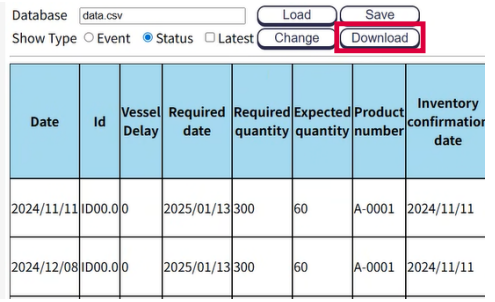
2. Simulation execution function

Execute the simulation



3. Result output function

Output the simulation results on the screen and in CSV format



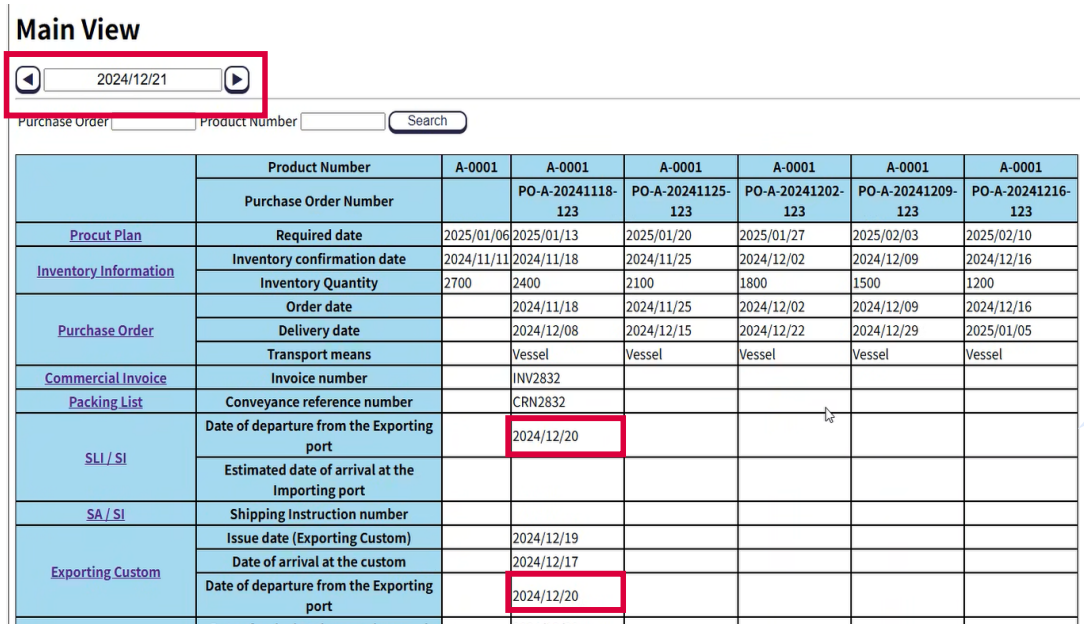
Source: Authors, 2025.

Table 2.6. Detailed Formula of Simulation Execution Function

Item	Regular Ordering: vessel	In the Event of a Delay: Air
Order date	Weekly (Orders are placed every Tuesday)	An order is placed after detecting the delay in the vessel shipment, ensuring that the products can arrive by the initial scheduled delivery date specified in the vessel purchase order.
Order quantity *When the value is 0 or less, no order is required	= 'Quantity shortage for production until the next order date' + 'Quantity shortage for production from the next order date until one lead time cycle has passed ' 'Quantity shortage for production until the next order date' = 'Quantity required for production until the next order date' - ('Actual inventory' - 'Safety inventory' + 'Expected arrival quantity until the day before the next order date') *Actual inventory refers to the inventory level at the end of the previous day. 'Quantity shortage for production from the next order date until one lead time cycle has passed' = 'Quantity required for production from the next order date until one lead time cycle has passed' - 'Expected arrival quantity until the day before one lead time cycle has passed from the next order date'	= 'Quantity shortage for production until the estimated arrival date, taking into account the delayed vessel shipping' = 'Quantity required for production until the estimated arrival date, taking into account the delayed vessel shipping' - ('Actual inventory' - 'Safety inventory' + 'Expected arrival quantity until the day before the estimated arrival date, taking into account the delayed vessel shipping') *Actual inventory refers to the inventory level at the end of the previous day. Place an order when the following two conditions are met: *1 Order significance decision: An additional order for shipment by air (AIR) will be placed if it can arrive even one day earlier than delayed vessel shipping *2 Order necessity decision: Place the order when the following conditions are met 'Safety inventory' > 'Actual inventory' - 'Quantity required for production until the estimated arrival date, taking into account the delayed vessel shipping' + 'Expected arrival quantity until the day before the estimated arrival date, taking into account the delayed vessel shipping'

Source: Authors, 2025.

Figure 2.6. Screen Images of the Prototype System (Result Output Function: Main View)



Main View

2024/12/21

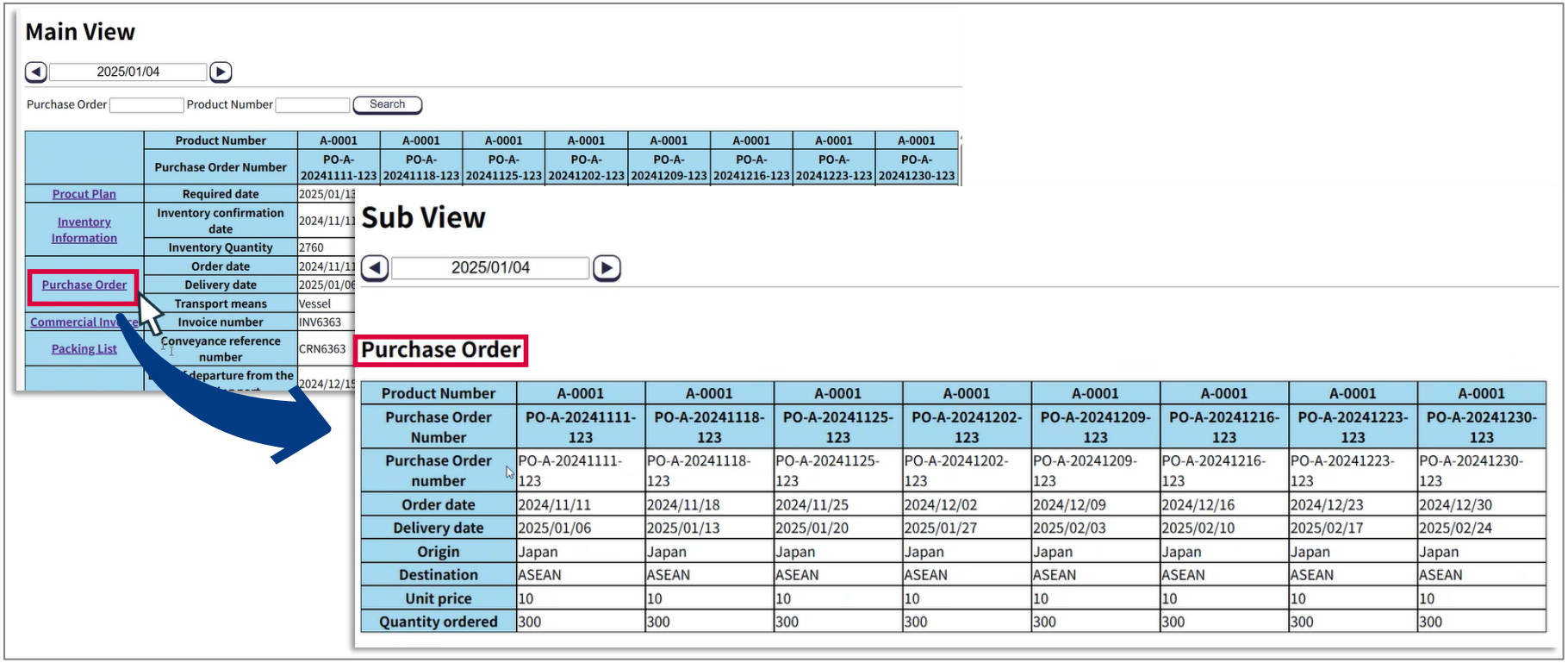
Purchase Order Product Number Search

	Product Number	A-0001	A-0001	A-0001	A-0001	A-0001	A-0001
	Purchase Order Number		PO-A-20241118-123	PO-A-20241125-123	PO-A-20241202-123	PO-A-20241209-123	PO-A-20241216-123
Procut Plan	Required date	2025/01/06	2025/01/13	2025/01/20	2025/01/27	2025/02/03	2025/02/10
Inventory Information	Inventory confirmation date	2024/11/11	2024/11/18	2024/11/25	2024/12/02	2024/12/09	2024/12/16
	Inventory Quantity	2700	2400	2100	1800	1500	1200
Purchase Order	Order date		2024/11/18	2024/11/25	2024/12/02	2024/12/09	2024/12/16
	Delivery date		2024/12/08	2024/12/15	2024/12/22	2024/12/29	2025/01/05
	Transport means		Vessel	Vessel	Vessel	Vessel	Vessel
Commercial Invoice	Invoice number		INV2832				
Packing List	Conveyance reference number		CRN2832				
SLI / SI	Date of departure from the Exporting port		2024/12/20				
	Estimated date of arrival at the Importing port						
SA / SI	Shipping Instruction number						
Exporting Custom	Issue date (Exporting Custom)		2024/12/19				
	Date of arrival at the custom		2024/12/17				
	Date of departure from the Exporting port		2024/12/20				

[e.g.] As of December 21, 2024
For the order placed on November 18th, the Date of Departure from the Exporting Port has been updated to December 20th.

Source: Authors, 2025.

Figure 2.7. Screen Images of the Prototype System (Result Output Function: Sub View)



Product Number	A-0001	A-0001	A-0001	A-0001	A-0001	A-0001	A-0001	A-0001
Purchase Order Number	PO-A-20241111-123	PO-A-20241118-123	PO-A-20241125-123	PO-A-20241202-123	PO-A-20241209-123	PO-A-20241216-123	PO-A-20241223-123	PO-A-20241230-123
Purchase Order number	PO-A-20241111-123	PO-A-20241118-123	PO-A-20241125-123	PO-A-20241202-123	PO-A-20241209-123	PO-A-20241216-123	PO-A-20241223-123	PO-A-20241230-123
Order date	2024/11/11	2024/11/18	2024/11/25	2024/12/02	2024/12/09	2024/12/16	2024/12/23	2024/12/30
Delivery date	2025/01/06	2025/01/13	2025/01/20	2025/01/27	2025/02/03	2025/02/10	2025/02/17	2025/02/24
Origin	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan
Destination	ASEAN	ASEAN	ASEAN	ASEAN	ASEAN	ASEAN	ASEAN	ASEAN
Unit price	10	10	10	10	10	10	10	10
Quantity ordered	300	300	300	300	300	300	300	300

Source: Authors, 2025.

4.5. Relationship between Focused Issues and KPIs

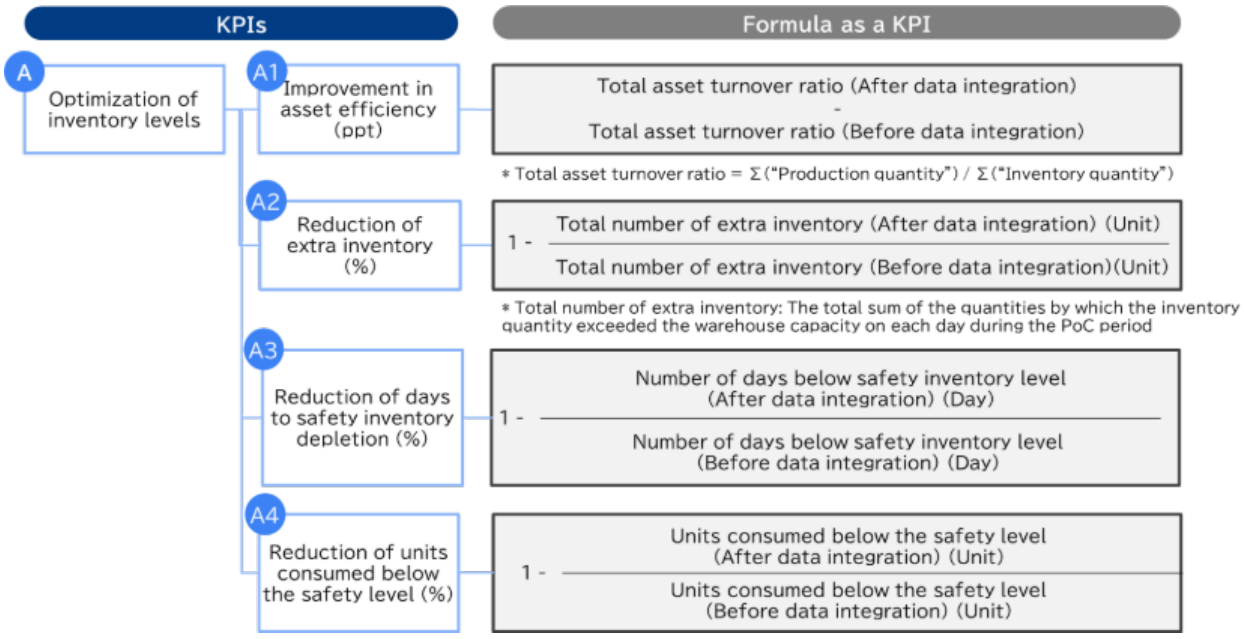
To provide better sense on how PoC will influence existing practice, these definitions are provided here as a supplementary information:

- **Before PoC (data integration):** A state where each player in the supply chain holds their own data in silos. **Consignee only receives the information of approaching vessel arrival to the importing port last-minute from the issuance of Arrival Notice document by Vessel Company.**
- **After data integration:** A state where all the data regarding order, logistics, transportation, and customs inspection in the data list (see: Appendices 4 PoC Assumption (Data List)) has been fully integrated at unit level. **Therefore, Consignee could obtain better visibility of their cargo movement starting from the first mile after the vessel departs the exporting port.**

Afterwards, KPIs (A to C) have been established to verify issue #1 and #2. This section details their definitions and calculation formulas.

Firstly, if all the data has been integrated throughout the supply chain, the location and delay status of cargo can be determined more quickly and accurately. Extra inventory in the warehouse can be reduced and supplies shortages can be prevented. 'Optimisation of inventory levels' can be evaluated using the following formula.

Figure 2.8. Formula of Optimisation of Inventory Levels



Source: Authors, 2025.

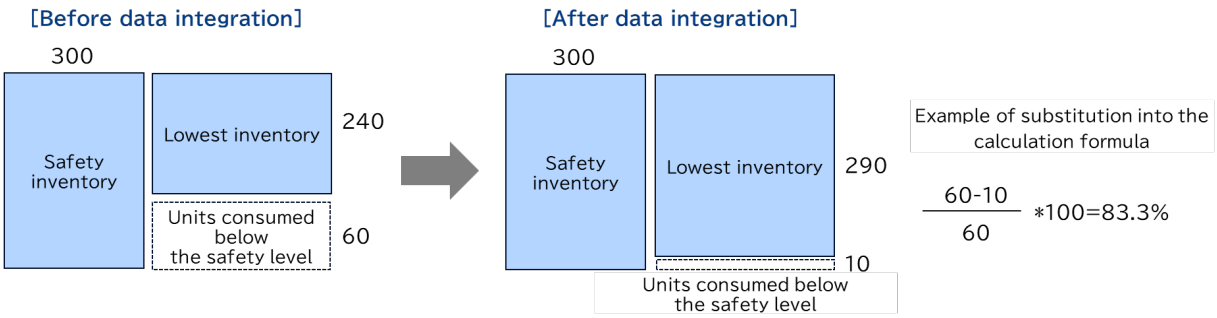
The explanation of each KPIs is as below:

- KPI A1: Improvement in Asset Efficiency
  Asset turnover ratio is a management indicator showing how efficiently a company converts its assets into sales. High ratio indicates efficient management where

assets are effectively utilised, such as through optimised inventory levels, enabling significant sales with minimal assets. Whereas low ratio indicates assets are not generating sufficient profit or are underutilised. Therefore, after simulation, this KPI is expected to increase.

- KPI A2: Reduction of Extra Inventory
  Extra inventory refers to the remaining stock that can't be stored within the warehouse and must be placed in additional space. As mentioned in PoC Setting (Table 2.2), warehouse can accommodate only 480 units. When extra inventory increases, both inventory holding costs and external warehouse fees rise. Therefore, this KPI is expected to decrease after the simulation.
- KPI A3: Reduction of Days to Safety Inventory Depletion
  'Safety inventory' is the minimum stock level a manufacturer should maintain to buffer against unexpected events, such as vessel delays or demand fluctuations. This ensures continuous production flow and prevents production halts, even though falling below this threshold doesn't immediately stop production.
  By detecting the disruptions earlier, vessel delay in this case, immediate countermeasures such as placing necessary additional order using air freight can be implemented to stabilise inventory levels. Therefore, this KPI, which measures the number of days of safety inventory depletion is expected to decrease (if possible, drop to zero) after the simulation.
- KPI A4: Reduction of Units Consumed Below the Safety Levels
  This KPI also aligns with the previous one but uses a different unit of measurement. While KPI A3 counts the number of days when the safety inventory level is depleted, KPI A4 measures how many units are consumed once inventory falls below the safety threshold (refer to Figure 2.9). Under data integration, safety inventory is maintained without going below the threshold, so the number of pieces used below that level is expected to decrease (if possible, fall to zero) after the simulation, reflecting stable safety levels.

Figure 2.9. Supplementary Explanation of Reduction of Units Consumed Below Safety Levels



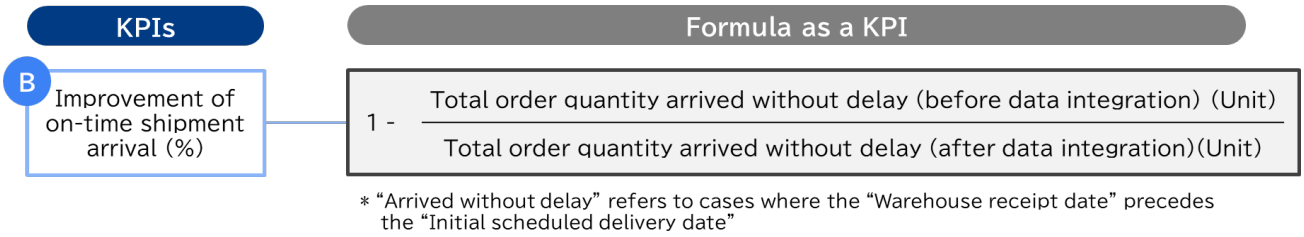
*Lowest inventory is the smallest recorded amount of inventory in the warehouse during PoC timespan.
Source: Authors, 2025.

Secondly, data integration enhances real-time monitoring of product location and timing. This improvement allows vessel delays to be detected much earlier than before integration. Early detection enables stakeholders to take preventive measures so that

goods can still arrive on schedule and remain aligned with the initial estimated time of arrival – usually stated in the Purchase Order. This also helps prevent the depletion of safety stock. Consequently, this KPI is expected to improve after the simulation.

'Improvement of on-time shipment arrival' can be calculated by the below formula.

Figure 2.10. Formula of Improvement of On-Time Shipment Arrival

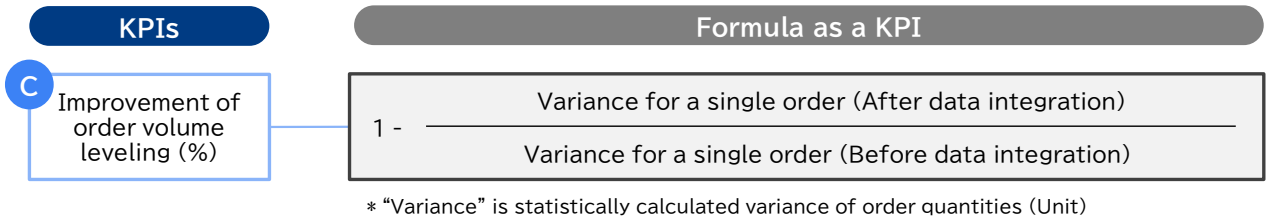


Source: Authors, 2025.

Thirdly, real-time visibility of cargo status and in-house inventory enables more predictable ordering. With clearer in-house information on required production stock, actual warehouse levels, and incoming shipments, this KPI which measures variance in average order quantities is expected to decrease after the simulation, reflecting more stable and consistent ordering behaviour.

'Improvement of order volume levelling' can be verified by the formula as follows:

Figure 2.11. Formula of Improvement of Order Volume Levelling



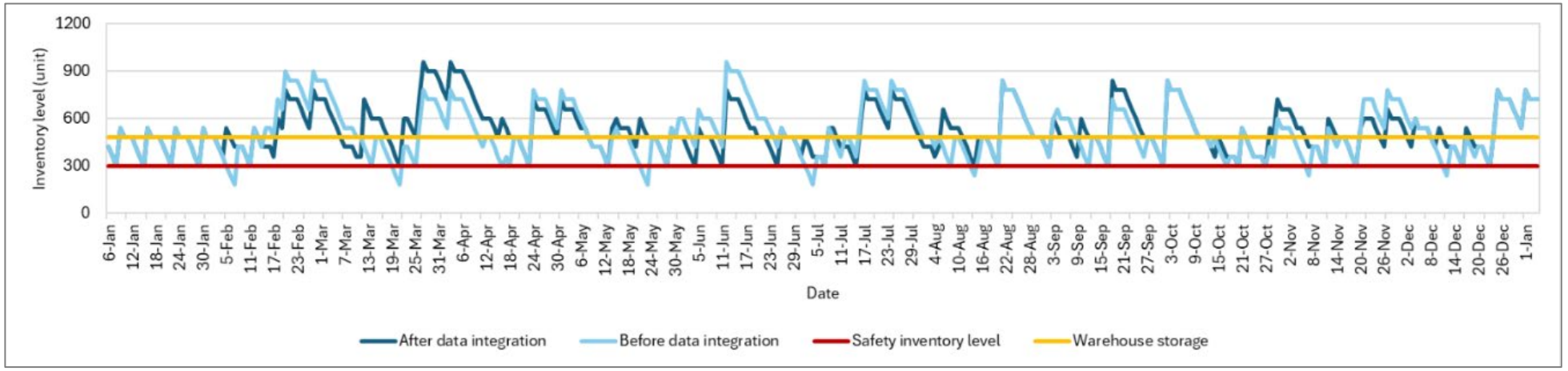
Source: Authors, 2025.

5. Result

5.1. Inventory Level Trends

The inventory level trends before and after data integration are compared. Before data integration, the total inventory quantity is 188,340 units, but after data integration, it is reduced to 191,940 units. On the other hand, before data integration, there were 11 days where inventory fell below the safety stock level; however, after data integration, this was reduced to 0 day (Figure 2.12).

Figure 2.12. Inventory Level Trends



Source: Authors, 2025.

5.2. KPI Evaluation Results

The simulation results are evaluated based on the seven KPIs using the synthetic data. The results are as follows.

A1. Improvement in asset efficiency: -0.16ppt (Asset efficiency increased from 8.28% annually to 8.13% annually)

Although the production quantity remained unchanged before and after data integration, order arrangement after integration increases the number of total annual stocks in the warehouse. This is likely influenced by the fact that, in before data integration, inventory fell below the safety stock level, while after data integration, amount of inventory remains above safety threshold (300 units). As a result, asset efficiency has decreased (divert from initial expectation).

A2. Reduction of extra inventory: 3% (Extra inventory decreased from 30,420 units in a year to 29,520 units in a year)

Optimised order arrangement after data integration reduced the annual extra inventory that could not be accommodated in the warehouse (aligned with the initial expectation).

A3. Reduction of days to safety inventory depletion: 100% (Days to safety inventory depletion decreased from 11 days to 0 days)

Data integration allowed for responsive order placements while ensuring inventory levels remained above the safety threshold, eliminating days of depleted stock (aligned with initial expectation).

A4. Reduction of units consumed below the safety level: 100% (Units consumed below the safety level decreased from 120 units to 0 units)

Data integration allowed for responsive order placements while ensuring inventory levels remained above the safety threshold, ensuring no units were consumed below the threshold (aligned with initial expectation).

B. Improvement of on-time shipment arrival: 31% (Total order quantity arriving on-time increased from 6,060 units to 8,760 units)

Data integration led to an increase of 1,620 units in the total quantity that arrived without delay (aligned with initial expectation).

C. Improvement of order volume levelling: -2% (Variance in order volume increased from 7,318 to 7,485)

Data integration enabled optimal ordering and made unexpected vessel delays visible. This triggered more frequent small emergency orders with varying quantities to the supplier. As a result, the variance increased after data integration (divert from initial expectation).

6. Review Results by Stakeholders

To ensure that the PoC results align with the realities of the automotive industry, reviews are conducted by one OEM company and one general parts manufacturer. Additionally, this PoC assumes that real-time data, such as vessel delays, can be accurately identified. However, accurately capturing real-time data is highly challenging. Therefore, consultations are conducted with the platform operator providing real-time data and a general parts manufacturer exploring the utilisation of real-time data.

6.1. Review Insights

The OEM and automobile general parts manufacturer gave the feedback that the KPI values represent a reasonable range of effectiveness in actual commercial transactions. However, they also mentioned that actual commercial transactions require customised setting of minimum order quantities and still rely on container-level management, making the prerequisites and calculation formulas more complex.

The insights gained from stakeholders' review are summarised in the Appendices 2. Insights Gained from Stakeholders' Review.

6.2. Potential for Utilising Real-time Data

The utilisation of real-time data has the potential to significantly contribute to the advancement of supply chain management. Nonetheless, challenges remain, such as limited data acquisition due to inadequate digitalisation and the inconsistent accuracy of real-time data.

Detailed results of the consultation on real-time data utilisation are summarised in Appendices 3. Consultation Results on the Potential for Utilising Real-Time Data.

7. Consideration

The simulation results show that data integration has enabled optimal ordering tailored to the situation, resulting in improved asset efficiency and reduced extra inventory. However, the increase in frequent smaller orders to avoid falling below the safety stock level has led to a heavier burden on the shipper. Moving forward, it will be necessary to explore an operational balance that is optimal for both the consignee and the shipper.

Based on the consultation results, it was found that the prerequisites set this time were simplified, and more complex conditions are required in the business field. To determine whether the PoC system can be operated under more realistic conditions, the PoC using actual data is necessary.

Furthermore, since the method for setting prerequisites varies by company, a mechanism allowing for customisation is also demanded. The consultations highlighted that each company differs in aspects such as minimum order quantity settings, integration with annual order calendars, and safety inventory definitions, and that these differences significantly impact the effectiveness of the system implementation. Additionally, while this PoC assumed that real-time data could be accurately captured at an early stage, consultations have revealed that many challenges exist in practice.

This project lays a foundation for further development in the future. In the next phase, the Proof of Concept (PoC) can utilise actual data, customise detailed assumptions, and integrate cutting-edge technologies such as AI-based demand and supply forecasting. This approach could more effectively address real-world business challenges and enhance the accuracy of order processing and inventory management within the supply chain.

Chapter 3
Survey

1. Overview

Building upon the insights gained through the development and evaluation of the PoC phase, following sections shift focus to a comprehensive analysis of the current state of digital supply chain transformation across six target countries, Singapore, Malaysia, Thailand, Indonesia, Philippines and Viet Nam, examining how four key pillars are presently addressed and what gaps remain to be filled to achieve a truly optimised and resilient digital supply chain.

2. Analytical Framework and Method

The survey part of this study consists of two main components: desktop research and an interview-based qualitative inquiry. These complementary approaches were adopted to ensure both breadth and depth of analysis, combining secondary data synthesis with first-hand insights from practitioners and authorities. This methodological combination has also been employed in previous research by ERIA; for instance, the approach was utilised in the report 'Vision for the Digitalisation of Supply Chains in ASEAN and Japan',[3] which demonstrated the effectiveness of integrating secondary data review with qualitative interviews to enhance validity and contextual understanding.

The research was guided by the following overarching questions:

- What is the current level of supply chain digitalisation (in relation to the four digitalisation pillars)?
- How does this compare with an ideal digital supply chain model?
- What actions are needed to close the identified gaps and enable interoperability and resilience?

2.1. Desktop Research

The desktop research systematically reviewed publicly available documents and web-based sources, including national strategies, ASEAN and international policy papers, and technical reports related to trade digitalisation and customs modernisation.

Documents were selected based on their relevance to the four digitalisation pillars and their credibility as authoritative sources, drawing primarily on publications from reputable international organisations (e.g. ASEAN Secretariat, UNESCAP, OECD, World Bank) and national government agencies. The review focused on materials published between 2020 and 2024 to capture the most recent developments in ASEAN supply chain digitalisation.

Information was analysed and summarised by pillar, providing a structured overview

[3] https://www.eria.org/research/vision-for-the-digitalisation-of-supply-chains-in-asean-and-japan

to define the 'ideal vision' of a digital supply chain and identify performance gaps across AMS.

To contextualise the analysis, the following steps were undertaken:

- Assessment of national initiatives

  A comprehensive review of publicly available documents and web-based sources was conducted to examine each country's efforts related to the four pillars of digitalisation, assessed under three evaluation criteria for each pillar (see Appendices 5. Overview by Country and Criteria (Current State and Challenges) for detail). This step provides the foundation for conducting gap analysis.

- Mapping ASEAN trade flows

  The major trade flows within ASEAN were clarified and organised to contextualise the digitalisation landscape. This serves as a foundational tool for understanding procedural differences across countries, highlighting where and how national procedures diverge, including country-specific steps and document requirements. It is relevant as one of analytical items for Criteria 1-2: Digital Format Readiness.

- Examining status of National Single Window (NSW) and digital platform

  The status of NSW systems and associated digital platforms, which serve as central elements in the digital transformation of trade processes, will be examined as part of the evaluation framework for Criteria 1-3: Presence of National Single Window.

- Development of a 'Document map'

  A Document map was created to visualise the current state of trade documentation and procedural digitalisation. This map served to illustrate the complexity of processes and highlight disparity between the current practices and the ideal digitalised state. Document map also becomes one of the analytical items for Criteria 1-2: Digital Format Readiness.

Through these steps, the desktop research provided a structured overview of the current landscape and informed the design of the subsequent interview phase.

2.2. Interviews

The second phase consisted of in-depth interviews with key stakeholders, including government authorities (customs and ports), freight forwarders, shippers and consignees, and other relevant industry associations. subject-matter experts engaged in trade procedures. A total of 25 interviews were conducted between June and October 2025 with the following respondents:

Table 3.1. List of Interviewees/Respondent Organisations

Category	Sub-category	Interviewee/Respondent Organisations
Authorities	Customs	Singapore Customs
	Customs	Customs department of Thailand
	Customs	1. Directorate General of Customs and Excise of Indonesia 2. Indonesia National Single Window 3. Indonesia National Logistic Ecosystem
	Customs	Royal Malaysian Customs Department
	Customs	Philippine Bureau of Customs
	Customs	General Department of Viet Nam Customs
	Port	Port Authority of Thailand (PAT)
	Port	PT Pelabuhan Indonesia (Pelindo)
	Port	Port of Penang (Malaysia)
	Port	Philippines Port Authority
	Port	Viet Nam Seaport Association
Forwarder	Association	ASEAN Federation of Forwarders Association
	Association	Singapore Logistics Association
	Association	Thailand International Freight Forwarders Association
	Association	Indonesian Logistics Freight Forwarding Association
	Private company	Company V (Logistics company)
	Private company	Company W (Logistics company)
Shippers/ Consignees	Association	Federation of Thai Industries (Automotive Industry Club)
	Association	The Association of Indonesia Automotive Industries (GAIKINDO)
	Association	Federation of Automotive Industries of the Philippines
	Private company	Company X (Automobile parts company)
	Private company	Company Y (Industrial & Electronics, including automobile parts)
	Private company	Company Z (Automobile company)

Source: Developed by Authors, 2025.

The interviews were designed to:

- Explore the four pillars in greater depth
- Uncover underlying challenges associated with achieving digital supply chain integration in detail-oriented industries.
- Capture lived experiences and expert insights to understand what stakeholders perceive as critical issues requiring resolution.

This qualitative approach aimed to reveal nuanced perspectives and practical constraints that are not evident from secondary data alone. In addition to complementing and validating the insights obtained from the desktop research, the findings from this phase also provided essential input for the formulation of policy recommendations in the later stages of the study.

The following chapter introduces the **ideal vision of a digital supply chain (To-be)** that serves as the benchmark for the gap analysis. It also details the four pillars and the **three evaluation criteria** applied to assess each pillar.

3. Vision of Ideal Digital Supply Chain (To-be)

3.1. General Vision of Ideal Digital Supply Chain

In an increasingly complex and globally interconnected trade environment, the ideal digital supply chain is envisioned as a fully integrated, automatic, transparent, efficient, and resilient ecosystem. It enables seamless connectivity amongst all stakeholders such as manufacturers, logistics providers, regulatory authorities, and port operators while ensuring end-to-end cargo tracking at the unit level. This vision also emphasises secure and reliable data exchange based on the principle of Data Free Flow with Trust (DFFT), fostering interoperability and minimising data fragmentation across borders. Achieving this state requires robust digital infrastructure, harmonised standards, and inclusive mechanisms that benefit both public and private actors across ASEAN.

With this ideal state as the benchmark, the following sections detail the four pillars that define this vision and the three evaluation criteria applied to assess each pillar.

3.2. Four Pillars: Their Ideal States and Evaluation Criteria

This report examines supply chain digitalisation in six ASEAN countries against the ideal state to identify key gaps and derive practical insights.

To facilitate this analysis, the ideal state is deconstructed into four key pillars, each representing a critical aspect of supply chain digitalisation. For each pillar, a set of hypothetical conditions has been established to serve as evaluation criteria.

PILLAR 1. Domestic Process Efficiency

This dimension refers to the extent to which domestic business processes are digitised and automated, resulting in reduced time and eliminate manual intervention.

Ideal state: **All domestic trade-related processes and documents are fully digitalised and automated, enabling seamless workflows and eliminating paper-based transactions.**

It comprises the following three elements:

Criteria 1-1. Digital Infrastructure Readiness

- Ideal state: Supporting digital infrastructure, such as 5G networks, cloud computing environments, and data centres, is either sufficiently developed or has a concrete plan for development within the next few years.
- Rationale: Infrastructure readiness is a prerequisite for any digitalisation effort.

Criteria 1-2. Digital Format Readiness

- Ideal state: Six key trade documents commonly used in trade operations, as well as the trade processes themselves, have been converted into

digital formats.

- Rationale: Converting key documents into digital formats is essential for process automation and interoperability.
- Additional note: The status of document digitalisation will be analysed using Trade Flows, which visualise typical intra-ASEAN digital procedures for trade (see Chapter 3, Section 4.1), and the Document Map, which shows the digitalisation status of key trade documents across countries (see Appendices 6 Document Map), both serving as analytical references for this criterion)

Criteria 1-3. Presence of a National Single Window (NSW)

- Ideal state: A National Single Window system has been established and is operational, enabling the electronic centralisation of domestic trade and regulatory-related procedures, thereby facilitating the digitalisation of trade practices.
- Rationale: NSW is a critical enabler for streamlining domestic trade processes and reducing administrative burdens.
- Additional note: The analysis presented in Chapter 3, Section 4.2 regarding National Single Window implementation will serve as one of the analytical items for this criterion.

PILLAR 2. Seamless Cross-border Connectivity and Interoperability

This dimension refers to the ability of systems to communicate using a common language, allowing for the seamless exchange of information and documentation amongst stakeholders, including suppliers, customers, logistics partners, and regulatory authority.

Ideal state: **All cross-border trade platforms are interoperable, enabling real-time, secure, and standardised data exchange across jurisdictions.**

It comprises the following three elements:

Criteria 2-1. Technical Interoperability

- Ideal state: The ability of different systems to effectively communicate and exchange data, including the capacity to understand and interpret data structures, formats, contexts, and semantics through shared protocols, interfaces, syntaxes, ontologies, taxonomies, and vocabularies.
- Rationale: Technical interoperability ensures that systems can 'speak the same language,' which is fundamental for cross-border digital trade.

Criteria 2-2. Organisational Interoperability

- Ideal state: The ability of multiple organisations or entities to collaborate efficiently and economically by utilising shared policies, procedures, and operational frameworks – such as those based on the principle of Data Free Flow with Trust (DFFT).

- Rationale: Organisational alignment is necessary to operationalise technical standards and ensure smooth collaboration.

Criteria 2-3. Legal Interoperability

- Ideal state: The capacity of systems to comply with legal and regulatory requirements during data exchange, including alignment with international frameworks such as United Nations Commission on International Trade Law (UNCITRAL) Model Law on Electronic Transferable Records (MLETR), Model Contract Clauses (MCC), and Binding Corporate Rules (BCR).
- Rationale: Legal interoperability removes regulatory barriers and builds trust in cross-border data exchange.

PILLAR 3. End-to-End Unit-Level Traceability and Resilience

This dimension refers to the ability to track products and components throughout the entire supply chain, and to ensure resilience through diversified logistics channels.

Ideal state: **Products and components can be tracked in real time at the unit level across the entire supply chain, supported by robust data-sharing frameworks and diversified logistics networks.**

It comprises the following three elements:

Criteria 3-1. Real-time Cargo Tracking

- Ideal state: GPS-based real-time tracking of documents and cargo is enabled through technologies such as Internet of Things (IoT), Radio Frequency Identification (RFID), and Quick Responses (QR) codes, supported by integrated technical and operational protocols.
- Rationale: Real-time tracking is essential for visibility, risk management, and operational continuity.

Criteria 3-2. Management Capability for Tracking Data

- Ideal state: Public and private sector organisations, particularly key industry stakeholders, demonstrate an institutional and managerial willingness to adopt traceability practices, thereby enabling the visualisation and management of trade data.
- Rationale: Adoption and capability to manage tracking data determine the effectiveness of traceability systems.

Criteria 3-3. Supply Chain Diversification

- Ideal state: Export and import markets are sufficiently diversified, ensuring that no single country is excessively relied upon.
- Rationale: Diversification enhances resilience against disruptions and geopolitical risks.

PILLAR 4. Trustworthy and Secure Infrastructure

This dimension refers to the presence of robust cybersecurity and data governance mechanisms that ensures platform protection and fosters trust.

Ideal state: **A secure and trusted digital environment is established, supported by strong legal frameworks, institutional arrangements, and technical safeguards, ensuring data integrity and privacy across the supply chain.**

It comprises the following three components:

Criteria 4-1. Cybersecurity Legal Framework

- Ideal state: A comprehensive legal framework for cybersecurity has been established, enabling the government to formulate strategies, set standards, conduct audits, and maintain incident response systems.
- Rationale: Legal frameworks provide the foundation for national cybersecurity governance.

Criteria 4-2. Governmental/Public Organisation Responsible for Data Security

- Ideal state: A national or public agency responsible for data security has been established and is operating in accordance with international standards.
- Rationale: Institutional responsibility ensures accountability and effective enforcement of cybersecurity measures.

Criteria 4-3. Appropriate Cybersecurity Environment and Operational Status

- Ideal state: Digital signatures, authentication, authorisation, and identification mechanisms have been firmly implemented, supporting robust cybersecurity and effective data governance practices.
- Rationale: Technical safeguards are critical for maintaining trust and preventing cyber threats.

Additional Note (applies to all pillars):
Interview findings will be utilised as supplementary evidence to reinforce the insights derived from desktop research across all evaluation areas.

4. Current Development Status of Digital Supply Chain (As-is)

Following the previous section, which presented the ideal state (To-be) of supply chain digitalisation through the lens of four pillars and their respective criteria, this section marks a shift toward examining the current state (As-is) of trade practices in the ASEAN region. In preparation for the subsequent analysis, we focus here on organising and visualising the actual maritime trade flows that shape the region's economic landscape.

4.1. Overview and Summary of Trade Flows in Six ASEAN Countries

Trade flow analysis is essential for assessing Criteria 1-2. It reveals procedural differences amongst countries, including unique steps and document requirements. The following table illustrates the import and export trade flows, including the sequence of steps from shipper to consignee and the associated action and documents.

Table 3.2. General Intra-ASEAN Trade Flow (Import)

	Ocean	Port	Custom (Port)	Inland	Consignee's door
Trade flow [Import]	• Carriage and transportation • Get import permit	• Ship arrival • Container unloading	• Customs inspection & clearance • Container pick-up	• Delivery to consignee	• Arrange freight with forwarder • Receive order (cargo) [★ Final step]
Action, documents	[Consignee] • Send Purchase Order (PO) to shipper • Request Import permit via declaring agent • Sign a service contract with forwarder [Shipper] • Send Request for Proposal (RFP) to consignee • Sign a service contract with forwarder • Prepare documents - Shipping Instruction (SI) - Bill of Landing (BOL, B/L) - Packing List, Commercial Invoice, Inward declaration form	[Vessel] • Proceed notice of arrival to customs [Forwarder] • Proceed FAL documents - manifest, notice of arrival to customs, notice of readiness, discharge order • Berth & depot booking • Proceed arrival notice to consignee • Share	[Custom] • Check trade documents - Commercial invoice, packing list, SI details (e.g. VGM), copied BOL - e-Form D number - Master BOL (for SG, TH, MY, PH, VN) - Import/Goods declaration form (for TH, PH, VN, ID) - NP, K1 form (for TH) - Inspection certificate (for VN) • Proceed import permit [Forwarder] • Delivery order & Equipment Interchange Receipt from shipping company in exchange of Master BOL	[Deliverer] • Make **a service contract with forwarder** • Notice delivery schedule by SI • Share **tracking data of delivery process** [Forwarder] • Share tracking data of vessel and container	[Consignee] • Order initiation according to Manufacturing/Sales and marketing plan [★ First step] • Check documents - Commercial invoice, PL, BOL (B/L), SI, e-Form D number, etc. • Delivery note

Trade flow [Import]	Ocean	Port	Custom (Port)	Inland	Consignee's door
	• Carriage and transportation • Get import permit	• Ship arrival • Container unloading	• Customs inspection & clearance • Container pick-up	• Delivery to consignee	• Arrange freight with forwarder • Receive order (cargo) [★ Final step]
	(for SG,TH,MY,VN) - Manifest (TH, MY) - Certificate of Origin (CO): e-Form D number (for TH, MY, VN), CO (for SG) - Foreign ship notification (PKKA form) for ID • **Book vessel** • Share delivery schedule to consignee **[Vessel owner]** • Prepare vessel departure/arrival declaration at port **[Forwarder]** • Share tracking data of vessel and container	tracking data of vessel and container	• Tracking data of container		

Source: Compiled by Authors from public sources (as of 2025).

Table 3.3. General Intra-ASEAN Trade Flow (Export)

	Supplier's door	Inland	Custom (Port)	Port	Ocean
Trade flow [Export]	• Manufacturing • Order processing • Forwarder arrangement • Container loading	• Container pick-up at supplier & delivery to port • Delivery to port	• Container unloading • Customs clearance	• Container loading on ship	• Carriage and transportation
Action, documents	• Production, Order initiation by consignee according to its Manufacturing/Sales and marketing plan • Send Request for Proposal (RFP) to consignee • Receive Purchase Order (PO) from consignee • Share PO with forwarder • Prepare documents - Container arrival details, Shipping Instruction (SI), Delivery order to consignee - Commercial Invoice (for SG) - Packing List (for SG) - Certificate of Origin (CO): e-Form D number (for TH, MY, VN), CO (for SG)	• Make a service contract with forwarder • Notice delivery schedule by SI • Share tracking data of delivery process (container depot -> shipper -> port) • Custom release order (CRO) from shipping company • Depot space booking • EIR, House BOL & delivery shipment advice	• Get export permit • Process documents - PL, BOL, e-Form D number, Port space booking, SI details (e.g. VGM) - Export/Goods declaration form (for ID, TH, MY, PH, VN) • Delivery notes to shipper • Tracking data of container	• Proceed FAL documents - manifest, notice of arrival to customs, notice of readiness, discharge order - Master BOL - Notice of readiness (ID, TH, MY, PH, VN) • Berth & depot booking • Share tracking data of vessel and container	• Service contract with forwarder, • delivery schedule, • SI • Vessel booking • Vessel departure declaration • Tracking data of vessel

Source: Compiled by Authors from public sources (as of 2025).

From these visualisations, several key observations emerge:

1) While import and export trade flows generally follow a common structure, the required documents and procedures vary significantly by country.
2) Procedures such as customs clearance, inspections, permits, and port handling are largely similar across many countries, following nearly the same processes.
3) The specific documents and procedures required differ widely by country. For example, in the trade flow diagrams (Table 3.2 and 3.3), the steps in blue text represent country-specific procedures (e.g. applications to designated agencies, additional inspections or certifications). The fact that each country requires submission of its own trade documents highlights that trade procedure systems amongst ASEAN Member States remain unharmonised.
4) Trade flows involve both documents (e.g. commercial invoices, packing lists, e-Form D) and information (e.g. tracking data, shipping schedules), making digitalisation targets diverse. Amongst these, real-time tracking data, such as container locations and vessel schedules, has become increasingly important for ensuring supply chain visibility and reliability.

The trade flow analysis here informed Criteria 1-2, which assess the readiness of digital formats. Currently, each country still requires an additional document for exports and imports that is not standardised. This indicates that trade procedures and the necessary documentation involved in the process are still unharmonised, resulting in uneven progress across different countries.

4.2. Overview of National Single Window (NSW) and Digital Platform

Building on the previous section that examined trade flows and associated documentation, this chapter focuses on the current state of National Single Window (NSW) systems across ASEAN Member States. This analysis relates to Criteria 1-3, which evaluates the presence and operational maturity of NSW within a country as a critical enabler for domestic process efficiency and cross-border trade facilitation.

Summary of Key Findings:

- National Single Window (NSW) systems are now a standard feature across ASEAN, functioning as centralised platforms to streamline customs and regulatory processes. Most digital platforms are built under the authority of the Ministry of Finance or Customs, supporting functions such as electronic permits, customs declarations, and certificates of origin, forming a foundation for interoperable and increasingly integrated regional supply chains.
- Most systems are connected to the ASEAN Single Window's gateway (ASW), enabling direct point-to-point exchange; however, integration remains uneven due to gaps in document implementation – such as delays in adopting e-Phyto (electronic phytosanitary certificates).
- Export/import functions of NSW remain partially implemented, with various connection status to other government agencies and logistics-related processes

(Singapore' NTP is the only one effectively offering 'Value-Added Services' that connect to logistics providers).

These findings directly inform Criteria 1-3: Presence of National Single Window (NSW), which is one of the key evaluation criteria under Pillar 1: Domestic Process Efficiency. Key findings show that NSWs are widely established and typically managed by customs authorities, focusing on digitising trade declarations and permits. However, integration levels vary, as some countries have extensive agency connectivity, while others lag behind. Additionally, logistics-related processes like warehouse and container yard operations are often not yet integrated

The following table illustrates the present structure and connectivity of NSW systems across ASEAN Member States.

Table 3.4. National Single Window (NSW) and Digital Platform

		Singapore	Malaysia	Thailand	Indonesia	Philippines	Viet Nam
National Single Window		TradeNet	NSW (myTRADELINK)	TNSW	INSW	In transition (Former TradeNet being transitioned to alternative system)	VNSW
Jurisdiction		Customs	Ministry of Finance	Ministry of Finance Customs	Department of Treasury (INSW Division)	Ministry of Finance	General Department of Customs
Connection		30 licensing agencies, 10 banks, 160 customs offices, etc.	34 stations	18 Authorities	21 Organisations	8 Ministries	
Digital platform		Networked Trade Platform (NTP)	myTRADELINK	TNSW operated by National Telecom Public Company Limited (NT)	SINSW (Single Submission System)	NSW–Integrated Trade Facilitation Platform (NSW-ITFP)	VNACCS/VCIS
ASW connection status	e-Forum D	✓	✓	✓	✓	✓	✓
	ACDD	✓	✓	✓	✓	✓	✓
	e-Phyto	Not clear	System already built	Exchange with Indonesia	Exchange with Thailand	Exchange with Thailand and Indonesia	Not clear
Export	Shipping						✓

		Singapore	Malaysia	Thailand	Indonesia	Philippines	Viet Nam
Functions	Export Customs Clearance	✓	✓	✓	✓	✓	✓
	Bonded warehouse transportation/CY loading				✓		
	Permission from other government agencies and export declaration	Partial	Partial	✓	✓	✓	
	Departure procedures					Partial	
	Collection of customs duties	✓	✓	✓		✓	
Import Functions	Permission from other government agencies and export declaration		Partial	✓	✓	Partial	
	Port entry procedures	✓				Partial	Partial
	CY/Bonded Entry						Partial
	Import customs clearance	✓	✓	✓	✓	✓	✓
	Customs collection	✓	✓	✓		✓	Partial

Source: Compiled by Authors from public sources and interview findings (as of 2025).

4.3. Document Map

This section introduces the Document map, which also serves as a key analytic item for Criteria 2: Digital Format Readiness. The Document map was developed to systematically capture the digitalisation status as well as the diversity of approaches amongst ASEAN countries, offering insights into where harmonisation efforts may be needed.

In this study, the Document map organises information along two dimensions:

1. Key data elements contained in major trade documents (e.g. commercial invoices, packing lists, certificates of origin).
2. The formats in which these data are exchanged, ranging from paper-based formats to fully digital and interoperable systems.

Summary of key findings (For detail, see Appendices 6 Document map)

Common Features across ASEAN:

- Though the degree of progress differs across countries, all six AMS are transitioning from paper-based to electronic and ultimately digital systems.
- NSW and ASW platforms serve as key enablers of trade document digitalisation.
- Customs declarations and certificates of origin are amongst the most digitised documents.
- The integration of Permit Issuing Agencies (PIAs) into the National Single Window remains fragmented in several AMS (excluding Singapore). In these cases, traders often face semi-digital processes where online submission is possible, but backend approval in some Other Government Agencies (OGA) may still require manual intervention.
- While major hub ports in the region (e.g. Singapore, Port Klang, Tanjung Priok) have adopted electronic Equipment Interchange Receipts (e-EIRs) and automated gates, paper-based documentation remains prevalent at the last-mile at the gate, off-dock depots, empty container yards, and secondary ports across the developing AMS.
- Business-to-Business (B2B) exchanges typically use Enterprise Resource Planning (ERP) and forwarder systems, while Business-to-Government (B2G) exchanges rely on NSW and TradeNet for declarations.

Country Highlights:

- Singapore: Most documents, including Customs Permits, Preferential Certificate of Origin (PCoO), and Shipping Instructions, are exchanged in digital formats and some of them are consolidated into NSW. Strong integration between logistics and customs platforms.
- Thailand: Customs declarations and certificates of origin are handled electronically, but digital exchange of logistics documents is partially implemented but fragmented (i.e. Major ports have adopted 'Smart Port' initiatives for the electronic Delivery Order (e-DO), but the e-EIR remains less standardised, often relying on a mix of digital systems and physical verification at the gate).

- Indonesia: Actively digitalising via platforms like e-SKA (Electronic Certificate of Origin Service) and Single Submission (SSm) Pengangkut under National Logistics Ecosystem (NLE). e-DO is fully digital and mandatory at major ports; SP2 Online (digital e-EIR) is widely implemented with Auto Gate verification. Most logistics documents are electronic, though last-mile gate operations can still be hybrid.
- Malaysia: Key documents (Invoices, Packing Lists, Custom Declarations) increasingly electronic. Centralized platforms (e-PCoO, e-Permit) exist. e-DO is fully digital, and the traditional EIR has been replaced by an electronic Gate Pass. OCR cameras capture container condition at the gate, with receipts available online.
- Philippines: Customs Declarations and Certificates of Origin processed electronically. Logistics flows are increasingly digital through OLRS and ACTS. e-DO is processed online; e-EIR has shifted fully to the ICTSI mobile app. Gate Pass/TABS receipts may still be printed as backup due to connectivity issues around ports.
- Viet Nam: Most documents exchanged electronically, some moving toward structured digital formats. e-DO is widely adopted across major terminals, but e-EIR remains hybrid, with physical signatures still required at gates due to container damage liability concerns.

4.4. Interview

Through interviews with government authorities (customs and port officials) in six ASEAN countries, as well as representative organisations of forwarders, shippers, and consignees engaged in intra-ASEAN trade activities, challenges and expectations related to the four pillars of supply chain digitalisation were identified.

While many initiatives are being pursued independently by each country, the challenges and requests identified through the interviews were largely shared across multiple nations. Based on interviews conducted across six ASEAN countries, the following table highlights common cross-cutting issues and expectations raised under each of the four pillars of supply chain digitalisation, observed across different countries and interviewees:

Table 3.5. Interview highlights

Pillars	Comment Category	Main Speaker Category			Key Comments
		Authority	Forwarder	Shipper/ Consignee	
Pillar 1 Domestic Process Efficiency	Challenges/ pain-points	X	X	X	Although digital systems have been introduced, **outdated or misaligned regulations and the traditional mindset** prevent digital files from being recognised as original documents, making them unusable for direct customs clearance.
		X	X		**SME logistics providers and suppliers tend to be slower in adopting digital technologies.**
	Benefits	X	X		Digital transformation is essential to **reduce human error and data duplication through single digital submission.**
	Expectations/ recommendations	X		X	Sharing **low-cost digital best practices,** and standard operating procedures are essential.
		X	X		To **lay the groundwork for SME digitalisation**, providing accessible tools such as web platforms or simple Excel/CSV templates is a practical first step.
Pillar 2 Seamless Cross-border Connectivity and Interoperability	Challenges/ pain-points	X	X		In ASW framework, connections between NSWs are currently limited to a few key trade documents (e.g. ATIGA Form D, Customs Declaration Document, etc.) **Broader document exchange is still under development.**
		X	X	X	**Lack of common digital infrastructure standards** is the biggest challenge (e.g. standardised data transmission protocol, standardised trade document formats, standardised cross-border digital identity

Pillars	Comment Category	Main Speaker Category			Key Comments
		Authority	Forwarder	Shipper/ Consignee	
					protocols).
		X			Limited vendor incentives to open-source secured APIs or interoperable standards.
		X	X		Concerns over data sensitivity and accountability make it difficult for member states to establish a trusted coordinating body for digital interconnectivity.
	Benefits		X		Establishing a mutually interconnected digital trade system across ASEAN is expected to substantially reduce trade-related costs.
	Expectations/ recommendations	X	X	X	There is a need for an ASEAN-level coordinating body to establish shared rules on governance, system integration, data security, and document standardisation to enable seamless interconnectivity. While global data frameworks exist (e.g. the WCO Data Model, UN/CEFACT), ASEAN can develop its own common data model that reflects the unique logistics and digital maturity of its member state.
		X	X		Countries should also test ideas regionally and building interoperability layers (sandboxes) between national systems before full standardisation.
		X			As AMS are currently exploring the development of ASW 2.0, this could be an opportunity for greater alignment or collaboration between AMS

Pillars	Comment Category	Main Speaker Category			Key Comments
		Authority	Forwarder	Shipper/ Consignee	
					to facilitate the potential exchange of additional electronic trade documents.
<u>Pillar 3</u> End to End Unit Level Traceability and Resilience	Challenges/ pain-points	X	X	X	As **suppliers use varied systems** and sectoral differences result in incompatible infrastructures, the creation of a common data language remains a challenge.
	Benefits		X	X	End-to-end traceability will enable **more resilient response to disruptions.** Also, advantage will be that **delays can be detected more quickly. The higher the accuracy of predictions, the more beneficial for planning.**
		X		X	**Predictability at the consignee's end would improve,** leading to greater efficiency in various aspects, including the coordination of storage and transportation.
	Expectations/ recommendations		X	X	**Establishing linkages between unit-level shipment details and relevant business documents** (e.g. Purchase Orders, tracking by Waybill number) is expected to enhance traceability and efficiency during customs clearance and inland transport.
<u>Pillar 4</u> Trustworthy and Secure Infrastructure	Challenges/ pain-points			X	Reluctance to join a common system due to **confidentiality concerns** (who will be accessible to which data, who will be accountable, etc.)
	Benefits			X	Ensuring trust and security in government systems **builds user confidence and reduces**

Pillars	Comment Category	Main Speaker Category			Key Comments
		Authority	Forwarder	Shipper/ Consignee	
					resistance to digital adoption, while protecting sensitive data from costly breaches
	Expectations/ recommendations			X	Industry trust will only be built through proven system reliability over time. **Pilot projects should be rolled out in phases**, allowing trustworthiness to be tested gradually
		X		X	**Common Data Trust Protocols (CDTP) is necessary** to define what data can be shared, how, etc.
		X	X	X	A **neutral oversight authority** at the ASEAN level would provide significant value in ensuring consistency and trust across member states.
			X		Implementation should begin at the national level. **Each country must first designate a responsible entity to lead its secured digital integration efforts**

Source: Compiled by Authors from interview findings, 2025.

4.5. Current Evaluation of Six ASEAN countries through Four Key Pillars

This section provides an overview of the current status of supply chain digitalisation across six major ASEAN countries, based on the four pillars and their respective sub-elements (criteria) outlined earlier.

PILLAR 1: Domestic Process Efficiency

Criteria 1-1. Digital Infrastructure Readiness

1. Ideal State

The ideal state for Criterion 1-1 is defined as:

'Supporting digital infrastructure, such as 5G, cloud, and data centres, is sufficiently developed, or there is a plan for development within the next few years.'

2. Current State

Digital infrastructure development across the six major ASEAN economies is advancing along broadly similar lines, albeit at different rollout phases, and is experiencing rapid growth under each country's national strategy.

- Promotion of digital infrastructure under national strategies (SG, MY, TH, ID, PH, VN)

  Each country positions digital infrastructure as a national priority under its own strategy (e.g. Smart Nation, Digital Philippines, Thailand 4.0, Digital Indonesia Road Map, Digital Viet Nam 2030). These strategies constitute comprehensive policy frameworks that encompass telecommunications infrastructure, cloud environments, and data centre development, as well as digital talent cultivation and the promotion of e-government.

- Adoption of cloud-first policies and cloud migration of government agencies (SG, MY, PH, VN)

  Several governments have adopted cloud-first policies, accelerating the migration of government information systems to the cloud. In particular, Singapore, the Philippines, Viet Nam, and Malaysia are advancing agency cloud adoption as part of their national strategies, improving the efficiency of e-government services and strengthening disaster resilience.

- Entry of global cloud providers and expanding private-sector use (SG, MY, TH, ID, PH, VN)

  Global cloud providers such as AWS, Microsoft Azure, and Google Cloud are actively entering ASEAN markets, driving broader cloud usage across both private enterprises and public institutions. As a result, cloud adoption is advancing in trade-related operations and as IT solutions for SMEs.

- Rapid growth of the data centre market and attraction of foreign investment (MY, TH, ID, PH, VN)

  Data centre development is accelerating across the region, with increased

investment from foreign companies. In the Philippines, Viet Nam, Malaysia, Thailand, and Indonesia, data centres are being promoted as part of national strategies, supported by measures such as tax incentives and land provision.

3. Challenges: The Gaps in Comparison to the Ideal State

While digital infrastructure development is steadily progressing across the major ASEAN economies, a set of common challenges has also become apparent. Although the gap between the ideal and current states across the six countries is relatively small, with each country either having made progress in infrastructure development or having concrete plans in place, challenges remain, particularly in the following areas:

- **Infrastructure disparities and lagging connectivity in rural areas (MY, ID, PH, VN)**

  In many countries, the rollout of 5G and high-speed broadband has centred on urban areas, whereas 4G remains predominant in rural regions and telecommunications build-out lags behind. This widens the digital divide and prevents rural SMEs and residents from fully benefiting from digital services.

- **Insufficient support for SME cloud adoption (MY, ID, PH, VN)**

  Although cloud services are a cost-effective IT solution for small and medium-sized enterprises, many countries lack adequate technical and financial assistance for adoption. Particularly in rural areas, limited ICT skills and low awareness of cloud technologies act as barriers, slowing efficiency gains from cloud utilisation.

- **Environmental and power constraints in data centre development (SG, MY, TH, PH, VN)**

  The data centre market is expanding rapidly, yet sustainability challenges persist. Stable power supply, integration with renewable energy, and advances in cooling technologies are essential for reliable operations of data centres, however these requirements demand large amounts of electricity, which in many cases is still sourced from coal-fired power plants. This reliance on non-renewable energy creates unsustainable practices and increases carbon emissions. Without addressing these technical and environmental issues, long-term operating costs and environmental impacts may rise and sustainable growth of data centres is becoming increasingly difficult.
  In other words, ensuring a stable power supply and integrating with renewable energy remains a challenge, highlighting the need to secure sustainability practice of data centre operation which are crucial as core data infrastructure.

- **Insufficient application to trade and logistics (SG, MY, TH, ID, PH, VN)**

  Current digitalisation efforts in ASEAN remain largely government centric, focused on administrative G2B and G2G processes such as NSW and cloud first policies, while advanced B2B adoption in private sector trade and logistics such as WMS, TMS, and digital EIRs remains limited, though rapid expansion is

expected through initiatives like Indonesia's NLE and Singapore's NTP.

4. Closing the Gap: Recommendations

Based on the current situation outlined above, the region should further advance the following initiatives to realise the desired state.

(1) Expand infrastructure investment and cloud adoption support for rural areas and SMEs

A major challenge common to all countries under this criterion is the lack of progress in reducing regional disparities and in SME adoption. ASEAN Member States should promote initiatives aiming at strengthening connectivity in rural areas. In addition, ASEAN Member States should promote a regional programme to increase SME cloud utilisation, such as through technical training, subsidy schemes, and the development of cloud adoption guidelines, building on ASEAN Digital Masterplan 2025 and Go Digital ASEAN programme. It is expected to contribute to revitalising intra-regional trade.

(2) Promote green data centres and technical cooperation

At present, Singapore and Malaysia lead as green data centre hubs, with Indonesia expected to become another concentration point. Going forward, ASEAN Member States should strengthen coordination between national digital policies that drive data centre expansion and energy policies that scale grid capacity and renewable generation to support that growth. Such regulatory cooperation would enable the region to expand green digital infrastructure through market-driven renewable procurement while ensuring alignment between energy and digital policy across ASEAN.

Criteria 1-2. Digital Format Readiness

1. Ideal State

The ideal state for Criterion 1-2 is defined as:

'Six key trade documenta, as well as the trade operations themselves, have been converted into digital formats.'

2. Current State

➢ Digitalisation of Trade Documents Become a Trend (SG, MY, TH, ID, PH, VN)

- E-invoicing can be broadly categorised into three groups: Countries where implementation is mandatory nationwide, such as Viet Nam and Indonesia. Countries where only a specific group of businesses is subject to the mandate, such as Malaysia, Singapore (usage has been standardised effectively), and the Philippines. Country where implementation is currently voluntary, such as Thailand. Also, most countries adopt structured data formats to enable domestic invoice exchange. For example, Indonesia's e-Faktur uses XML format; Viet Nam's e-Invoice is issued in XML format; and Singapore's Peppol PINT/VC adheres to internationally standardised vocabularies.

- Certificates of Origin are now primarily applied for and issued electronically by the Issuing Authority. Submission to the Customs Authority is also conducted electronically. This process is common across all six countries included in the study.
- The ASEAN Customs Declarations Document (ACDD) is widely submitted digitally to the Customs Authority through National Single Window (NSW) systems, a trend observed across all six countries. PL are easy to submit as PDF/XML to Customs, but the actual use of the paper list by warehouse staff or port checkers persists.
- Packing List (PL) are increasingly submitted electronically, but paper-based usage persists in field operations. Paper remains the default because it provides clear liability documentation, serves as a fallback when systems lack interoperability, and persists due to entrenched operational practices and limited readiness for fully electronic processes.
- e-Phyto systems are being institutionally and technically developed through participation in the International Plant Protection Convention Hub (IPPC Hub) and integration with National Single Window, but full regional technical and legal alignment is still in progress.
- Electronic Bills of lading (e-BLs) are only being advanced in Singapore. It ratified UNCITRAL's MLETR (Model Law on Electronic Transferable Records) and actively promoting its use through platforms like the NTP.

In summary, while the degree of progress varies, e-invoicing and customs declarations are largely established as digital practices across the region. This has facilitated the broader digitalisation of trade documents.

➢ High Level of Domestic Paperless Operations (SG, MY, TH, ID, PH, VN)

Domestic digitalisation is easier to advance under national discretion, often resulting in high scores. For instance, according to the UN's assessments of Trade Facilitation and Paperless Trade, Singapore achieves a perfect score of 100 for its paperless operations, while Indonesia scores 96.3. This indicates significant progress in the adoption of paperless practices.

Result from Document Mapping and Trade Flow Section: Continued Reliance on Paper for Key Logistics Processes (TH, ID, PH, VN)

Thailand, Indonesia, the Philippines, and Viet Nam are all progressing in digital trade facilitation, though trade procedures across countries are still not harmonised. Import and export flows generally follow similar steps, yet each country requires its own documents and procedures.

Regarding documentation, Thailand has digitised customs declarations and certificates of origin, and major ports have adopted electronic Delivery Orders (e-DO), though e-EIRs remain less standardised. Indonesia has actively digitised logistics, making e-DOs mandatory at major ports and widely implementing digital e-EIRs (SP2 Online), though last-mile gate operations can be hybrid. In the Philippines, logistics

flows are increasingly digital with e-DOs processed online and e-EIRs shifted to mobile apps, though paper receipts persist as backups. Viet Nam is also advancing through the VNSW and wide adoption of e-DOs, although e-EIRs remain hybrid due to liability concerns. Since trade flows involve both documents and operational information, digitalisation now also depends on access to real-time tracking data.

3. Challenges: The Gaps in Comparison to the Ideal State

Regarding the digitalisation of key trade documents, digitalisation is progressing and/or the foundational infrastructure for it is being established. In addition, a certain degree of commonality can be observed across countries.

- **Insufficient legal certainty and advanced technologies for documents of title (e-BL) (MY, TH, ID, PH, VN)**

  Domestic legislation aligned with United Nations Commission on International Trade Law (UNCITRAL) Model Law on Electronic Transferable Records (MLETR) is unfinished or still in progress, so the full legal equivalence of e-BLs (title, transfer, and possession) is not guaranteed. As a result, operations depend on private platforms and counterpart arrangements, producing uneven practices within the same supply chain.

- **On-the-ground paper co-use practices (especially Packing List) (SG, MY, TH, ID, PH, VN)**

  Although electronic attachment of PL and any other logistics documents are becoming a trend, paper presentation is still required at ports, airports, and bonded areas often due to unwritten customs and lack of unified SOPs. Digitalisation often stops at the office or Customs portal. Paper remains the default because it provides clear liability documentation, serves as a fallback when systems lack interoperability, and persists due to entrenched operational practices and limited readiness for fully electronic processes.

4. Closing the Gap: Recommendations

Based on the current situation outlined above, the region should pursue the following initiatives to entrench digitalisation and move toward the desired state:

(1) Formulate a common roadmap to enhance legal certainty for e-BL adoption

- A shared reason why electronic bills of lading (e-BLs) have not taken hold in most countries is the absence of MLETR adoption. To promote uptake across the region, ASEAN should promote the agreement to accommodate mutual legal recognition of electronic transferable records (ETR), such as through DEFA (Digital Economy Framework Agreement).[4] This would allow e-BLs to be used within a predictable legal environment, even where progress in domestic legislation differs by country.

(2) Eliminate on-site paper requirements and refresh operations/processes

ASEAN should begin with the Packing List and systematically phase out

[4] https://medium.com/@nitaspolachai/asean-single-window-2-0-4e15994e1aad

entrenched paper-based practices, many of which persist as informal habits rather than formal requirements. By promoting e-document operations and the use of e-signatures mandated under the ASEAN Agreement on Electronic Commerce, especially at terminal gates, warehouses, and airports, member states can gradually shift everyday port and cargo handling processes from paper to fully digital.

Criteria 1-3. Presence of a National Single Window (NSW)

1. Ideal state

The ideal state for Criterion 1-3 is defined as:

'The National Single Window (NSW), a system for electronically centralising domestic trade and regulatory-related procedures, has been established and is in operation, enabling the digitalization of trade practices.'

2. Current State

Common Trends in the presence of NSW in six major ASEAN Countries.

- Official Notification of NSW Operations under WTO/TFA (SG, MY, TH, ID, PH, VN)

  Under Article 10.4 of the WTO Trade Facilitation Agreement (TFA), each country officially notifies the operation of its National Single Window (NSW) system. This serves as a declaration of the country's commitment to electronically centralise trade-related administrative procedures and clarifies the institutional foundation of its trade digitalisation to the international community. All six target countries have formally notified their NSW operations under the TFA, and their respective TFA portals display the official NSW websites, competent authorities, and notification dates. This establishes the NSWs as recognised systems both institutionally and internationally.

- Online Application and Inquiry via Official NSW Portals (SG, MY, TH, ID, PH, VN)

  The core function of a Single Window is the 'one-stop' process, allowing businesses to obtain approvals from multiple agencies through a single application. All six countries provide electronic application, permit inquiry, online forms, FAQs, and user registration functions through their respective NSW portals (e.g. TradeNet, myTRADELINK, THAI NSW, INSW, TradeNet PH, VNSW).

- Two-Tier Operation: NSW + Complementary Systems (SG, ID, other countries have similar structures, but these two are explicitly highlighted)

  In many countries, the National Single Window (NSW) acts as a coordination layer, while the customs core system handles actual processing like screening and risk selection, creating a 'two-tier' architecture. For example, Singapore's TradeNet is supported by the National Trade Platform (NTP), and Indonesia's National Single Window (INSW) integrates with CEISA 4.0 to streamline operations.

- ‘Full Implementation’ of E-Single Window in UN Global Survey (SG, MY, TH, ID, VN. PH is rated as ‘Partially Implemented’)

  Based on the assessment of The UN Global Survey on Digital and Sustainable Trade Facilitation, five target countries which are Singapore, Malaysia, Thailand, Indonesia, and Viet Nam have achieved a ‘Fully Implemented’ rating for their E-Single Window systems, while the Philippines is rated as ‘Partially Implemented.’ This indicates that in most of these countries, the NSW has established a robust framework for the centralised online management of trade-related procedures, achieving data centralisation at the domestic level, and is already integrated into routine operational processes.

  It should be noted that the ‘Fully Implemented’ rating in the UN Global Survey signifies a state where the measure is aligned with internationally accepted standards (e.g. WTO-TFA), is available for use by virtually all relevant domestic stakeholders, and where the necessary infrastructure and resources are in place. ‘Partially implemented’ refers to a state of partial execution, such as where the measure is only partially aligned with/being rolled out to meet international standards, or where only a limited number of relevant stakeholders are involved.

  In the five countries, key trade functions such as export/import declarations, customs payments, issuance of Licenses, Permits, Certificates, and other documents (LCPO), risk management, and pre-arrival data processing are electronically operational, confirming that NSW-based workflows are accepted as standard practice.

Result from Overview of National Single Window (NSW) and Digital Platform: Limited but Expanding Integration of ASEAN National Single Windows (SG, MY, ID, TH, VN)

ASEAN Member States have widely established National Single Window systems as centralised platforms that digitise customs declarations, permits, and certificates of origin, forming the backbone of domestic trade facilitation. These systems are generally operated by Customs or Ministry of Finance and are connected to the ASEAN Single Window for point-to-point document exchange, although actual integration varies across countries. Progress remains uneven due to gaps in implementing certain electronic documents. Export and import modules are still only partially implemented in many countries, with limited connectivity to other government agencies and minimal linkage to logistics operations (with the notable exception of Singapore’s NTP, which actively integrates logistics services). These findings show that while NSWs are firmly in place, their depth of integration and coverage across agencies and logistics activities remain incomplete.

3. Challenges: The Gaps in Comparison to the Ideal State

Regarding the challenges related to the presence and operation of NSW, a certain degree of commonality can be observed across countries.

- **Relatively Weak Institutional Arrangement Across Ministries (MY, TH, ID, PH, VN)**

  Since the NSW inherently operates through inter-ministerial consensus, insufficient institutional design and mandate, such as coordination mechanisms and change management (e.g. Change Advisory Board: CAB), can cause bottlenecks in specification alignment, prioritisation, and incident response, especially in the 'last mile' of implementation. In the target countries, scores related to this aspect tend to be lower than other categories, and regular meetings, cross-agency KPIs, and formalised change management processes are often underdeveloped.

- **Insufficient Integration with B2B Sectors (Logistics, Finance, etc.) (MY, TH, ID, PH, VN)**

  The true value of a Single Window is maximised only when it connects not just administrative regulatory procedures (B2G), but also B2B domains such as logistics providers, shipping lines, banks, and insurers. Currently, many countries lack secure APIs and data-sharing frameworks, limiting full visibility and automation across the entire supply chain involving authorities and businesses. By involving industry associations and establishing standard interfaces, shared dictionaries, and authentication linkages, it is possible to strengthen the 'data arteries' that connect commercial, logistics, and financial flows in addition to border checks.

- **Incomplete Digitalisation of Exception and Ancillary Processes (Refunds, Appeals, Guarantees, etc.) (MY, TH, PH)**

  While core functions such as declarations and payments have been digitised across the region, complex exception and ancillary workflows, especially those requiring multi-agency or legal review such as duty drawback claims, customs appeal, and the management of financial guarantees, are often delayed and remain dependent on paper or manual methods. This persistence stems from the inherent complexity of non-standardised outcomes and the high legal and fiscal risk associated with automating financial processes. As a result, the region has not achieved true end-to-end digitalisation, leading to longer processing times for legitimate claims and creating negative impacts on business cash flow and legal certainty.

- **Remaining Gaps in Nationwide and User-Level Penetration (SMEs and Regional Areas) (SG, TH, ID, PH, VN)**

  SMEs and regional businesses often face the 'final barrier' to NSW adoption due to initial investment, training costs, and operational burdens. Governments and system operators should lower entry barriers by offering financial support, onboarding assistance, regional seminars, and templates.

4. Closing the Gap: Recommendations

The advancement of National Single Window (NSW) systems constitutes a critical issue directly linked to the facilitation of intra-regional trade and the enhancement of competitiveness within ASEAN. Considering the current situation outlined above, it is imperative for the region to further promote the following initiatives in pursuit of realising the ideal state:

- Standardisation of Institutional Design and Governance regarding the NSW operation

  ASEAN should develop a common guideline for NSW operations, emphasising robust national institutional design elements, coordination mechanisms and change management to strengthen national cross-ministerial coordination. Additionally, each country must facilitate mutual learning and review regarding NSW in existing regular ASW meeting, with a focus on identifying and addressing national level of institutional issues.

- Technical Infrastructure for B2B Integration

  ASEAN should formulate a standardised real-time connection for B2B integration and collaborate with industry associations in logistics and finance. Advanced models such as Singapore's NTP should be used as benchmarks to promote shared interfaces, syntaxes, ontologies, taxonomies, dictionaries, and authentication protocols.

- Support for Digitalisation of Exception Processes

  ASEAN should develop and distribute guidelines and standards for the digitalisation of exception workflows (e.g. refunds, appeals, guarantees) and assist member states in creating roadmaps for their implementation within NSW platforms.

- Enhanced Support for SMEs and Regional Users

  ASEAN countries should recognise the importance of promoting NSW utilisation by SMEs, and work collaboratively to share guidelines and best practices, as well as supporting national programmes for SME training and outreach. Local governments and chambers of commerce should be engaged to implement onboarding campaigns at the regional level.

PILLAR 2: Seamless Cross-border Connectivity and Interoperability

Criteria 2-1. Technical Interoperability

1. Ideal State

The ideal state for Criterion 2-1 is defined as:

'The ability of different systems to communicate and exchange data effectively, including the capability to understand and interpret data structures, formats, contexts, and meanings through common protocols, interfaces, syntaxes, ontologies, taxonomies, and vocabularies.'

2. Current State

The following common elements can be observed in the efforts of six major ASEAN countries to achieve seamless cross-border connectivity through technical interoperability:

- Ensuring Alignment with International Data Standards (WCO Data Model, UN/CEFACT, and UNTDED, etc.) (SG, MY, TH, ID, PH, VN)

  Each country is working to align with international standards for customs procedures and trade data, such as the WCO Data Model, UN/CEFACT Business Requirement Specification/Requirements Specification Mapping (BRS/RSM), and the United Nations Trade Data Elements Directory (UNTDED), to enhance the reliability and compatibility of international electronic document exchange. These efforts are gradually establishing an environment in which data can be understood and utilised in a unified format across different countries and institutions.

- API Disclosure and Strengthening of Developer Governance (SG, MY, TH, ID, PH, VN)

  Each country is in different phase of promoting the initiatives such as the disclosure and standardisation of APIs to facilitate system-to-system integration, while also developing governance frameworks for version control and validation rules. While Singapore has established a mature API developer governance framework, Indonesia, Malaysia, and Thailand are currently transitioning from closed systems to standardised API disclosure to facilitate B2B integration. Meanwhile, Viet Nam and the Philippines remain focused on strengthening internal G2G data standardisation as a precursor to opening APIs to the private sector. For example, Singapore's NTP has introduced a mechanism in which, during the digitalisation of Banker's Guarantees, bank systems and NTP exchange data via APIs, enabling the automatic transmission and verification of guaranteed information. Similarly, Viet Nam's VNSW stipulates that, to share and integrate specialised data from ministries and sectors with localities, state agencies shall publish open data in accordance with the law, and most of the master data shall be stored in machine-readable format and shared as an API service.

3. Challenges: The Gaps in Comparison to the Ideal State

As ASEAN strives to achieve seamless cross-border data exchange capabilities (technical Interoperability), the advancement of digitalisation in each country has led to the emergence of structural challenges that go beyond the formulation of technical specifications and legal frameworks.

- Limited Cross-border e-Document Exchange (ID, SG, MY, TH, PH, VN)

  Despite domestic progress, robust international transmission is currently limited to regulatory G2G documents (e.g. ATIGA e-Form D, ACDD) supported by established ASW protocols. In contrast, the exchange of B2B documents (e-Invoice, e-BL) faces significant friction. For e-invoices, fragmentation exists between countries adopting the Peppol framework (SG, MY) and those using proprietary

XML/JSON schemas, necessitating complex data mapping. For e-BLs, the requirement for Distributed Ledger Technology (DLT) to guarantee title transfer poses a barrier, as many Member States lack the technical infrastructure to interface with blockchain-based solutions like TradeTrust.

In the case of Singapore, the limitation does not stem from domestic capability, but from the uneven maturity of partner countries, restricting Singapore's ability to utilise its globally compatible standards (e.g. UN/CEFACT, MLETR) within the regional ecosystem.

- Technical Gaps Between International Principles and Domestic Implementation (ID, MY, TH, PH, VN)

  Most member states are aligning policy with international frameworks (WCO Data Model). However, translating these into domestic systems remains a challenge due to legacy infrastructure. Moreover, ASEAN does not have a centralised, dynamic, and publicly accessible Data Vocabulary Registry that automatically maps national data elements to international standards. Instead, ASEAN relies on static technical specifications known as the ASEAN Data Dictionary (ADD).

  For example, in Indonesia, Viet Nam, and Thailand, newer National Single Windows struggle to map data perfectly from older backend systems used by line ministries (e.g. Agriculture, Health). Modern B2B platforms (NDTP, TradeFlat) is struggling to talk to older Customs mainframes. This results in a gap where the country claims WCO compliance, but the actual data flows require manual 'patches' to work. This creates a 'Semantics Gap' where the policy is aligned, but the actual system code lists and identifiers remain incompatible, requiring manual intervention to bridge the divide.

- Low System Reliability (ID, MY, PH (Primary), VN, TH (Secondary))

  The limited reliability of National Single Windows and ASW Gateways continues to undermine digitalisation. System downtime, missing acknowledgements, and inconsistent exception handling in countries such as Indonesia, Malaysia, and the Philippines frequently force traders to revert to paper. Even in Viet Nam and Thailand, minor data errors trigger unexplained rejections that require manual intervention. These operational weaknesses erode trust, raise compliance costs, and prevent the ASW from functioning as a dependable, end-to-end digital system.

4. Closing the Gap: Recommendations

Based on the current situation, the region must further promote the following initiatives to realise the desired state of interoperability:

- Building a Private Sector-Led Operational Trust Framework for B2B Transactions

  ASEAN countries have made steady progress in integrating B2G and G2G transactions through the ASW. As the next step, it is desirable to strengthen efforts to build a framework that ensures the reliability of data exchange between private digital platforms, which is essential for true end-to-end digitalisation of the supply chain. For example, this could include the development of ASEAN B2B

operational trust standards based on UN/CEFACT BSP RDM and UN/CEFACT ISCRM.

- Development of a 'Common Trade Language' for Cross-Border Data Exchange

  To mitigate technical misalignment between domestic and regional standards, each country should disclose and share the process of mapping its unique data elements to common reference standards. For instance, ASEAN could establish a central data vocabulary registry (machine-readable API or metadata repository) that provides standardised definitions for frequently used trade data elements (e.g. product classifications, certificate types), building on ASEAN Open Data Dictionary.

- Technical and Operational Harmonisation for System Reliability

  The core technical and operational solution to low system reliability in the ASEAN Single Window (ASW) is to achieve regional harmonisation through standardised exception handling and system modernisation. This involves implementing a uniform set of error codes and automated response messages across all National Single Windows (NSWs), standardising the business process specifications for critical events like system failures, cancellations, and corrections, and enhancing the ASW technical architecture with automated retry logic and robust logging to manage transient communication failures. Simultaneously, AMSs must proactively upgrade and modernise their NSW systems to ensure compliance with international standards (like the WCO Data Model), utilise modular system design for easier maintenance, and implement comprehensive auditing mechanisms, thereby increasing system uptime and minimising the need for paper-based backup processes.

Criteria 2-2. Organisational Interoperability

1. Ideal State

The ideal state for Criterion 2-2 is defined as:

'The ability of several organisations or entities to collaborate successfully and economically by utilizing shared policies, procedures, and processes (using shared framework such as DFFT)'.

2. Current State

ASEAN countries are focusing on establishing cross-ministerial and cross-national governance frameworks, as well as common business processes, starting from their National Single Windows (NSWs).

- ASEAN Single Window Hub (SG, MY, TH, ID, PH, VN)

  The ASEAN Single Window Steering Committee (ASWSC) was established to coordinate actions at national and regional levels for effective implementation of the ASEAN Single Window (ASW) and to address future development needs, such as the exchange of additional trade-related documents and potential expansion with Dialogue Partners.

The ASWSC is supported by two subsidiary bodies: the Technical Working Group (TWG), which focuses on business processes and ICT system development, and the Legal Working Group (LWG), which assists in creating the legal framework for the ASW's establishment and expansion.

- Cross-Border Governance and Shared Responsibilities (SG, MY, TH, ID, PH, VN)

  Effective inter-organisational collaboration in ASEAN's digital trade relies on governance frameworks operating across borders that define roles, responsibilities, and contingency processes for both public authorities and private-sector actors. Public authorities are responsible for harmonising standards and enforcing compliance, while private actors implement technical solutions and ensure operational continuity. These responsibilities are increasingly formalised through regional agreements, governance guidelines, and contingency protocols. For example, during a technical failure in ASW operations, Malaysia's Ministry of Investment, Trade and Industry (MITI) communicated a fallback procedure that allowed all affected parties, including foreign trading partners, to revert temporarily to paper-based Form D. Similarly, the Philippines adopted a Public-Private Partnership (PPP) and Build-Operate-Transfer (BOT) model for its National Single Window, explicitly defining shared responsibilities between government agencies and private operators in official documents.

3. Challenges: The Gaps in Comparison to the Ideal State

As ASEAN countries advance digitalisation, they face governance-related challenges as follows.

- Institutional Conflicts in Aligning Regional and National Data Governance Frameworks (MY, TH, ID, PH, VN)

  The introduction of regional governance frameworks such as cross-border data transfer rules, combined with complex inter-agency coordination within each country involving multiple Cross-Border Regulatory Agencies (CBRAs), can lead to conflicts over authority and responsibilities. These issues often arise when new regional frameworks are misaligned with existing national regulations.

- Difficulty in Maintaining Broad and Rapid Penetration of Common Processes and Policies (SG, TH, VN)

  As the scope of common policy implementation expands from a limited number of government agencies to a broader range of private companies, international partners, and SMEs, achieving widespread adoption and sustained compliance becomes increasingly challenging. Even when advanced policies in Singapore or proposed digital gatekeeper regulations in Thailand are introduced, ensuring rapid and consistent implementation across diverse jurisdictions with varying technical and legal frameworks remains difficult.

- Consensus-Based Decision Making as a Barrier to ASEAN Single Window Integration (Common challenges across countries)

  ASEAN's consensus-based decision-making model, combined with economic

diversity, divergent national interests, and heterogeneous governance systems, often slows progress and produces diluted agreements that fall short of strategic objectives. This structural limitation continues to impede timely policy alignment and delays full integration of the ASEAN Single Window (ASW).[5]

4. Closing the Gap: Recommendations

In light of the current situation, ASEAN as a region must further advance the following initiatives to achieve the envisioned future.

- Institutionalising a Unified 'Define-and-Deploy' Governance Model

  ASEAN must operationally fuse regional capacity with national enforcement through a 'Define-and-Deploy' framework. The ASEAN Digital Sector, such as ASEAN Digital Ministers Meeting should expand its mandate to serve as a 'Technical Enablement Hub,' deploying standardised 'Onboarding Kits' (APIs and sandboxes) that simplify SME compliance. Crucially, adoption must be enforced by designated National Data Governance Focal Points with the legislative power to transpose these regional protocols into binding domestic regulations; this legally compels National Cross-Border Regulatory Agencies (CBRAs) to recognise ASEAN-standardised data, ensuring that technical interoperability is not merely available, but institutionally mandated.

- Strengthen Political Commitment via 'Pathfinder' Initiatives

  ASEAN's consensus-based decision-making often acts as a bottleneck. To address this, member states should adopt a 'Pathfinder' (ASEAN-minus-X) approach, where prepared nations (e.g. Singapore, Thailand, Viet Nam) proceed with advanced ASW integration pilots without waiting for full regional consensus. Also, direct involvement of national leaders, as seen in Indonesia and Viet Nam, accelerates progress.

Criteria 2-3. Legal interoperability

1. Ideal state

The ideal state for Criterion 2-3 is defined as:

'The capacity of systems to comply with legal and regulatory requirements during data exchange, including alignment with international frameworks such as UNCITRAL MLETR, Model Contract Clauses (MCC), and Binding Corporate Rules (BCR).'

[5] https://www.researchgate.net/publication/393734688_ASEAN_Single_Window_Implementation_Exploring_Benefits_Challenges_Solutions_and_Future_Roadmap#:~:text=Findings%20show%20that%20ASW%20significantly,and%20limited%20legal%20harmonization%20persist.

2. Current State

The following common initiatives have been observed across the six ASEAN countries.

- **Limited Full Adoption of Model Law on Electronic Transferable Records (MLETR) (Only Singapore; Thailand shows significant movement; Others in Preparation or Partial Alignment)**

  Only Singapore has fully implemented MLETR through its 2021 amendment to the Electronic Transactions Act, granting electronic bills of lading the same legal status as paper versions and embedding authenticity, uniqueness, and control into law.

  Other ASEAN countries have not yet adopted similar legislation, creating uncertainty in cross-border recognition and forcing reliance on contracts that specify governing law and jurisdiction. As a result, many international parties choose Singapore law or other MLETR-compliant jurisdictions as the governing framework to ensure enforceability

  In practice, logistics, banking, and insurance contracts increasingly adopt MLETR-aligned provisions, resulting in 'quasi-MLETR' contractual practices that offer a degree of operational mutual recognition without waiting for full regional legal harmonisation.

- **Institutionalisation of Cross-Border Data Transfers via Contractual Mechanisms (MY, TH, ID, PH)**

  Regarding cross-border data transfers, many ASEAN countries have adopted or operationalised frameworks referencing the ASEAN Model Contractual Clauses (MCC). These mechanisms allow cross-border data flows to be governed by contractual provisions that define data protection obligations, processing purposes, and restrictions on third-party disclosures, thereby ensuring alignment with international best practice such as European Union General Data Protection Regulation (GDPR).

  This reflects a growing trend in ASEAN toward achieving legal interoperability through contracts, facilitating cross-border digital operations while maintaining regulatory compliance.

3. Challenges: The Gaps in Comparison to the Ideal State

Regarding the Legal interoperability, there are some common challenges as below.

- **Fragmented Legal Framework for Cross-Border Data and Document Transfers (Common challenges across countries)**

  ASEAN countries have not yet harmonised laws governing cross-border data and document transfers. Singapore and the Philippines maintain the most open regimes with mature privacy laws and recognised transfer mechanisms, while Malaysia and Thailand allow transfers but impose stricter procedural controls. Indonesia and Viet Nam continue to enforce localisation obligations, especially for sensitive or regulated sectors, reflecting sovereignty and security priorities. Although ASEAN introduced the Data Management Framework, its adoption and

consistent application by national agencies such as ministries of trade, agriculture, and health remain uneven, leaving cross-border legal interoperability incomplete.

- Contractual Dependence Due to Non-Adoption of UNCITRAL MLETR (MY, TH, ID, PH, VN)

  In these countries, the formal adoption of the UNCITRAL Model Law on Electronic Transferable Records (MLETR) remains incomplete. As a result, the legal validity of electronic transferable records such as electronic bills of lading (e-BL) continues to rely on contractual provisions and the selection of governing law. This contract-based approach has limitations in terms of international legal certainty and interoperability, leaving gaps in the reliability of digital infrastructure.

- Lack of Established or Effective BCR Frameworks (PH, VN)

  In the Philippines and Viet Nam, there is no established framework for cross-border personal data transfers based on Binding Corporate Rules (BCR). Consequently, some intra-group data transfers within the region remain reliant on more rigorous, legally reliable frameworks such as Standard Contractual Clauses (SCC), which are based on government-side templates. This lack of adherence to internationally recognised, shared legal trust frameworks like the SCCs and Binding Corporate Rules (BCRs) places limitations on ensuring international trustworthiness and legal certainty, particularly in data transfers spanning multiple jurisdictions.

- Insufficient Capacity and Support Systems for SMEs (SG, PH, VN)

  As legal requirements become increasingly sophisticated, small and medium-sized enterprises (SMEs) face challenges due to limited knowledge and resources. In countries such as Singapore, the Philippines, and Viet Nam, although legal frameworks are in place, SMEs struggle to keep pace with implementation, highlighting the need for enhanced support systems. In particular, the lack of practical support systems to help SMEs meet requirements related to the authenticity and control of electronic documents may hinder the actual utilisation of these systems, even when legal frameworks are in place.

4. Closing the Gap: Recommendations

Based on the current situation outlined above, the region should pursue the following initiatives to entrench digitalisation and move toward the desired state:

- Strengthen Regional Legal Harmonisation

  ASEAN should build on existing frameworks for cross-border data and document transfers, such as the ASEAN Model Contractual Clauses and ongoing DEFA negotiations, to enhance regional cooperation and establish consistent compliance standards that bridge legal differences.

- Phased Support for MLETR Adoption

  It is recommended that AMS revises their electronic transaction laws to gradually incorporate the principles of MLETR such as authenticity, uniqueness, and control. The ASEAN Secretariat could take a lead in advocating for and promoting the adoption or alignment with MLETR.

- Adopting the Global CBPR Framework as the Regional Standard

  Since ASEAN legal architecture is fragmented which necessitates redundant approvals across disparate national jurisdictions, the development of ASEAN BCR is operationally impossible today. Instead, ASEAN should pivot toward a bloc-wide endorsement of the Global Cross-Border Privacy Rules (CBPR). By establishing a mutual recognition mechanism where Member States accept CBPR certification as a valid green lane for data transfers, the region can replace complex, case-by-case government reviews with a single, globally recognised audit.

- Establishment of Practical Support Systems for SMEs

  By establishing a collaborative support system (or entity) amongst ASEAN Member States, such as through ASEAN Coordinating Committee on MSMEs, practical support such as training and information sharing can enhance SMEs' capability to meet legal and technical requirements, contributing to the overall harmonisation of capabilities across the region.

PILLAR 3: End-to-end Unit-level Traceability and Resilience

Criteria 3-1. Real-time Cargo Tracking

1. Ideal State

The ideal state for Criterion 3-1 is defined as:

'GPS-based real-time tracking of documents and cargo using Internet of Things (IoT), Radio Frequency Identification (RFID), and Quick Response (QR) codes are in place (technical and operational aspect).'

2. Current State

The following common initiatives have been observed across the six ASEAN countries.

- Digitalisation and Real-Time Visualisation of Port and Warehouse Operations (SG, MY, TH, ID, VN)

  Most member states are implementing 'Smart Port' initiatives to capture real-time status data of cargo and vehicles, involving the targeted application of technologies such as IoT, GPS, and RFID. Singapore (PSA) and Malaysia (Port Klang/Westports) have matured systems, while Indonesia (Inaportnet) and Viet Nam (Cat Lai/VPA) are rapidly digitising terminal operations. These efforts serve as the foundational 'nodes' for supply chain traceability.

- Monitoring Inland Transport Using GPS-Enabled Electronic Seals for Compliance Purposes (e-Seals) (MY, ID, PH, VN)

  As part of customs procedures, several countries such as Malaysia, Indonesia, the Philippines, and Viet Nam are increasingly mandating GPS-enabled electronic seals (e-Seals) to monitor high-risk cargo during inland transport. These devices provide real-time location tracking, tamper detection, and enhanced security during transportation. Across ASEAN, Customs authorities in The Philippines' E-TRACC system is the most advanced model, requiring real-time tracking for containerised transit, while Malaysia and Indonesia use e-Seals extensively for transshipment and bonded movements to prevent diversion and ensure tax compliance.

- Development of Integrated Data-Sharing Platforms Across the Trade and Logistics Ecosystem (SG, MY, and TH: Mature; ID, PH, and VN: Emerging)

  Beyond port boundaries, there is a movement toward 'Community Data Platforms' that aggregate data for multiple stakeholders (banks, hauliers, shippers). Notable examples include Singapore's SGTraDex (focusing on data utility) and Malaysia's Port Klang Community System. These platforms are evolving from simple status updates to providing near real-time predictive visibility.

3. Challenges: The Gaps in Comparison to the Ideal State

Despite various efforts to introduce real-time tracking in many ASEAN countries, several challenges remain, suggesting that practical implementation is still in progress.

- Structural Disconnect and Lack of Standards Between Dynamic Tracking Data (GPS/IoT) and Electronic Documents (SG, MY, TH, ID, PH, VN)

  Although National Single Windows and the ASEAN Single Window have advanced in exchanging static electronic documents such as e-Form D, most countries still lack standardised technical specifications for integrating real-time events like GPS location into these systems in a machine-readable format. Current integrations are mostly one-way (e.g. declaration → notification), with limited mechanisms to feed real-time cargo status back into customs inspection and risk management processes. Event subscription models that automatically notify systems of key events, such as cargo arrival or inspection completion, are not yet established between Port Community Systems and NSW platforms. This results in a persistent disconnect between static digital information and dynamic traceability data.

- Imbalances in Technical Infrastructure and Operational Resilience Across Regions and Institutions (ID, PH, VN)

  In several countries, especially archipelagic or geographically vast ones, disparities exist in the availability of IoT devices, communication infrastructure, and operational frameworks for managing real-time data. As a result, even if tracking technologies are implemented at major ports or central government systems, tracking may be interrupted in inland areas, peripheral agencies, or local

port, hindering the realisation of nationwide real-time cargo visibility.

- Lack of Standardisation in Unit-Level Data and Event Vocabularies (MY, TH, ID, PH, VN)

  Current tracking across ASEAN remains container-centric (tracking the box) rather than product-centric (tracking the SKU/Unit), making end to end visibility impossible at the SKU or unit level. True unit level traceability requires consistent identifiers such as serial numbers or lot IDs, but fragmented coding systems and the absence of a unified event vocabulary (standardised definitions for 'Arrival', 'Damaged', 'Released') prevent systems across sectors from interpreting product level data in a compatible way.

  Achieving end-to-end visibility requires consistent handling of unit-level events such as product or serial numbers across all sectors including ports, customs, logistics, shippers, and commercial flows. This should be supported by a unified vocabulary for unit-level identifiers like lot or serial numbers. Currently, differences in code systems, event vocabularies, and data processing protocols across sectors and countries create fragmentation, preventing full implementation of unit-level tracking.

- High Implementation Burden for SMEs (SG, MY, TH, ID, PH, VN)

  While government-led digitalisation is progressing, a common bottleneck across countries is the high cost and complexity (implementation burden) of IoT devices and API integration required for real-time tracking, particularly for smaller private-sector players such as SMEs. Without broader participation from small freight forwarders and shippers, it is difficult to generate network effects.

4. Closing the Gap: Recommendations

In light of the above challenges, the following regional initiatives should be further promoted to realise the desired future state:

- Standardisation of Real-Time Event Data (Adopting GS1/WCO Standards)

  To bridge the static and dynamic gap, ASEAN must adopt a standardised event-driven architecture for the ASW. ASEAN should endorse a common Event Vocabulary referencing the WCO Data Model (for compliance) and GS1 EPCIS (for tracking). This defines the 'Who (party), What (status), Where (location), When (timestamp), and Why (triggering events)' of a logistics event in a machine-readable format. NSWs and Port Community Systems should deploy unified APIs based on these standards, allowing them to subscribe to cargo events. Finally, integrating dynamic cargo event data from Port Community Systems into customs risk management systems and linking it with electronic documents used in paperless clearance should be incorporated into ASW operational guidelines. These measures will enable seamless real-time visibility and interoperability across ASEAN's trade infrastructure, creating the foundation for smarter and more responsive supply chain management.

- Bridging the Infrastructure and Governance Divide

  A comprehensive solution to overcome this challenge requires harmonising

physical infrastructure with governance protocols. On the technical side, governments should invest in peripheral digital infrastructure such as IoT devices, sensors, satellite links, and LPWAN to extend real time tracking beyond major ports, while standardising data capture, enabling interoperability through modular low-cost APIs, and ensuring resilience through store and forward systems in low connectivity areas. On the policy side, countries should implement a phased mandatory rollout of digital tracking across all customs and regulatory agencies. Start by mandating digital tracking for high-risk and bonded cargo (similar to the Philippines' E-TRACC) before expanding to general trade, giving the industry time to adapt. AMS also need to provide sustained capacity building programmes for local authorities to ensure consistent and reliable adoption of the new systems.

- Introducing 'Common Rules' for Data and Terminology with Unit-Level Granularity

  Due to differences in terminology and formats used for tracking data across countries and industries, systems often fail to interconnect effectively. To address this, a minimal common event vocabulary in product-level that maps unit-level identifiers (e.g. Invoice Item Number) to tracking event should be defined and shared, covering key logistics stages such as port arrival, customs clearance, and inland transport.

  By mapping these terms to existing national systems, the need for major system modifications can be avoided. A pilot initiative could begin in high-volume intra-regional sectors (e.g. Automotive or Electronics parts).

- Provide Technical Support for SMEs and Promote Adoption Initiatives

  Instead of mandating expensive hardware, ASEAN should support private sector development of 'ASW Lite' mobile solutions by enabling low code apps that let SME drivers scan QR codes and transmit geolocation data through their existing smartphones. Governments should provide the standardised API and accredit these applications so SMEs can join the regional tracking ecosystem without any hardware investment.

Criteria 3-2. Management Capability for Tracking Data

1. Ideal State

The ideal state for Criterion 3-2 is defined as:

'Organizations and institutions across the public and private sectors, especially key industry stakeholders, demonstrate the institutional willingness to adopt traceability practices, thereby enabling the visualization of trade data (managerial and institutional aspect).'

2. Current State

In ASEAN-6, various initiatives are underway to realise traceability practices. While the degree of progress varies by country, the following commonalities can be observed.

- Strong Policy Capacity and Clear Commitment (SG, MY, TH, ID, PH, VN)

  National level policy goals such as digitalisation, smart ports, and wide area integration have been established, and political momentum is strong across the region. Indonesia's presidential instruction on the National Logistics Ecosystem mandates interagency data sharing, Viet Nam's national digital transformation decision prioritises logistics modernisation, and Singapore and Thailand have fully integrated smart port development into their economic strategies, reflecting a shared ASEAN commitment to advancing traceability.

- Development and Integration of Common Data Platforms through Public-Private Collaboration (SG, MY, TH, ID, PH, VN)

  Each country is advancing core platforms that connect customs, ports, logistics, and commercial flows, forming the foundational systems for institutionalising interoperability through public-private collaboration. Singapore's NTP and SGTraDex and Malaysia's Port Klang Net already operate with mature governance models, while the Philippines' TradeNet and Viet Nam's emerging systems are still establishing technical baselines and formalising cross-sectoral coordination. Across ASEAN, these cross-sectoral common data infrastructures, National Single Windows, and Port Community Systems are being deployed in phases to support shared SOPs and SLAs and strengthen end-to-end interoperability.

- Strengthening Visibility Through Digitalisation and Standardisation of Unit-Level Data and Port/Customs Operations (SG, MY, TH, ID, PH, VN)

  Willingness and efforts are being made to digitise and standardise data at the upstream chains of trade (e.g. pre-arrival declarations, invoices), improving the quality and quantity of static data necessary for real-time tracking. In parallel, time-sensitive operations including port scheduling, berthing windows, customs inspections, and inland transport updates are being transformed through digitalisation, strengthening the static data foundation needed for visibility while enabling time-sensitive operations to be monitored in real time or near real time.

3. Challenges: The Gaps in Comparison to the Ideal State

The following key points can be identified as common challenges related to Management Capability for Tracking Data:

- Gap Between Domestic Progress and International Integration (SG, ID)

  The ideal scenario is one in which public and private actors voluntarily adopt traceability practices, supported by clearly defined and continuously maintained international data-sharing rules for cross-border operations such as responsibility boundaries, secondary data usage, and data disclosure granularity. However, domestic platforms tend to advance ahead of international protocols, while the digital maturity of partner countries often lags.

  Stable cross-border operations increasingly depend on the readiness of these partner countries. The case-by-case basis management of Service Level Agreements (SLAs), exception-handling procedures, and responsibility demarcation for cross-border data makes institutions risk-averse.

- Implementation Barriers and Disparities Amongst SMEs (Region-wide)

  Ideally, SMEs would participate alongside major players to maximise network effects across the supply chain. In practice, participation remains insufficient due to disparities in technical, financial, and human resource capacity. High costs for integrating enterprise systems and securing skilled personnel hinder adoption, limiting the ability of many trade participants to benefit from real-time tracking systems.

4. Closing the Gap: Recommendations

Based on the current situation, the following regional initiatives can be considered to move toward the realisation of the desired future state:

- Establishing the ASEAN Model Data Governance Framework for Logistics

  ASEAN should establish an ASEAN Model Data Governance Framework for Logistics, using the ASEAN Smart Logistics Network as a regulatory sandbox to produce a practical, immediately deployable basis for cross-border data collaboration. The ASLN Steering Committee can publish a Reference Template that sets out data taxonomy, data sovereignty such as ownership of GPS and IoT data, liability and service-level standards for data accuracy, disclosure requirements, and rules for secondary data use.

  Logistics and Transport Services Sectoral Working Group should formalise this through a Joint Guideline on Logistics Data Governance that adopts GS1 EPCIS as the regional reference standard for tracking data. By allowing companies to directly copy and apply standardised clauses in their commercial agreements, ASEAN fills the current gap in commercial data governance while creating a soft-law standard that ASLN projects, and eventually the broader industry, can adopt as the de facto regional norm

- The Aggregator-Led Onboarding Strategy

  ASEAN should incentivise Digital Aggregators (e.g. Major Port Operators, National Logistics Associations, or large Digital Platforms like Dagang Net/LNSW) to act as the onboarding agents for SMEs. Governments provide Train-the-Trainer funding to these Aggregators. In return, the Aggregators provide free lite versions of their tracking tools to SME subcontractors. This leverages the existing business relationships in the supply chain rather than creating a new bureaucratic support layer.

Criteria 3-3. Supply Chain Diversification

1. Ideal State

The ideal state for Criterion 3-3 is defined as:

'Export/import markets are well diversified, ensuring no excessive reliance on one country.'

2. Current Issue (Overview of Trade Structure)

ASEAN countries have achieved remarkable economic growth in recent years. However, they continue to face structural vulnerabilities stemming from geographic and industrial concentration within the global supply chain.

- Geographic Concentration Risk: Overdependence on China

  The six major ASEAN economies exhibit significant dependence on China for both exports and imports. China serves as a central hub across the supply chain, spanning intermediate goods and components as well as final product demand. This structure creates a resonance effect in which demand shocks, such as reduced Chinese consumption, and supply shocks, such as disruptions or cost increases in components, occur simultaneously and limit diversification options. Institutional and non-institutional disruptions, including stricter customs procedures, cross-border data regulations (such as China's Personal Information Protection Law), or public health crises, can also trigger cascading delays in trade operations and data connectivity, as the region lacks alternative 'digital highways' to other markets.

- Industrial Concentration Risk: Skewed Product Portfolios

  Key ASEAN economies such as Singapore, the Philippines, and Viet Nam exhibit high export dependency on electronics and semiconductors. This industrial concentration also affects the supply chains of neighbouring countries like Malaysia, Thailand, and Indonesia. As a result, the region becomes uniformly sensitive to the following types of shocks:

  - ✓ Technological transitions: Shifts in adoption toward advanced technologies or reallocation away from outdated tools.
  - ✓ Export control regulations: Strengthening of export controls or tariff/non-tariff measures on high-end chips by specific countries.
  - ✓ Business cycles: Boom-and-bust patterns unique to the semiconductor industry, known as the 'silicon cycle.'

  Heavy reliance on intermediate goods makes the region highly susceptible to fluctuations in final consumer markets and regulatory changes, often resulting in wider price spreads for affected products.

- Barriers to Diversification: Weak Institutional Linkages with Emerging Markets

  Although ASEAN maintains a strong network of free trade agreements with East Asia (RCEP) and the West, its institutional connectivity with emerging markets such as Latin America, Africa, and the Middle East remains limited. This weak linkage raises transaction costs for preferential tariff application, rules of origin compliance, and adherence to sanitary and technical standards, both during pre-trade preparation and post-trade processes. As a result, the ability to shift swiftly to alternative demand or supply sources in times of disruption is constrained. Moreover, the absence of mutual recognition of electronic certificates of origin and harmonised legal frameworks for data transfer further restricts document portability and increases friction in market switching.

- Upstream Supply Concentration in Intermediate Goods and Single Point of Failure (SPOF) Risk

  Upstream supply of intermediate goods such as electronic components, manufacturing equipment, and machinery is highly concentrated in China and a few other countries including Japan and the United States. Certifying new suppliers, which involves assessments of quality, ESG compliance, and information security, as well as validating product design and process changes, requires substantial time and cost. These high switching costs increase the risk of dependency on existing suppliers as single points of failure (SPOF). Shortages in components can halt production lines, trigger contract breaches, raise credit costs, and ultimately cause direct damage to the export of finished goods.

3. Challenges (Potential Impacts from a Digital Perspective)

The trends mentioned above might cause significant implications for the digitalisation of trade supply chains, as outlined below:

- Geographic Concentration Risk: Overdependence on China

  This situation is closely linked to issues of data sovereignty and cross-border data connectivity. For instance, if a heavily relied-upon trading partner imposes stricter cross-border data regulations or customs procedures, existing digital linkages may experience cascading delays. Even with progress in digitalisation, there is a heightened risk that data connectivity may become non-functional due to unilateral institutional changes by partner countries.

- Industrial Concentration Risk: Skewed Product Portfolios

  ASEAN's digital systems, many of which remain monolithic and difficult to update, are increasingly strained by rapid regulatory changes in the semiconductor sector. With new US and EU compliance rules and expanding export controls, digitalisation is no longer just about efficiency but core to risk management to ensure compliant. Platforms must support agile updates and real-time unit-level traceability to quickly identify regulated components and prevent production disruption.

- Barriers to Diversification: Weak Institutional Linkages with Emerging Markets

  This situation underscores the need to broaden the scope and applicability of digitalisation. Limited institutional connectivity with emerging markets often results in inadequate mutual recognition of electronic certificates of origin and weak legal frameworks for data transfers. In the event of a disruption, shifting to alternative suppliers may require reverting to paper-based documentation and manual procedures, creating significant operational friction even where digital systems exist.

4. Closing the Gap: Recommendations

While trade diversification is largely governed by national industrial strategies and economic security policies, from the perspective of digitalisation and electronic

systems, ASEAN can consider the following measures to enhance supply chain resilience, leveraging existing initiatives and frameworks:

(1) Mitigating Geographic Concentration Risk (Overdependence on China and Vulnerabilities in Cross-Border Data Connectivity)

- Expand ASW Interoperability: Move beyond ASEAN+3. Accelerate technical pilots to connect the ASEAN Single Window (ASW) with the Pacific Alliance (LATAM) and Pan-African Payment and Settlement System, creating digital infrastructure that matches diversification goals.
- Multilateral data governance agreements: Reduce reliance on bilateral data deals. Aggressively promote the Data Free Flow with Trust (DFFT) framework to establish a trust layer that allows data to flow to EU, India, and US partners irrespective of changes in Chinese regulations.
- Distributed digital infrastructure: Deploy cloud services and data centres across multiple countries to avoid dependence on any single nation and to ensure redundancy and resilience against geopolitical risks and disasters. However, from the perspective of operational cost-efficiency, utilising existing large-scale data centres may also be a viable option.

(2) Addressing Industrial Concentration Risk (Dependence on Specific Industries and Regulatory Challenges)

- Enhancing unit-level traceability: Introduce IoT tagging to enable real-time tracking at the product level, moving from container-tracking to part-level tracking. Align with the ASEAN Smart Logistics Network to upgrade logistics and customs systems.
- Improving flexibility of digital customs systems: Implement modular microservices, instead of monoliths systems, capable of responding swiftly to export controls and tariff changes. Jointly develop AI-based rule change detection and adaptation mechanisms within ASEAN. This allows governments to update tariff rules or sanction lists in hours, not months, protecting the fast-moving electronics sector from regulatory lag.
- Supporting diversification of industrial portfolios: Encourage ASEAN countries to invest in emerging industries (e.g. green products, medical devices, agricultural goods) and support digitalisation to facilitate risk dispersion.

(3) Overcoming Barriers to Diversification (Weak Institutional Linkages with Emerging Markets)

- Expanding mutual recognition of electronic certificates of origin: Promote the adoption and mutual recognition of e-Form D within and beyond ASEAN to accelerate the transition away from paper-based systems. Digitally enhance existing agreements such as the ASEAN-

Australia–New Zealand FTA.

- Digitalisation support with Open Digital Architecture style: ASEAN should take the lead in providing technical assistance for electronic customs and data connectivity to emerging countries with underdeveloped institutional frameworks.
- Establishing digital trade agreements with emerging markets: Develop digital trade frameworks (e.g. Digital Economy Partnership Agreements) with South Asia, Africa, and Latin America.

PILLAR 4: Trustworthy and secure infrastructure

Criteria 4-1. Cybersecurity Legal Framework

1. Ideal State

The ideal state for Criterion 4-1 is defined as:

'A comprehensive legal framework for cybersecurity has been established, enabling the government to formulate strategies, set standards, conduct audits, and maintain incident response systems.'

2. Current State

Common Trends in the cybersecurity-related legal frameworks of six major ASEAN Countries.

- Legal Recognition of Electronic Signatures in Domestic Legislation (SG, MY, TH, ID, PH, VN)

  All six ASEAN countries legally recognise electronic data and electronic signatures, providing a common foundation that gives electronic documents full evidentiary and contractual force. Although the legal acts differ by country, such as Singapore's Electronic Transactions Act and Malaysia's Electronic Commerce Act and Digital Signature Act, they all establish equivalence between electronic and paper-based transactions. In parallel, each country is also advancing cybersecurity and digital identity legislation, strengthening the legal basis for secure authentication and electronic IDs, although the maturity of these systems still varies.

- Existence of Personal Data Protection Legislation (SG, MY, TH, ID, PH, VN)

  All six countries have enacted personal data protection laws, but their enforcement capacity and private-sector applicability vary widely. Singapore's PDPA represents a mature regime with a robust track record of enforcement. Thailand and Malaysia are in a transitioning phase as they ramp up compliance audits and strengthen regulatory oversight. Indonesia and Viet Nam, despite the PDP Law (2022) and Decree 13, remain in early stages with weak and inconsistent penalty enforcement, limited corporate audit precedents, and uncertain cross-border data transfer management.

3. Challenges: The Gaps in Comparison to the Ideal State

ASEAN Member States have individually developed cybersecurity laws (e.g. Singapore's Cybersecurity Act) and personal data protection laws (e.g. Indonesia's PDP Law, Thailand's PDPA), but their definitions, scope of application, reporting obligations, and levels of penalties are not harmonised.

- **Fragmentation of CII Governance and Compliance Standards (Region-wide)**

  While most ASEAN nations now possess cybersecurity laws, the definition and regulation of Critical Information Infrastructure (CII) remain highly fragmented, creating a compliance patchwork for regional supply chains. Singapore, Malaysia, Thailand, and Viet Nam have enacted cybersecurity legislation that mandates CII protection, though with differing emphases: Viet Nam's framework leans heavily toward content control and data localisation, while Singapore and Malaysia focus more on operational resilience and incident reporting. In contrast, Indonesia and the Philippines rely on sector-specific regulations or national cybersecurity plans rather than a unified cybersecurity act that sets CII standards.

  As a result, parties involved in international trade across these six countries must navigate four distinct audit regimes and two grey regulatory environments, significantly increasing compliance costs.

- **Operational Immaturity of Incident Reporting Protocols (Region-wide)**

  While the ASEAN CERT Framework was operationally launched in late 2024, it functions as an administrative mechanism rather than a legal mandate. No Member State has yet amended its domestic cybersecurity legislation (e.g. Malaysia's Cyber Security Act 2024 or Singapore's Cybersecurity Act) to explicitly align reporting timelines or definitions with the ASEAN protocol. Consequently, the regional framework lacks a statutory footing, leaving cross-border incident sharing subject to discretionary 'National Filters' rather than automated legal triggers.

4. Closing the Gap: Recommendations

Based on the current situation outlined above, the region should pursue the following initiatives to entrench digitalisation and move toward the desired state:

- **Negotiation and Adoption of a Mutual Recognition Arrangement (MRA) for CII Definitions and Security Audit Standards**

  Instead of attempting to unify disparate national CII definitions and audit standards, ASEAN should negotiate a Cybersecurity MRA that allows member states to mutually recognise one another's security certifications. This approach avoids the need for countries to rewrite their laws while reducing redundant compliance burdens for cross-border digital supply chain operators. For example, under such an arrangement, a logistics provider audited as CII compliant in Singapore under its Cybersecurity Act would have that certification recognised by regulators in Malaysia and Thailand, eliminating the need for repeated audits and respecting national sovereignty while streamlining regional cybersecurity compliance.

- Legalisation of a Common Protocol (Triggers and Deadlines) for Cross-Border Incident Reporting

  To prevent delays in information sharing during incidents, a common protocol must be formulated and integrated into national laws, specifically for incidents with cross-border implications. This protocol mandates a common reporting trigger (e.g. defining what constitutes a cross-border incident) and a shortest initial reporting deadline (e.g. within 24 hours). This action enhances the speed and reliability of crisis response across the entire supply chain.

Criteria 4-2. Governmental/Public organisation responsible for ensuring data security

1. Ideal State

The ideal state for Criterion 4-2 is defined as:

'A national or public agency responsible for data security has been established and is operating in accordance with international standards.'

2. Current State

Regarding the establishment of government agencies responsible for information security in the six major ASEAN countries, the following trends are observed:

- Establishment of National-Level Cybersecurity Agencies (SG, MY, TH, ID, PH, VN)

  Singapore (Cyber Security Agency), Malaysia (National Cyber Security Agency), Thailand (National Cyber Security Agency), Indonesia (National Cyber and Crypto Agency), Philippines (Department of Information and Communications Technology and Cybercrime Investigation and Coordinating Centre), and Viet Nam (Ministry of Public Security/Authority of Information Security) have each established core government agencies. The purpose of these agencies is to centralise the management and coordination of national defence capabilities against cyber threats, based on national strategies (such as National Cybersecurity Strategies). Their primary functions include formulating and regulating cybersecurity policies, providing National CSIRT (Computer Security Incident Response Team) functions, collecting and analysing domestic and international threat intelligence (Cyber Threat Intelligence or CTI), and supervising CII. Their establishment dates are relatively recent (2015–2021), often through the reorganisation and strengthening of former cryptology agencies or departments within the Ministry of Information and Communications.

- Establishment of Supervisory Bodies for Personal Data Protection (SG, MY, TH, PH)

  Singapore, Malaysia, the Philippines, and Thailand have established dedicated supervisory bodies such as the Personal Data Protection Commission (Singapore), Personal Data Protection Department (Malaysia), National Privacy Commission (Philippines), and Personal Data Protection Commission (Thailand) to oversee personal data protection. These agencies enforce regulations on data collection,

usage, and transfer, investigate breaches, and safeguard citizens' privacy rights.

In contrast, Indonesia and Viet Nam rely on ministry-led supervision. Indonesia is currently in a transitional phase where the Ministry of Communication and Digital acts as the regulator pending the establishment of the independent DPA mandated by the 2022 PDP Law. Viet Nam relies on the Ministry of Public Security (MPS) for enforcement under Decree 13.

- System of Multiple Agencies Sharing Responsibilities (Policy, Technology, and Supervision) (MY, TH, PH, ID, VN)

  In many ASEAN countries, cybersecurity governance is fragmented, with authority spread across multiple ministries and agencies, creating overlapping mandates and complex compliance obligations for businesses. For example, in Malaysia, cybersecurity policy is led by the National Cyber Security Agency under the Prime Minister's Department, technical incident response is handled by CyberSecurity Malaysia under the Ministry of Digital, data protection is overseen by the Personal Data Protection Department, and digital economy development is led by the Malaysia Digital Economy Corporation, resulting in overlapping and sometimes conflicting compliance requirements for businesses.

3. Challenges: The Gaps in Comparison to the Ideal State

While the establishment of public agencies has accelerated in recent years, the following challenges may impact data flow in supply chains:

- Insufficient Inter-Organisational Collaboration and Silo Structure (MY, TH, PH, ID, VN)

  Ideally, a single national authority would coordinate cybersecurity across borders, but many countries divide responsibilities amongst cybersecurity agencies, data protection regulators, information and communications technology ministries, and security institutions. This siloed structure slows policy implementation and weakens incident response, since a supply chain breach may be reported to one authority but not the technical agency needed to contain it. Clearer coordination mechanisms are needed to ensure faster and more effective cross-border cybersecurity management.

- Institutional Capacity Constraints in National Cybersecurity Management (ID, PH, VN)

  Many institutions in the region face limited technical expertise, and human capital remains a major bottleneck. Peripheral agencies, such as transport or health regulators, often lack the specialised cybersecurity talent needed to audit the complex critical infrastructures under their supervision and must rely heavily on central bodies like national cybersecurity agencies, creating audit backlogs and a reactive security posture. At the same time, cyber threat intelligence, incident response capabilities, and collaboration with private-sector and regional response teams remain underdeveloped. Strengthening skilled personnel, technical systems, and institutional coordination is essential for improving national cybersecurity readiness.

4. Closing the Gap: Recommendations

Based on the current situation described above, the region must further promote the following initiatives to realise the ideal state:

(1) Promotion of cross-sectoral dialogue on data security within the region

It is desirable to establish a cross-sectoral national platform that brings together cybersecurity, personal data protection, ICT policy, and national security functions, which are currently dispersed across multiple ministries and agencies. Such a mechanism would enable regular information sharing, help identify fragmentation challenges, and support the adoption of best practices. It should also harmonise definitions of incidents and reporting triggers across agencies so that a single report submitted by a business is automatically shared with all relevant regulators, removing the burden of multiple reporting and ensuring faster, more coordinated responses.

(2) Build Capacity in Peripheral Agencies

Improve the ability of sectoral regulators and local agencies to detect and report cyber incidents by providing targeted training, basic monitoring tools, and clear reporting protocols. Strengthening these frontline units ensures higher-quality data and faster contributions to regional and cross-institutional information-sharing networks.

Criteria 4-3. Appropriate cybersecurity environment and operational status

1. Ideal State

The ideal state for Criterion 4-3 is defined as:

'Digital signatures, authentication, authorisation, and identification mechanisms have been firmly implemented, supporting robust cybersecurity and effective data governance practices.'

2. Current State

Regarding the appropriate cybersecurity environment and operational status, the six major ASEAN countries, the following trends are observed:

- **Standardisation of Authentication Based on National Digital Identification (NDI) or Unified Identification Systems (SG, MY, TH, ID, VN)**

  ASEAN countries are increasingly using government-issued digital identities as the main authentication method for national single windows and trade platforms, enabling government-wide single sign-on and improving the reliability of user identification across logistics and trade services. However, identity sources differ by country. Singapore and Thailand use citizen-based national digital IDs for trade logins, while Indonesia, Viet Nam, and Malaysia rely on business-based identifiers linked to corporate or business registries. In the Philippines, the national ID exists but trade platforms still depend primarily on credentials issued by value-added service providers.

- Establishment of Electronic Signatures and Promotion of Paperless and Auditable Trade Documents (SG, MY, TH, ID, VN)

  Across ASEAN, digital signatures and digital identity systems have become integral to national single windows and trade platforms, supporting secure authentication, authorisation, and document verification. Most of six countries now require digital signatures for customs clearance, though approaches differ. Indonesia, Thailand, Viet Nam, and Malaysia use direct public key infrastructure (PKI), requiring each declaration to be signed with a valid digital certificate. Singapore uses a cloud-based Sign with Singpass model that enables hardware-free, API-driven signing. In the Philippines, electronic signatures are recognised but still implemented through value-added service providers that act as intermediaries for customs transactions.

3. Challenges: The Gaps in Comparison to the Ideal State

- Inconsistent Cross-border Mutual Recognition and Levels of Assurance (LoA) for Electronic Signatures, Authentication, and PKI Trust Framework (Region-wide)

  Uniform Levels of Assurance and mutual recognition are essential for seamless cross-border digital trade, yet these mechanisms remain weak across the region. A digital signature valid in one country is often rejected in another because each nation has its own electronic signature rules but no shared framework to map security levels. As a result, a high-security token-based signature in Viet Nam may have no equivalent in the Philippines, and there is no clear way to compare identity systems such as Singapore's national digital identity with Thailand's. Without machine-readable, mutually accepted assurance levels, trust cannot be automated, and traders are forced back to wet signatures or manual re-verification, slowing cross-border transactions.

- Digital Transition and Burden on SMEs (Digital Divide) (ID, PH, VN, and to a lesser extent MY)

  Small and medium-sized enterprises face higher barriers in adopting digital signature systems and digital ID integration, especially in countries that rely on hardware tokens or paid digital certificates, such as Viet Nam and Malaysia. The annual cost of maintaining valid certificates for multiple employees can be significant, discouraging smaller traders from fully digitising their workflows. Unlike Singapore's free model, these cost pressures limit SME participation, making support measures such as education and simplified onboarding essential for a smoother digital transition.

4. Closing the Gap: Recommendations

Based on the current situation described above, the region must further promote the following initiatives to realise the ideal state:

(1) Introduction of a Unified Framework and Guidelines for Levels of Assurance (LoA)

ASEAN should introduce a common trust framework for Levels of Assurance aligned with the EU eIDAS model, using three tiers (low, substantial, high) to establish a common basis for cross-border trust. Member states would map their national digital identity and trade login systems to these tiers so that a high-assurance identity in one country can be automatically recognised by another, allowing customs and trade systems to validate foreign digital signatures without manual checks. In parallel, ASEAN countries should agree on a common set of technical rules that define how users are allowed to act on behalf of someone else in trade systems. Adoption of these specifications across national single windows and digital identity systems, supported by a joint auditing mechanism involving trade, identity, and cybersecurity regulators, would strengthen interoperability and ensure proper audit log management.

(2) Standardisation of 'Cloud Signing' to Reduce SME Burden

ASEAN should reduce the implementation burden for the private sector, especially SMEs, by shifting away from costly hardware-based digital signatures and providing incentives and technical support. Countries that still rely on USB tokens, such as Viet Nam, Malaysia, and Indonesia, should accredit cloud-based remote signing solutions similar to Singapore's model. Offering low-cost or free digital signature services and enabling secure signing through smartphones would remove the need for physical tokens or specialised software, lower costs for SMEs, and support broader participation in the digital trade ecosystem.

Table 3.6. Summary of Existing Gap and Recommendation for Each Criterion

Criteria	Existing Gaps in Comparison to the Ideal State	Closing the Gap: Recommendations
1-1. Digital Infrastructure Readiness	▪ Infrastructure disparities and lagging connectivity in rural areas ▪ Insufficient support for SMEs cloud adoption ▪ Environmental and power constraints in data centre development ▪ Insufficient application to trade and logistics	▪ Expand infrastructure investment and cloud adoption support for rural areas and SMEs ▪ Promote green data centres and technical cooperation
1-2. Digital Format Readiness	▪ Insufficient legal certainty and advanced technologies for documents of title (e-BL) ▪ On-the-ground paper co-use practices (especially Packing List)	▪ Formulate a common roadmap to enhance legal certainty for e-BL adoption ▪ Eliminate on-site paper requirements and refresh operations/processes
1-3. Presence of	▪ Relatively weak institutional	▪ Standardisation of institutional

Criteria	Existing Gaps in Comparison to the Ideal State	Closing the Gap: Recommendations
National Single Window (NSW)	arrangement across ministries · Insufficient integration with B2B sectors (logistics, finance, etc.) · Incomplete digitalisation of exception and ancillary processes (refunds, appeals, guarantees, etc.) · Remaining gaps in nationwide and user-level penetration	design and governance regarding the NSW operation · Technical infrastructure for B2B integration · Support for digitalisation of exception processes · Enhanced support for SMEs and regional users
2-1. Technical Interoperability	· Limited cross-border e-document exchange · Technical gaps between international principles and domestic implementation · Low system reliability	· Building a private sector-led operational trust framework for B2B transactions · Development of a 'common trade language' for cross-border data exchange · Technical and operational harmonisation for system reliability
2-2. Organisational Interoperability	· Institutional conflicts in aligning regional and national data governance frameworks · Difficulty in maintaining broad and rapid penetration of common processes and policies · Consensus-based decision making as a barrier to ASEAN Single Window integration	· Institutionalising a unified 'define-and-deploy' governance model · Strengthen political commitment via 'pathfinder' initiatives
2-3. Legal interoperability	· Fragmented legal framework for cross-border data and document transfers · Contractual dependence due to non-adoption of UNCITRAL MLETR · Lack of established or effective BCR frameworks · Insufficient capacity and support systems for SMES	· Strengthen regional legal harmonisation · Phased support for MLETR adoption · Adopting the global CBPR framework as the regional standard · Establishment of practical support systems for SMEs
3-1. Real-time Cargo	· Structural disconnect and lack of standards between	· Standardisation of real-time event data (adopting GS1/WCO

Criteria	Existing Gaps in Comparison to the Ideal State	Closing the Gap: Recommendations
Tracking	dynamic data (IoT/GPS) and electronic documents • Imbalances in technical infrastructure and operational resilience across regions and institutions • Lack of standardisations in unit-level data and event vocabularies • High implementation burden for SMEs	standards) • Bridging the infrastructure and governance divide • Introducing 'common rules' for data and terminology with unit-level granularity • Provide technical support for SMEs and promote adoption initiatives
3-2. Management Capability for Tracking Data	• Gap between domestic progress and international integration • Implementation barriers and disparities amongst SMEs	• Establishing the ASEAN model data governance framework for logistics • The aggregator-led onboarding strategy
3-3. Supply Chain Diversification	• Geographic concentration risk • Industrial concentration risk: skewed product portfolios • Barriers to diversification: weak institutional linkages with emerging markets	• Mitigating geographic concentration risk (strengthening intra-ASEAN data connectivity/ multilateral data governance agreements/ distributed digital infrastructure) • Addressing industrial concentration risk (enhancing unit level traceability/improving flexibility of digital customs systems/supporting diversification of industrial portfolios) • Overcoming barriers to diversification (expanding mutual recognition of electronic certificates of origin/digitalisation support with open digital architecture style/establishing digital trade agreement with emerging markets)
4-1. Cybersecurity Legal Framework	• Fragmentation of CII governance and compliance standards • Operational immaturity of incident reporting protocols	• Negotiation and adoption of a mutual recognition arrangement (MRA) for CII definitions and security audit standards • Legalisation of a common protocol (triggers and deadlines)

Criteria	Existing Gaps in Comparison to the Ideal State	Closing the Gap: Recommendations
		for cross-border incident reporting
4-2. Governmental/Public organisation responsible for ensuring data security	· Insufficient inter-organisational collaboration and silo structure · Institutional capacity constraints in national cybersecurity management	· Promotion of cross-sectoral dialogue on data security within the region · Build capacity in peripheral agencies
4-3. Appropriate cybersecurity environment and operational status	· Inconsistent cross-border mutual recognition and levels of assurance (LoA) for electronic signatures, authentication and PKI trust framework · Digital transition and burden on SMEs (digital divide)	· Introduction of unified framework and guidelines for levels of assurance (LoA) · Standardisation of 'cloud signing' to reduce SME burden

Source: Developed by Authors.

Chapter 4

Policy Recommendations

1. Policy Direction based on the Findings of this Project

In recent years, the international discussions around trusted and secure cross-border data flows, including initiatives under the DFFT have gained momentum. While DFFT represents an important value for facilitating seamless digital trade, it is not the only pathway for enhancing supply chain efficiency. In ASEAN, countries are exploring various approaches to digitalisation and cross-border integration that balance national sovereignty with operational integration.

The importance of these efforts is reflected in the simulation results presented in Chapter 2, which illustrate that data integration can enable more optimal ordering, improve asset utilisation, and reduce excess inventory, demonstrating the operational benefits of effective information sharing.

Nevertheless, as Chapter 3 shows, the region's digitalisation remains incomplete, indicating that multiple complementary measures, ranging from interoperable digital platforms to coordinated national and cross-border initiative, are needed.

Building on this context, this study provides a set of recommendations to advance an end-to-end digital supply chain in ASEAN that respects sovereignty while strengthening regional competitiveness through coordinated national efforts and enhanced cross-border cooperation.

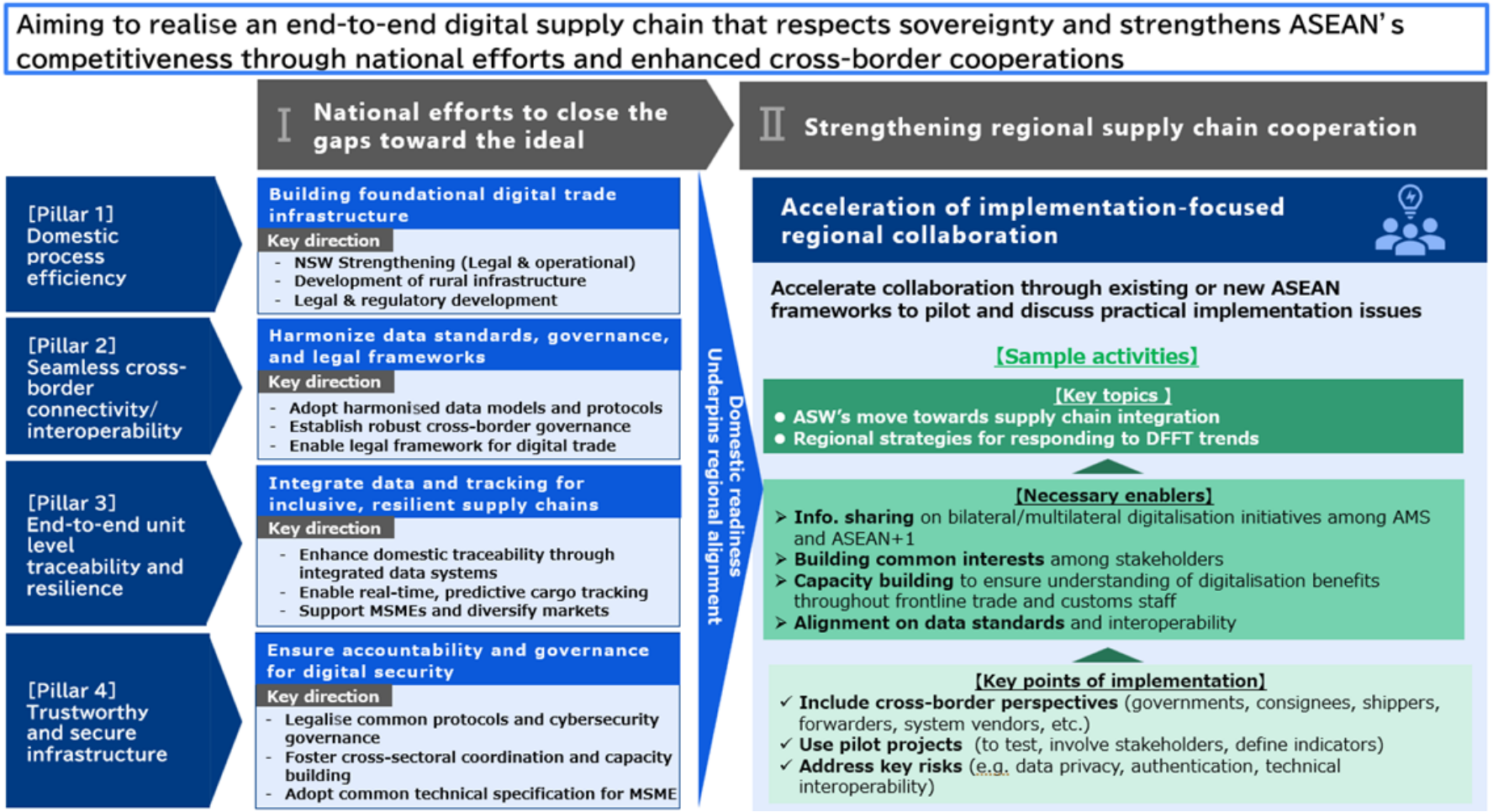
2. Policy Recommendations

2.1. Overall Structure of the Recommendations

To create an optimal end-to-end supply chain, each country must work to identify and address its own gaps while acknowledging that cross-border connectivity requires collaboration under common international frameworks. Initiatives that involve multiple stakeholders, such as achieving full supply chain visibility, rely heavily on this cooperation. Furthermore, since negotiation often remains theoretical, it is crucial for ASEAN-level cooperation to focus on practical, technical, and implementation aspects to advance these efforts effectively.

The following sections provide detailed descriptions of the individual proposed measures.

Figure 4.1. Policy Recommendations



Source: Developed by Authors.

2.2. National Efforts to Close the Gaps toward the Ideal

Before proposing regional cooperation within ASEAN, it is essential that each member country first takes concrete steps toward building its own national foundations for secure and trustworthy digital infrastructure. This approach is based on the recognition that ASEAN-wide digital integration cannot be realised without individual countries first establishing robust domestic governance structures. Also, by prioritising national-level efforts, countries can avoid the risks associated with prematurely enforcing regional integration before domestic governance and institutional readiness are in place.

In the previous Chapter, pillar-specific recommendations were made to close the identified gaps based on a set of defined criteria. Building on this and considering insights from stakeholder interviews and broader contextual analysis, this section presents a set of common recommendations applicable across countries, proposing priority actions that countries should undertake under each of the four key pillars.

Recommendations to Advance Pillar 1 – Domestic Process Efficiency:

- Strengthen National Single Windows (NSW) – Legal and Operational Aspects

Enhancing NSW systems, which serve as the core infrastructure for digitalisation in many countries, is essential to first improve institutional coordination amongst relevant ministries and agencies. This ensures cohesive governance and facilitates smoother decision-making across sectors.

- Development of Infrastructure in Rural Area to Ensure Inclusivity

Given the persistent infrastructure disparities and lagging connectivity in rural areas, coupled with insufficient support for SME cloud adoption, the recommendation to develop rural infrastructure aims to bridge the digital divide and enable inclusive participation in supply chain digitalisation. Addressing these gaps is critical to ensure that rural SMEs can access high-speed networks and adopt cloud-based solutions, thereby enhancing operational efficiency and competitiveness. Such inclusivity is not only a matter of equity but also a prerequisite for achieving end-to-end digitalisation across the entire supply chain.

- Develop Legal and Regulatory Frameworks – Including Operations and Capacity Building

Governments need to update and harmonise trade-related laws and regulations especially for B2B relation. Through the interviews conducted for this study, stakeholders including authorities, freight forwarders, and shippers/consignees consistently pointed out that, despite the advancement of technical digitalisation, corresponding updates to relevant laws and regulations have not kept pace.

To address these gaps and ensure uniform operations, this study recommends updating laws and regulations, introducing technical standardisation, and implementing capacity building programmes to support consistent application.

Recommendations to Advance Pillar 2 – Seamless connectivity/interoperability

- Harmonise Data Models and Protocols

Implement international data models and region-wide transmission protocols, including standardised procedures for handling exceptions such as failures, cancellations, and

corrections. From a technical perspective, this is critical because fragmented data structures and inconsistent handling of exceptions undermine interoperability, creating inefficiencies and increasing operational risks in cross-border trade.

- Establish Robust Cross-border Governance

Create strong coordination mechanisms for regulatory alignment, define roles and responsibilities, and provide remedies for conflicts between regional and national regulations. At the organisational level, such governance ensures accountability and coherence in implementation, which is essential for sustaining trust and reducing regulatory friction across jurisdictions.

- Enable Legal Frameworks for Digital Trade

Adopt international legal instruments such as UNCITRAL/MLETR and pursue regional legal harmonisation for cross-border data transfers through mechanisms such as Mutual Contract Clauses (MCCs). From a legal standpoint, certainty is a prerequisite for electronic document exchange and data flows; without it, businesses face compliance risks and hesitate to adopt digital solutions, slowing overall trade digitalisation.

Recommendations to Advance Pillar 3 – End-to-End Unit Level Traceability and Resilience

- Enhance Domestic Traceability through Integrated Data Systems

Countries should strengthen domestic traceability by integrating unit-level tracking data with relevant business documents (e.g. purchase orders, invoices, waybills) within their national systems. This integration improves data linkages across customs, logistics, and regulatory platforms to enable seamless tracking from origin to destination and streamlining clearance processes.

Interviews with forwarders, shippers, and consignees highlighted the need to link shipment units with business documents such as purchase orders and waybill numbers to improve traceability and streamline customs clearance and inland transport.

- Enable Real-time, Predictive Cargo tracking

Many countries have already begun deploying IoT and RFID technologies at key logistics nodes and developing digital infrastructure to support real-time cargo visibility. Building on this progress, further efforts should focus on enhancing system integration and expanding coverage to enable predictive analytics and full end-to-end traceability such as those enabled by Artificial Intelligence (AI) and Machine Learning (ML), essential to proactive risk management.

- Support SMEs and Diversify Markets for Resilience

Provide financial and technical assistance, such as operations manuals and standardised data templates to help SMEs adopt traceability systems, while promoting industry and market diversification beyond ASEAN. This combined approach reduces systemic risk from regional disruptions and ensures inclusivity in digital transformation.

Recommendations to Advance Pillar 4 – Trustworthy and Secure Infrastructure

- Legalise Common Protocols and Cybersecurity Governance

Establish legal recognition of common protocols and governance frameworks for incident reporting and mutually recognise legal terms and definitions for cybersecurity elements such as Critical Information Infrastructure (CII) and audit standards. This legal alignment is essential to reduce compliance uncertainty during cross-border incidents and ensure consistent enforcement of cybersecurity measures.

Stakeholder interviews revealed concerns about data leakage and emphasised the need for robust security measures. While many countries have advanced legal frameworks for data protection, moving toward a data-sharing environment requires stronger institutional responsibility and oversight.

- Foster Cross-Sectoral Coordination and Capacity Building

Create a platform for dialogue and coordination amongst sectors while equipping peripheral groups with capacity-building programmes, basic monitoring tools, and clear reporting protocols. Institutional collaboration strengthens resilience by improving incident response and reducing fragmentation across regulatory bodies.

- Adopt Common Technical Specifications and Support SMEs

Implement standardised procedures for authorisation, data validation, and auditability, and promote the use of National Digital ID systems with harmonised Levels of Assurance (LoA). Additionally, provide incentives and technical assistance to lower implementation barriers for SMEs. Technical harmonisation ensures interoperability and security, while SME support fosters inclusivity in digital transformation.

2.3. Strengthening Regional Digital Supply Chain Cooperations

While national-level initiatives form the essential foundation for institutional development and industrial advancement, addressing complex and cross-border challenges, such as data interoperability to enable idealistic end-to-end traceability, requires enhanced collaboration at international or regional level. Although ASEAN has established several policy dialogue frameworks, their non-binding nature often limits the ability to drive substantial progress.

To advance an end-to-end digital supply chain that respects national sovereignty and strengthens ASEAN's competitiveness, it is therefore essential to accelerate collaboration through existing or newly established ASEAN frameworks. Within this framework, the following Key Topics, Necessary Enablers, and Key Points of Implementation may be considered.

Key Topics:

(1) Identifying strategic options for engaging with global digital trade trends, including DFFT

ASEAN should not only monitor global digital trade facilitation movements such as DFFT but also assess how and to what extent the region should engage with these frameworks. This includes exploring alternative or complementary approaches that align more closely with ASEAN's sovereignty-respecting integration model. By mapping multiple

strategic options, ASEAN can determine the most suitable pathways for cooperation, benchmark against international practices, and ensure the region does not fall behind global developments.

(2) Broadening the ASW beyond customs while exploring diverse models for regional digital integration

While a full transformation of the ASW may not be mandatory, ASEAN needs to examine various models for expanding the ASW's role beyond customs processes. These models may range from incremental enhancements to more integrated supply chain information frameworks. Evaluating different options, including but not limited to DFFT-inspired architectures, will help ASEAN identify an approach that respects national sovereignty, improves operational interoperability, and supports region-wide digitalisation without imposing a single rigid pathway.

Necessary Enablers:

To advance the Key Topics from concept to implementation, ASEAN will need a set of foundational enablers that provide the institutional, technical, and collaborative basis for regional progress. Following are examples of necessary enablers:

(1) Information sharing on bilateral/multilateral digitalisation initiatives amongst AMS and ASEAN+1

Exchanging knowledge on ongoing initiatives and lessons learned between member states and with key partners facilitates alignment, accelerates learning, and reduces redundancy in implementation efforts.

(2) Capacity building to ensure complete understanding of digitalisation benefits

Improving digital literacy amongst stakeholders including frontline personnel is critical, and targeted training programmes are necessary to achieve this. One key reason is that many frontline personnel struggle to grasp the broader significance of digitalisation and often resist changes to familiar procedures in their legacy system. Therefore, efforts to deepen their understanding of how these shifts deliver tangible benefits are essential, enabling them to see the advantages as relevant to their own work and fostering stronger engagement.

(3) Building shared/common interests amongst stakeholders

The lack of shared incentives amongst ASEAN countries and stakeholders is a major barrier to achieving end-to-end digitalisation. While private firms stand to benefit most, initial investment must be government-led, and short-term adaptation costs for businesses further reduce motivation. Building common interests and identifying non-competitive areas for collaboration are therefore critical to overcoming fragmented approaches and enabling trust-based cooperation that delivers regional and firm-level benefits.

(4) Early alignment on data standards and interoperability across countries

Establishing common data definitions, technical protocols, and interoperability standards is essential to facilitate cross-border data exchange and ensure that digital systems can communicate effectively across different national platforms.

Key Points upon Implementations:

To effectively advance the discussion on the key topics and necessary enablers, the following key implementation principles should serve as the foundation for our

discussions. Adhering to these points will facilitate structured, evidence-based dialogue and enhance the likelihood of actionable outcomes:

(1) Include cross-border perspectives from government, shippers, forwarders, and system providers through pilot-based engagement

Because convening all relevant stakeholders in formal dialogue settings is often challenging, pilot projects should be used as practical exemplary mechanisms to incorporate insights from government agencies, shippers, forwarders, and system providers. Engaging these actors within real operational workflows allows ASEAN to surface practical bottlenecks, validate assumptions, and ensure that any regional solution reflects on-the-ground realities.

(2) Use pilot project to:

- Test end-to-end document/data exchange and workflow

  Pilot implementations provide a controlled environment (sandboxes) to assess system reliability, operational feasibility, and process efficiency before broader deployment.

- Gather feedback from all stakeholders

  Involving different stakeholders in pilot projects helps create useful feedback that improves both processes and system design.

- Define success indicators (e.g. processing time reduction, error reduction, user satisfaction)

  Clear and measurable indicators ensure objective evaluation of pilot performance and support evidence-based policy and operational decisions.

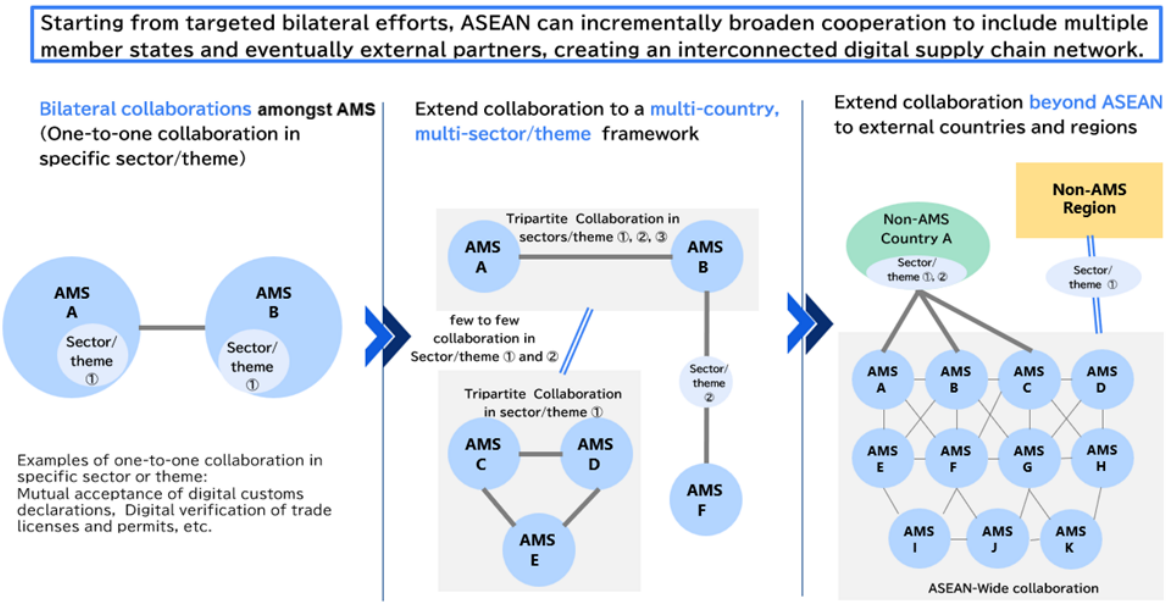
(3) Address key risks: data privacy, authentication/authorisation, technical interoperability

Identifying and fixing these risks early in pilot projects helps build trust, meet legal requirements, and ensure strong technical systems for sustainable regional digitalisation.

By leveraging pilot-based, practical insights and actively incorporating feedback from multiple stakeholders through a multistakeholder platform, ASEAN can create a collaborative environment that bridges operational realities and policy frameworks. Such an approach lays the groundwork for realising an end-to-end digital supply chain that respects national sovereignty while enhancing regional competitiveness through both national initiatives and strengthened cross-border cooperation.

To translate the vision discussed within the multi-stakeholder framework into action, ASEAN can begin by focusing on domains where bilateral cooperation is more feasible, such as customs-to-customs data exchange, port community system interoperability, or sector-focused pilots, countries can gradually expand the scope of cooperation by learning from these early cases and scaling what works. By progressively broadening participating partners and aligning cooperation areas, from ASEAN-wide initiatives to ASEAN+1 frameworks and eventually cross-regional linkage, ASEAN can move toward building a truly interconnected, trusted, and resilient digital trade ecosystem that delivers value at both national and regional levels.

Figure 4.2. Progressive Expansion of Digital Supply Chain Collaboration in ASEAN



Source: Developed by Authors, 2025.

2.4. Closing remarks

This project highlights the need to shift from aspirational dialogue on supply chain digitalisation to actionable collaboration, and as a critical first step, a PoC was implemented. The PoC validated that, with ideal visibility, optimal ordering tailored to real-time conditions can be achieved, resulting in improved asset efficiency and reduced excess inventory. However, realising such outcomes requires foundational enablers, as highlighted in the survey component of this study. When discussions on these enablers remain detached from implementation, progress tends to stall. ASEAN can play an active role in supporting implementation-driven initiatives within a multi-stakeholder framework that engages both public and private actors. By institutionalising such mechanisms, ASEAN has the potential to accelerate trust-building, foster systemic interoperability, and ultimately ensure resilience and adaptability in an increasingly interconnected global economy.

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Appendices

Appendix 1. Details of the Advisors' Feedback

Table A1. Details of the Advisors' Feedback

Type	Name	Feedback
OEM (Automaker)	A	The supply chain management between Japan and ASEAN, as well as amongst ASEAN countries, is conducted in Japan. The challenges include the inability to comprehensively manage the process from the Shipper to the Consignee and the fact that shipping delays can only be identified at the last minute. Regarding shipping information, a PoC on delay prediction using AI has been underway.
	B	Delays in marine transportation for parts shipped from Indonesia are an issue. Another issue is that export operations for trucks manufactured in Thailand have not been digitised. The sales department is aware of the issue of vehicle inventory management. The Overseas Procurement Division is interested in mediating regular deliveries between Japan and ASEAN and measuring the efficiency gains from consolidating and delivering related parts from Japan to overseas factories.
	C	Challenges are being felt in both the business process and the transportation process. Business process: Parts are procured from multiple Tier 1 factories and consolidated at the plant before being exported to other countries. It is sometimes managed with local EDI, and the information is not fully integrated. Transportation process: The transportation status is not being fully monitored for both land and maritime transportation. In ASEAN, many small-scale operators are involved in land transportation, making it difficult to obtain information about delays and other issues. For maritime transportation, which is like other companies, a key issue is that updates from shipping companies are not provided until the last minute. Furthermore, the influence of geopolitical risks, such as tariffs imposed by the Trump administration, along with weather and seasonal variations, is substantial, making it difficult to forecast the future. However, the priority for addressing these issues is not high because the volume in ASEAN is limited and the benefits do not justify the costs.
	D	SAP is used as the ordering and inventory management system. Three months' amount of inventory is owned in the consignee's neighbourhood as a reserve, so that even if delays in deliveries occur, the impact on the business will not be significant. Operations up to delivery are supported by the trading company to

Type	Name	Feedback
		which improvement requests are sent. Regarding delivery management, data have already integrated from overland, sea, and post-importation, so it is possible to trace the quantity of products. Accuracy at every delivery stage is also standardised.
General parts manufacturer	E	Data acquisition and integration in the supply chain are currently done manually, and they expressed a desire to move towards automation. In addition, they also face similar challenges as other companies in terms of the frequency of obtaining information about shipping delays and port omissions.
	F	Although they recognised the challenges related to the integration and visualisation of data in their supply chain, they are already working on the development of the system which is like the prototype system. Currently, the challenge is that information regarding vessel delays is not known until the last minute.
	G	The supply chain management is entrusted to the forwarder. There is no issue if the forwarder ensures that the specified quantities are delivered according to the ETA. Customer delivery schedule changes and shipper shipment delays account for most delays. Delay factors vary significantly by industry and company and cannot be resolved solely through platform construction and information management. While common challenges exist in general terms, from the perspective of platform adoption, the optimal solution must be sought on an industry-by-industry and company-by-company basis. To grasp this balance, researching forwarders' information management systems is beneficial.
Automotive parts trading companies	H	Inventory management and lead-time coordination are mainly carried by trading companies (Fragile local expatriate structure or high currency risk will be requirements for outsourcing), but a certain portion of core components is likely to be managed in-house. In case of shortage, trading company routinely used alternative methods such as AIR or imports from other countries.
	I	Most of the delays are attributed to maritime transportation. Since delivery delay factors, port omission status, and offshore waiting status is not kept as data, it is necessary to consider whether open data can be supplemental. There is no trend analysis of planned and actual values of past vessel operations and delays. As a result, mid- to long-term delivery plans are formulated based on the experience and intuition of the person in charge. They are interested in the development of statistical data on annual delay trends, as it would improve the accuracy of delivery planning proposals to customers.

*Indicated in blue: Aligns with the hypotheses of this project
*Indicated in red: Does not align with the hypotheses of this project
Source: Authors, 2025.

Appendix 2. Insights Gained from Stakeholders' Review

Table A2. Insights Gained from Stakeholders' Review

Type	Name	Feedback
OEM (Automaker)	A	[Positive Points] The content and definitions of KPIs align with actual business conditions. 'Reduction of days to safety inventory depletion' is particularly evaluated as a high-priority KPI. The 31% increase rate in 'Improvement of on-time shipment arrival' is impactful figures. When vehicle models change or design modifications occur, older parts become extra inventory or subject to disposal. Therefore, daily improvements lead to mid-term effectiveness. [Future Challenges] It would be ideal to incorporate the following prerequisites: Refining order units (currently based on individual items, but transactions are sometimes in dozens) Integration with the annual order calendar (e.g. bulk orders before extended holidays can lead to inventory buildup, though this is not considered an actual problem) Setting quality assurance periods (which can expire within months, potentially turning parts into extra inventory or subject to disposal)
General parts manufacturer	F	[Positive Points] - KPIs are set as following metrics: for financial aspects, the ratio of monthly sales to total assets; for operational aspects, total asset value and air freight transportation costs. A safety inventory level is set for automatic ordered items but not for manually ordered items. Instead, maximum and minimum inventory levels are set and compliance within this range is verified. - It is not prioritised to maintain safety stock due to the tendency to accumulate inventory for peace of mind. If operations can be maintained with lower inventory, KPI A5 prior to data integration could be judged as having been at a more appropriate level. - On the other hand, the concept of safety inventory varies depending on corporate management policies and item characteristics. Considering the purpose of the PoC, all KPIs definitions can be evaluated as appropriate. - Under conditions of small-lot, high-frequency ordering, the inventory reduction effect achieved through data integration manifests. Therefore, the results of the KPI calculations can all be considered at appropriate levels. [Future Challenges] - Under CIF, risk transfers from the seller to the buyer at the time of shipment. DAP, where risk remains with the seller until arrival at the buyer's designated location, is likely more effective for implementing KPI B. - Setting a minimum order quantity and requiring full container shipments reduces the effectiveness of inventory reduction. Since

Type	Name	Feedback
		minimum order quantities are typically set, 'reduction of extra inventory' of around 10% is realistic. - Not only inventory reduction but also reducing labour costs for inventory management is required. However, calculating the actual amount of labour cost savings achievable is difficult.

Source: Authors, 2025.

Appendix 3. Consultation Results on the Potential for Utilising Real-Time Data

Table A3. Consultation Results on the Potential for Utilising Real-Time Data

Type	Feedback
Platform operator	[Purpose of utilising real-time data] - There are many cases where real-time data is utilised to understand the ETA (estimated time of arrival) of vessel shipments more quickly and accurately. ETA is calculated by analysing past voyage data of sea shipments and AIS (Automatic Identification System) data using AI (artificial intelligence). - Most companies utilising real-time data are consignees, but it is also being used by shipping companies and forwarders. In the case of shipping companies and forwarders, they use it to provide information to their customers, the consignees. [Effectiveness of utilising real-time data] - The reduction rate of excess inventory through the utilisation of real-time data is around 1–2%. [Challenges] - For land transportation such as trucks and railways, the obligation to equip GPS devices varies by country, resulting in differences in the availability of real-time data. - For small to medium-sized transportation operators, the lack of developed IT systems may make it difficult to acquire real-time data. Obtaining real-time data remains a significant challenge in countries where such operators are the majority. [Future potential] - The goal is to develop the intelligence platform that not only visualises the supply chain but also contributes to operational decision-making.
General parts manufacturer	[Current Status] - From a BCP (Business Continuity Planning) perspective, the purpose of utilising real-time data is to track the location of vessels and visualise the status of the supply chain. - The department manufacturing mass-produced products has a consistent

Type	Feedback
	need for real-time data utilisation due to regular parts procurement. [Challenges] - The internal data has not been structured into a database, making it difficult to utilise real-time data. - Challenges exist with the accuracy of real-time data, and there have been cases where congestion at ports could not be detected. [Others] - Optimal supply chain management requires the utilisation of real-time data and centralised data management.

Source: Authors, 2025.

Appendix 4. PoC Assumptions (Data List)

Table A4. PoC Data List

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
1	#1	Production plan	Required date	List the weekdays (Monday to Friday) within the target period in order. Format: YYYY-MM-DD.
2			Required quantity	Set as a fixed value of 60 units.
3			Product number	Set it as 'A-0001'.
4	#2	Inventory Information	Inventory confirmation date	List the weekdays (Monday to Friday) within the target period in order. Format: YYYY-MM-DD.
5			Inventory Quantity	The values after the first day are calculated by the prototype system.
6			Product number	(The same values as #3)
7		Purchase Order	Purchase Order number	PO-A-YYYYMMDD-xxx *A: Parts *YYYYMMDD: order date *xxx: Ordering sequence * For emergency orders, add '-E' at the end.
8			Order date	(Calculated by the simulation execution function)
9			Delivery date	(Calculated by the simulation execution function)
10			Origin	ASEAN/Japan
11			Destination	ASEAN/Japan
12			Unit price	(Calculated by the simulation execution function)
13			Quantity ordered	(Calculated by the simulation execution function)
14			Product number	(The same values as #3)

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
15	#3	Commercial Invoice	Purchase Order number	(The same values as #7)
16			Invoice number	'INV'+'4-digit random number
17			Incoterms	Set it as 'CIF'.
18			Unit price	(The same values as #12)
19			Quantity	(The same values as #13)
20			Product number	(The same values as #3)
21			Product name	Set it as 'A'.
22			HS Code (Commodity Code)	8708.40
23	#4	Packing List	Purchase Order number	(The same values as #7)
24			Invoice number	(The same values as #16)
25			Quantity	(The same values as #13)
26			Product name	(The same values as #21)
27			HS Code (Commodity Code)	(The same values as #22)
28			Conveyance reference number	'CRN' + '4-digit random number'
29			Transport means	Vessel/Air
30	#5	Shipper's letter of instructions or	Shipping Instruction number	Change 'INV' in the #16 to 'SI'.

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
31		Shipping instructions	Purchase Order number	(The same values as #7)
32			Invoice number	(The same values as #16)
33			Date of departure from the Exporting port	(Calculated by the simulation execution function)
34			Estimated time of arrival	(Calculated by the simulation execution function)
35			Consignee	Company name 'ABC Motor'
36			Shipper	Company name 'XYZ Manufacturing'
37			Goods value	(The same values as #12)
38			Shipping cost (Trucker, custom)	Fixed value ($500)
39			Shipping cost (vessel or air)	Fixed value ($500)
40			Product name	(The same values as #21)
41			Number of packages	(Calculated by the simulation execution function)
42			Conveyance reference number	(The same values as #28)
43			Transport means	(The same values as #29)
44			Vessel number	'VSS'+'4-digit random number'
45			Container number	'CNT'+'4-digit random number'

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
46	#7	Shipping Advice or Shipping Notice	Shipping Instruction number	(The same values as #30)
47			Invoice number	(The same values as #16)
48			BL number	Change 'SI' in the #30 to 'BL'.
49			Date of notification	(Calculated by the simulation execution function)
50			Hauler Port Entry	Set it as 'Terminal A Gate 3'.
51			Transport means	(The same values as #29)
52			Vehicle registration number (Exporting)	VEH-EXP-'4-digit random number'
53	#8	Customs Declaration	Booking reference number	BRN-EXP-'4-digit random number'
54			Invoice number	(The same values as #16)
55			Carrier (Transport Services provider)	Company name '123 Ship'
56			Consignee	(The same values as #35)
57			Shipper	(The same values as #36)
58			HS Code (Commodity Code)	(The same values as #22)
59			Product name	(The same values as #21)
60			Number of packages	(The same values as #41)

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
61			Trade terms	(The same values as #17)
62			Goods value	(The same values as #12)
63			Shipping cost (Trucker, custom)	(The same values as #38)
64			Shipping cost (vessel or air)	(The same values as #39)
65			Date of custom clearance	(Calculated by the simulation execution function)
66			Date of arrival at the custom	(The same values as #49)
67			Date of departure from the port	(Calculated by the simulation execution function)
68			Origin	(The same values as #10)
69	#9	Container yard information	Booking reference number	(The same values as #53)
70			Date of arrival at the container yard	(The same values as #65)
71			Date of departure from the container yard	(The same values as #67)
72			Container number	(The same values as #45)
73	#10	Bill of Lading	BL number	(The same values as #73)
74			Consignee	(The same values as #35)
75			Shipper	(The same values as #36)

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
76			Number of packages	(The same values as #41)
77			Goods value	(The same values as #12)
78			Shipping cost (Trucker, custom)	(The same values as #38)
79			Shipping cost (vessel or air)	(The same values as #39)
80			Date of departure from the Exporting port	(The same values as #67)
81			Estimated time of arrival	(Calculated by the simulation execution function)
82			Conveyance reference number	(The same values as #28)
83			Transport means	(The same values as #29)
84			Vessel number	(The same values as #44)
85			Container number	(The same values as #45)
86		Sea Waybill	BL number	(The same values as #73)
87			Consignee	(The same values as #35)
88			Shipper	(The same values as #36)
89			Number of packages	(The same values as #41)
90			Transport means	(The same values as #29)

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
91			Vessel number	(The same values as #44)
92			Container number	(The same values as #45)
93		Sea Cargo Manifest	BL number	(The same values as #73)
94			Consignee	(The same values as #35)
95			Shipper	(The same values as #36)
96			Number of packages	(The same values as #41)
97			Conveyance reference number	(The same values as #28)
98			Transport means	(The same values as #29)
99			Vessel number	(The same values as #44)
100			Container number	(The same values as #45)
101	#11,12	Shipping Information (vessel or air)	Data timestamp	(Calculated by the simulation execution function)
102			Estimated time of arrival	(Calculated by the simulation execution function)
103			Vessel number	(The same values as #44)
104	#13	Arrival Notice	arrival at the importing port	(The same values as #102)
105			Vessel number	(The same values as #44)
106	#14	Customs	Invoice number	(The same values as #16)

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
107		Declaration	Carrier (Transport Services provider)	(The same values as #55)
108			Consignee	(The same values as #35)
109			Shipper	(The same values as #36)
110			HS Code (Commodity Code)	(The same values as #22)
111			Product name	(The same values as #21)
112			Number of packages	(The same values as #41)
113			Trade terms	(The same values as #17)
114			Goods value	(The same values as #12)
115			Shipping cost (Trucker, custom)	(The same values as #38)
116			Shipping cost (vessel or air)	(The same values as #39)
117			Date of custom clearance	(Calculated by the simulation execution function)
118			Date of arrival at the custom	(The same values as #104)
119			Date of departure from the port	(Calculated by the simulation execution function)
120	#15	Bill of Lading	BL number	BL-EXP-'4-digit random number'
121			Consignee	(The same values as #35)

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
122			Shipper	(The same values as #36)
123			Number of packages	(The same values as #41)
124			Goods value	(The same values as #12)
125			Shipping cost (Trucker, custom)	(The same values as #38)
126			Shipping cost (vessel or air)	(The same values as #39)
127			Date of departure from the Exporting port	(The same values as #67)
128			Date of arrival at the Importing port	(The same values as #104)
129			Conveyance reference number	(The same values as #28)
130			Transport means	(The same values as #29)
131			Vessel number	(The same values as #44)
132			Container number	(The same values as #45)
133		Sea Waybill	BL number	(The same values as #73)
134			Consignee	(The same values as #35)
135			Shipper	(The same values as #36)
136			Number of packages	(The same values as #41)

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
137			Transport means	(The same values as #29)
138			Vessel number	(The same values as #44)
139			Container number	(The same values as #45)
140		Sea Cargo Manifest	BL number	(The same values as #73)
141			Consignee	(The same values as #35)
142			Shipper	(The same values as #36)
143			Number of packages	(The same values as #41)
144			Conveyance reference number	(The same values as #28)
145			Transport means	(The same values as #29)
146			Vessel number	(The same values as #44)
147			Container number	(The same values as #45)
148	#16	Ship's Delivery Order	BL number	(The same values as #120)
149			Date of departing from the port	(The same values as #119)
150			Destination	(The same values as #11)
151			Product number	(The same values as #3)
152			Product name	(The same values as #21)
153			Container number	(The same values as #45)

#	Process No.	Data	Data Item	Synthetic Data (Creation Method)
154	#17	Shipping Information (Trucker)	Actual Date of notification	(The same values as #119)
155			Hauler Port Exit	Set it as 'Terminal B Gate 4'.
156			Transport means	Set it as 'Trucker'.
157			Vehicle registration number	VEH-IMP-'4-digit random number'
158			Container number	(The same values as #45)
159	#19	Warehouse Receipt	Purchase Order number	(The same values as #7)
160			Invoice number	(The same values as #16)
161			Issue date	(Calculated by the simulation execution function)
162			Quantity	(The same values as #13)
163			Product number	(The same values as #3)

Source: Authors, 2025.

Appendix 5. Overview by Country and by criteria (Current state and Challenges)

1. Singapore

PILLAR 1: Domestic process efficiency

Criteria 1-1. Digital Infrastructure Readiness

(1) Current State

Singapore's development of digital infrastructure stands as a leading case within ASEAN. This is evidenced by its consistent top ranking in the IMD World Digital Competitiveness Ranking 2024,[6] which evaluates the capacity and readiness of 67 countries in adopting and utilising digital technologies across economic and social domains. Singapore has maintained the top overall position for several consecutive years and ranks fourth globally in the 'Technology' sub-factor, underscoring its high standards not only within ASEAN but also on a global scale.

Under its national strategy 'Smart Nation', Singapore has prioritised digital infrastructure development as a national agenda, led by the Infocomm Media Development Authority (IMDA). In the telecommunications sector, the nationwide rollout of 5G was completed in 2022, with population coverage expected to exceed 99% by 2025.[7] Commercial 5G services are already available in major urban areas, and logistics hubs such as ports and airports are adopting automated transport systems and smart inspection technologies. These advancements are laying the foundation for real-time communication, enabling enhanced visibility and efficiency in supply chains. For example, smart logistics systems utilising IoT sensors and 5G connectivity have been implemented at the Tuas Port of Singapore, allowing real-time monitoring of cargo location and temperature, thereby improving operational efficiency and traceability in import/export processes.

In terms of cloud infrastructure, global cloud service providers such as Amazon Web Services (AWS), Google Cloud, and Microsoft Azure have established regional hubs in Singapore. This enables both government agencies and private enterprises to access highly reliable and available cloud services. Furthermore, the government supports cloud adoption amongst SMEs through the 'GoCloud' programme, promoting the digitalisation of trade-related operations.

Singapore has also emerged as a major data centre hub in the Asia-Pacific region. As of 2023, over 100 data centres are in operation,[8] positioning the country as a key node for cross-border data flows within ASEAN and a critical infrastructure for regional trade digitalisation. In 2024, the government introduced the 'Green Data Centre Roadmap',[9] promoting the development of environmentally sustainable data centres. IMDA has secured an additional 300MW of capacity, with 200MW allocated exclusively to operators utilising green energy.

In summary, Singapore has either already achieved or is on track to achieve an ideal level of digital infrastructure development in areas such as 5G, cloud computing, and data centres. These infrastructures serve as the backbone for the digitalisation of trade supply

[6] Institute for Management Development, World Digital Competitiveness Ranking 2024.

[7] IMDA (2020), Singapore Forges Ahead with Nationwide 5G Rollout.

[8] ASEAN BRIEFING (2023).

[9] INFOCOMM MEDIA DEVELOPMENT AUTHORITY, Green Data Centre (DC) Roadmap.

chains. Singapore's advanced initiatives are expected to serve as a model for other countries and play a leading role in driving digital transformation across the ASEAN region.

(2) Challenges

While Singapore is widely regarded as a leading model for digital infrastructure development within ASEAN, several challenges remain.

First, due to geographical constraints and limited energy resources, the development of new data centres is subject to increasingly stringent environmental regulations. This imposes limitations on future scalability. In fact, Singapore used to impose a moratorium (pause) on new data centres for three years (2019–2022) specifically due to power/carbon constraints. The development of energy-efficient data centres and the broader adoption of renewable energy sources are therefore key to ensuring sustainable infrastructure growth.

Second, although 5G is planned to cover 99% of the country, the nationwide implementation of 5G still faces challenges, particularly in rural and suburban areas, raising concerns about the digital divide. To address this, further investment is needed to ensure uniform 5G infrastructure coverage across the country, especially in logistics hubs and port areas.

Although support frameworks for SMEs are in place, the ITU has pointed out in its reports that Singapore's urban-centric infrastructure development should be re-evaluated from the perspective of digital inclusion.

Additionally, in an interview with Singapore authority, it was commented that budgetary constraints and infrastructure development limitations continue to pose significant bottlenecks to the advancement of digitalisation efforts.

Despite these challenges, Singapore remains one of the most advanced countries in the Asia-Pacific region in terms of digital infrastructure and is considered a near-ideal model for the digitalisation of trade supply chains. To achieve sustainable and inclusive digital transformation across the region, Singapore is expected to address these environmental and regional disparities and serve as a role model for other ASEAN countries.

Criteria 1-2. Digital Format Readiness

(1) Current State

Singapore has achieved a high level of maturity in the digitalisation of trade-related documents across institutional, infrastructural, and operational dimensions. The country's progress is driven by the integration of the Networked Trade Platform (NTP), which is centred around TradeNet, the national single window (NSW) launched in 1989, and the TradeTrust platform developed under the leadership of the Infocomm Media Development Authority (IMDA). Notably, TradeTrust leverages blockchain technology to ensure the authenticity, tamper-resistance, and transferability of electronic documents, enabling interoperability of international trade documents such as Commercial Invoices and Bills of Lading.

According to the UN Global Survey on Digital and Sustainable Trade Facilitation, Singapore scores 100% in 'Paperless Trade'.[10] The latter indicates that while some documents, such

[10] UN, Global Survey on Digital and Sustainable Trade Facilitation.

as certificates of origin have been partially digitalised full implementation is still in progress.

By document type:

Commercial invoices are widely used in electronic form through the nationwide InvoiceNow network which is built on Peppol network. Crucially, the Inland Revenue Authority of Singapore (IRAS) has mandated a phased adoption for Goods and Services Tax (GST) reporting: GST-registered businesses must adopt InvoiceNow solutions starting May 2025, with full mandatory coverage by April 2026. This effectively establishes InvoiceNow as the national de facto standard for B2G and B2B invoicing.

Certificates of origin (CO) have transitioned to electronic transmission and receipt under the ATIGA e-Form D as of 1 January 2024. However, since some partner countries, banks, and Letter of Credit requirements still demand paper COs or printed PDFs, a hybrid system continues to remain in place.

Customs declarations are fully digitalised through TradeNet, which has served as the core system since 1989. Integration with NTP enables end-to-end electronic processing of application, review, and approval procedures.

Packing lists are widely submitted and shared electronically as supporting documents for declarations. However, in air and land transport operations, printed copies may still be required,[11] meaning full paperless implementation depends on the operational context.

Phytosanitary certificates are managed by the National Plant Protection Organization (NPPO), under the National Parks Board/Plant Health, which aligns with the IPPC e-Phyto Hub. While institutional connectivity is in place, the depth of implementation varies depending on the partner country and commodity.

Bills of lading (e-BLs) have seen growing adoption in the industry following amendments to the Electronic Transactions Act (ETA), which now recognises electronic transferable records (ETRs) in line with MLETR. TradeTrust provides the technical and governance framework to support interoperability, authenticity verification, and transfer of rights, together with practical solutions such as Bunkerchain, Singapore demonstrates that strong domestic adoption of electronic bills of lading is achievable even without relying on trading partners that have implemented the MLETR. This contrasts with challenges faced by other jurisdictions, where underdeveloped trust frameworks and limited use of advanced technologies continue to constrain domestic digitalisation efforts.

Document map findings (Appendices 6): In Singapore's domestic procedures for both imports and exports, all key documents exchanged between forwarders and customs, including commercial invoices, certificates of origin, customs declarations, packing lists, and bills of lading, are fully digitalised and processed through TradeNet or NTP. However, for commercial invoice, packing list, and permits physical documents are required for inspections occasionally.

In summary, Singapore's institutional and infrastructural frameworks such as TradeNet/NTP, ASW, ETA amendments, and TradeTrust are amongst the most advanced in ASEAN. However, the maturity of operational practices varies by document type. Transitional elements remain, such as the continued use of printed packing lists and the dependence of e-BL implementation on the adoption of compatible platforms by

[11] Singapore Customs, Documents for Clearance of Goods.

counterparties.

(2) Challenges

Singapore has achieved a high level of maturity in digital trade through its robust institutional framework centred on TradeNet/NTP and the legal recognition of ETRs (including e-BLs) via ETA amendments and TradeTrust. However, the following operational challenges remain:

The continued use of printed documents in certain operational contexts, such as packing lists, may hinder the realisation of full paperless trade.

Although Singapore's TradeTrust framework has demonstrated that e-BLs can be used in cross-border trade, including with non-MLETR jurisdictions such as Thailand, the effective implementation of e-BLs still depends on the adoption by counterparties and shipping lines.[12] Fragmentation across platforms and uneven acceptance amongst carriers and banks continues to create bottlenecks in interoperability across institutions, carriers, and platforms.

In essence, while Singapore has established a comprehensive domestic legal and institutional framework for document digitalisation, challenges remain in overcoming paper-based practices, achieving cross-border interoperability, and ensuring last-mile paperless implementation.

Criteria 1-3. Presence of National Single Window (NSW)

(1) Current State

Singapore's National Single Window is centred around TradeNet, which began operations in 1989. It has long served as a centralised electronic platform for processing declarations and permits related to exports, imports, and transshipments. Complementing this system is the Networked Trade Platform (NTP), operated by Singapore Customs, which functions as a cross-sectoral hub encompassing not only B2G data exchange but also B2B integration and international connectivity. Under the WTO Trade Facilitation Agreement (TFA), Singapore has officially notified the operation of its NSW (Article 10.4.3), clearly establishing its institutional status.

From an operational perspective, users registered with TradeNet can access online services such as application submission (new, amendment, cancellation, refund), progress tracking, permit retrieval, and document output. For regional integration, the NTP provides a practical interface for electronic transmission and inquiry of Certificates of Origin (Form D) via the menu path: Government Services → International Connectivity → ATIGA e-Form D. These procedures are supported by up-to-date user guides. For businesses, both the TradeNet portal and NTP dashboard are publicly available, offering a well-structured user environment including account setup and login pathways.

In terms of implementation metrics, the UN Digital & Sustainable Trade Facilitation Survey (2025) rated Singapore at 96.77% overall, with full scores (100%) in transparency, procedural simplification, institutional framework, and paperless trade.[13] While the country is rated as 'Fully Implemented' for E-Single Window, cross-border electronic

[12] TradeTrust Newsletter May 2025

[13] UN, Global Survey on Digital and Sustainable Trade Facilitation.

exchange of Certificates of Origin remains partial, suggesting potential for further interoperability enhancement.

Overall, Singapore has achieved a high level of maturity in domestic trade digitalisation, with a robust two-tier architecture comprising TradeNet (NSW) and NTP (B2G/B2B hub). However, third-party assessments point to two key areas for future policy and operational focus:

Limited access for SMEs, which are still rated as 'Partially Implemented' in terms of NSW usage.

(2) Challenges

Singapore's TradeNet and the Networked Trade Platform (NTP) have functioned effectively for many years, and the country's domestic digitalisation of trade procedures is highly mature. However, from an institutional perspective, access and support for small and medium-sized enterprises (SMEs) remain insufficient. In particular, the lack of user education, onboarding assistance, and cost-reduction measures for SMEs has led to disparities in usage.

Additionally, there is functional overlap between TradeNet and NTP, and the government needs to clarify its system integration policy and roadmap for future updates.

In terms of penetration, cross-border integration still has room for improvement. Furthermore, data standardisation with related sectors such as trade finance and insurance is still not fully developed. From the perspective of operational improvement, there is a lack of publicly available quantitative KPIs that reflect the performance and usage trends of TradeNet/NTP. Enhancing technical transparency and data connectivity across the entire supply chain is a key next step.

PILLAR 2: Seamless Cross-border Connectivity and Interoperability

Criteria 2-1. Technical Interoperability

(1) Current State

The Singaporean government is globally promoting cross-border mutual verification and interoperability of electronic bills of lading (e-BL) and other trade documents, centred around the TradeTrust framework. To build trust, the framework uses blockchain or distributed ledger technology to verify the authenticity, uniqueness, and transferability of e-BLs across platforms. In 2025, the government released 'Model Terms' to provide practical clauses for interoperability and delineation of responsibilities between platforms. The previously used OpenAttestation framework reached its end-of-support on 1 October 2025, and IMDA officially recommended migration to TrustVC.

Additionally, Singapore has nationally deployed Peppol-compliant e-Invoicing through the InvoiceNow initiative. InvoiceNow e-invoices in Singapore are based on the Peppol BIS (Business Interoperability Specifications) Billing 3.0 standard, which is a structured XML format. Peppol is a global standard specification encompassing document formats, network infrastructure, and operational rules for electronic document exchange. Starting May 2025, GST-registered businesses are required to adopt InvoiceNow. IMDA, acting as the Peppol Authority, leads the development of technical specifications, vocabularies, and classification schemes. Full implementation for all GST-registered entities is scheduled to

begin in April 2026. InvoiceNow is expected to reduce invoice processing costs by approximately SGD 8 per invoice through automation of manual processes.[14] It also allows Peppol-compliant entities to exchange electronic invoice to other parties domestically and internationally using one access point only, either it is B2G or B2B transactions.

Lastly, Singapore is leading ASEAN in implementing advanced interoperability by combining APIs with standardised data. For example, on its trade platform NTP, Singapore adopts international standard data such as UN/CEFACT, and in the digitalisation of Banker's Guarantees, it has introduced a mechanism where bank systems and NTP automatically exchange guarantee information via APIs. Specifically, Singapore has established a mature API developer governance framework for its trade platforms. Unlike many regional counterparts, the NTP provides a public 'API Playbook' that rigorously defines version control policies, deprecation timelines, and sandbox validation rules. This ensures that private developers (e.g. banks, ERP vendors) can integrate their systems with government platforms using a stable, predictable roadmap.

In addition, Singapore and Malaysia have jointly advanced technical interoperability through the linkage of SGTraDex and MYEG, enabling trusted cross-border data exchange and more seamless regulatory processes between the two countries.

(2) Challenges

Singapore holds a position of technological leadership within the region. For example, Singapore is driving the transition toward the latest international standards areas such as cross-border e-invoicing based on Peppol and Peppol International Invoice (PIN).

However, this technological 'depth' has created a significant gap with the 'technological maturity' of other ASEAN countries and trade partners. When Singapore adopts new standards, there is a heightened risk that its partners may not be able to follow suit, resulting in a failure to achieve technical 'inheritance' even if common interoperability specifications exist.

Furthermore, as a 'First Mover,' Singapore faces unique legacy migration risks. For instance, the transition from the 'OpenAttestation' framework to the newer 'TrustVC' standard (with OpenAttestation reaching end-of-support in October 2025) imposes a technical maintenance burden on Singaporean stakeholders that later-adopting countries do not yet face.

In the interviews, a freight forwarder association noted that while Singapore faces fewer integration hurdles than its regional counterparts, it still reflects a shared challenge in harmonising cross-sector digitalisation.

Criteria 2-2. Organisational Interoperability

(1) Current State

Singapore, leveraging its technological leadership, promotes institutionalised inter-organisational collaboration through a dual-layered approach led by the Infocomm Media

[14] InvoiceNow FAQs, https://www.imda.gov.sg/-/media/imda/files/programme/nationwide-e-invoicing-framework/imdainvoicenow-faqs-final.pdf

Development Authority (IMDA) and Singapore Customs. Specifically, Singapore spearheads common frameworks such as TradeTrust and Data Free Flow with Trust (DFFT), utilising blockchain technology to establish a policy model that ensures the authenticity and legal validity of data exchanged between different organisations.

Furthermore, Singapore aims to expand governance adoption by encouraging not only domestic regulators but also cross-border trade partners and the maritime industry to adopt common interpretations and processes regarding the reliability of electronic documents.

Singapore Customs serves as Singapore's representative to the ASW Steering Committee and leads the country's participation in the ASW, including electronic exchanges such as the Certificate of Origin (Form D). Leveraging its advanced trade facilitation systems, Singapore often guides regional initiatives, contributes technical and legal expertise on data harmonisation and electronic frameworks, and frequently takes on chairing roles across working groups to support ASEAN's overall progress.

(2) Challenges

As a global leader in trade digitalisation, Singapore has developed advanced governance frameworks such as TradeTrust and DFFT. However, the challenge lies in how to ensure the rapid and widespread adoption of these frameworks – not only domestically but also across the international trade community, which comprises diverse technical and legal environments. This disparity in the pace and level of organisational coordination between Singapore and other ASEAN countries may hinder regional harmonisation. And this differences in the speed and level of this organisational coordination can, as a result, become a factor that slows down or complicates consensus-based decision making in ASEAN. This potential issue is common amongst ASEAN Member States.

Criteria 2-3. Legal interoperability

(1) Current State

Following the 2021 amendment to the Electronic Transactions Act, Singapore has implemented a framework aligned with the UNCITRAL MLETR. Electronic transferable records such as electronic bills of lading (e-BL) are granted the same legal effect as their paper counterparts.

For cross-border data transfers, Singapore commonly refers to the ASEAN Model Contractual Clauses (MCC) and the EU's Standard Contractual Clauses (SCC), combining contractual mechanisms with certifications such as APEC's Cross Border Privacy Rules (CBPR) and Privacy Recognition for Processors (PRP).

Beyond domestic legislation, Singapore is the most proactive advocate of high-standard digital rules. Building on its network of bilateral and plurilateral Digital Economy Agreements – including the Singapore–Australia DEA, Singapore–UK DEA, Singapore–Korea DEA, and the Digital Economy Partnership Agreement (DEPA) with New Zealand and Chile – and leveraging its ASEAN leadership role (e.g. through the ASEAN Agreement on Electronic Commerce and its bilateral digital-economy framework with Malaysia), it pushes for advanced provisions on data flows, cybersecurity, digital IDs, and trusted technologies, steering DEFA toward ambitious benchmarks. Singapore also actively

champions regional alignment through the ASEAN Data Management Framework (DMF). As the chair of the working group that developed the DMF, Singapore's Personal Data Protection Commission (PDPC) has released specific guides to help companies utilise the DMF and ASEAN Model Contractual Clauses (MCCs), serving as a practical bridge between domestic policy and regional frameworks.

(2) Challenges

Singapore has already established a legal framework aligned with the UNCITRAL MLETR, and through its TradeTrust initiative, it has built an advanced system that enables verification of the authenticity and control of electronic documents. However, a key challenge moving forward is the expansion of international certification and mutual recognition mechanisms to link domestic framework like TradeTrust with those of other countries. For instance, Singapore adoption of APEC CBPR only facilitates mutual legal recognition with limited number of countries joining such framework.

Furthermore, there is a need to strengthen practical support systems to help small and medium-sized enterprises comply with these complex legal and technical requirements of cross-border digital trade. Recent regional and international studies, including OECD[15] consistently show that SMEs often face relatively higher compliance costs and often lack the internal resources to interpret overlapping rules on privacy, data protection, and sector-specific regulations across different jurisdictions, etc. This makes it harder for SMEs to fully benefit from cross-border digital trade tools such as electronic transferable records or certification systems. In Singapore, public agencies like IMDA offer grants and advisory programmes to help SMEs participate in frameworks such as APEC CBPR.

PILLAR 3: End-to-end Unit-level Traceability and Resilience

Criteria 3-1. Real-time Cargo Tracking

(1) Current State

Singapore is advancing real-time cargo tracking using IoT, GPS, and RFID as part of a national strategy. Its approach is characterised by the integrated promotion of three pillars: technology standardisation, smart infrastructure, and operational data sharing.

The Infocomm Media Development Authority (IMDA) has established national standards for IoT interoperability and security (e.g. SS 695, SS 711), enabling secure technology integration. The deployment of 5G infrastructure across ports supports real-time sensor data collection and AI-driven analytics.

In terms of smart port operations, the Maritime and Port Authority (MPA) and PSA are leading the integration of IoT technologies into Automated Guided Vehicles (AGVs) and cranes at Tuas Mega Port, enabling real-time monitoring of location and status. For instance, DigitalPORT@SG facilitates Just-In-Time vessel arrivals using real-time data, which use predictive tracking to optimise vessel berthing speeds, moving beyond simple visibility to operational optimisation.

For data sharing, tracking data is standardised and disseminated across the ecosystem via community systems. PORTNET offers container tracking as a standard feature by

[15] OECD, The Digital Transformation of SMEs (2021).

integrating Radio-Frequency Identification (RFID), Electronic Data Interchange (EDI), and Automatic Identification System (AIS). SGTraDex enhances trade finance and operational efficiency by providing near real-time visibility.

These comprehensive efforts have enabled Singapore to achieve a high Logistics Performance Index (LPI) Timeliness score of 4.3, positioning it as a model for digital trade within ASEAN.

(2) Challenges

Despite its advanced initiatives, Singapore lacks standardised mechanisms for integrating real-time tracking data (e.g. GPS, IoT) into the ASEAN Single Window (ASW) or partner countries' NSWs in a machine-readable format. Additionally, SMEs face operational constraints due to the high costs of IoT devices and API integration, which hinders broader system interoperability.

Criteria 3-2. Management Capability for Tracking Data

(1) Current State

Singapore is simultaneously advancing both institutional design and implementation of data integration across port operations, customs, logistics, and finance, with strong public-private collaboration to enhance traceability. For example, systems such as *digitalPORT@SG*™ enable real-time optimisation of port operations, integrating event data like vessel arrival and berthing at the operational level. Additionally, *SGTraDex* serves as a shared data infrastructure connecting shippers, carriers, and financial institutions, enabling integrated visibility of documents, events, and financial data. Singapore demonstrates high policy execution capacity and private-sector implementation strength, forming a robust chain of regulation, operation, and interoperability.

These two initiatives are built on public–private collaboration. Amongst them, digitalPORT@SG™ serves as a 'Maritime Single Window,' led by the Maritime and Port Authority of Singapore (MPA), the maritime and port regulatory authority. It integrates application and approval processes from multiple government agencies, including the Immigration & Checkpoints Authority (ICA), which oversees vessel entry and exit procedures, and the National Environment Agency (NEA), responsible for port health management. Furthermore, port terminal operators such as PSA Singapore and Jurong Port, along with marine service providers like pilotage, tugboat, and bunker operators, digitally share operational schedules and service arrangements, working with MPA to achieve real-time optimisation of port operations. This granular visibility into support services represents a higher tier of ecosystem management than currently seen elsewhere in the region.

In addition, SGTraDex is designed and operated as a public–private consortium-based digital infrastructure, spearheaded by the Infocomm Media Development Authority (IMDA) and involving port operators, shipping lines, financial institutions, and major traders, including PSA International, Trafigura, DBS Bank, Jurong Port, OCBC Bank, Ocean Network Express (ONE), Advario, Pacific International Lines (PIL), Standard Chartered, and UOB.

Singapore demonstrates a willingness to enhance more granular, container-level data integration, particularly in customs and port operations. A concrete example is the evolution of PSA Corporation Limited's (PSA) and related national platforms, which enable

real-time tracking of specific container numbers and associated milestone events, and share this information with customers and logistics partners.

(2) Challenges

Going forward, establishing stable operations for cross-border transactions will be key. It is essential to include a wide range of stakeholders, including SMEs, and to standardise and enforce operational procedures (SOPs). Continuous consensus-building on secondary data usage, responsibility boundaries, and data disclosure granularity is needed to position Singapore as a regional model for digital integration.

In addition, a key challenge is the gap between domestic progress and international integration. While domestic data exchange platforms and frameworks are robustly developed, their seamless, real-time interoperability with diverse systems in other countries remains a significant hurdle for end-to-end global supply chain visibility.

Criteria 3-3. Supply Chain Diversification: Overview of Trade Structure

Singapore maintains a diversified trade structure, with major export destinations including China (around14%), ASEAN (around28%), the United States (around10%), and Hong Kong (around 11%). Re-exports exceed domestic exports, reinforcing Singapore's role as a global trade hubc.[16]

Imports are sourced from a wide range of countries, ensuring supply chain resilience. With 28 FTAs, including RCEP, CPTPP, DEPA, and EUSFTA, Singapore covers around 90% of its trade,[17] securing broad market access and integration into global value chains.

Despite its advanced and diversified trade infrastructure, the following characteristics highlight challenges in supply chain diversification:

- 14% of exports are directed to China, mainly semiconductors, posing supply chain risks.
- FTAs with Latin America, Africa, and the Middle East are limited, restricting access to emerging markets.

Advanced digital platforms such as SGTraDex and digitalPORT@SG™ can be assessed as being exposed to a certain degree of geographic concentration risk arising from dependence on specific countries or regions. If a partner country were to unilaterally tighten regulations on cross-border data transfers or alter customs data standards, the existing highly streamlined digital integration could suffer performance degradation or delays, potentially forcing temporary reliance on paper-based backups and manual alternative procedures for cross-border transactions.

Furthermore, since a substantial portion of exports to certain countries consists of semiconductor-related products, Singapore's digital trade systems are also significantly exposed to industrial concentration risk. While finished imports are diversified, Singapore's semiconductor manufacturing sector relies heavily on the import of specialised intermediate goods (e.g. raw wafers, specific chemical gases) which are highly concentrated in a few source countries. A disruption in these specific upstream inputs could halt high-value production lines, representing a hidden vulnerability despite broad

[16] JETRO, Trade and Investment Report of Singapore (2024).
[17] Prime Minister's office, Singapore, https://www.pmo.gov.sg/.

trade diversification. Under such circumstances, digital platforms like TradeTrust are increasingly required to maintain continuous agility to promptly incorporate new global standards and sudden export control measures on dual-use components. Consequently, the focus of digitalisation is shifting beyond mere improvements in processing efficiency toward comprehensive, real-time risk visualisation at the unit level.

PILLAR 4: Trustworthy and Secure Infrastructure

Criteria 4-1. Cybersecurity Legal Framework

(1) Current State

Singapore, under the Singapore Cybersecurity Strategy 2021, has been strengthening its national capabilities to respond to cyber threats.

This strategy is built around five key pillars: Protection of Critical Information Infrastructure (CII), Development of Cybersecurity Talent, Enhancement of International Cooperation, Collaboration with Industry, and Promotion of Technological Innovation. Through these pillars, Singapore implements comprehensive measures that encompass both legal and operational dimensions of cybersecurity.

The Cybersecurity Act provides the legal foundation for these efforts. It mandates security measures, audits, and incident reporting obligations for CIIs, thereby establishing a national framework for the government to strategically manage cyber risks.

Most recently, a major update came through the Cybersecurity (Amendment) Bill, passed by Parliament on 7 May 2024, the first amendment to the 2018 Act.

The amendments expand regulatory authority to include CIIs located outside Singapore, introduce oversight for Foundational Digital Infrastructure (FDI) such as cloud services and data centres, extend coverage to Short-Term Critical Systems (STCC) that pose temporary but high cyber risks, and strengthen incident reporting obligations. This explicitly brings cloud service providers and data centre operators under the national cybersecurity regulatory umbrella for the first time, setting a new regional benchmark for supply chain security.

The domestic legal framework for electronic signatures and electronic records is primarily established under the Electronic Transactions Act (ETA 2010). The ETA recognises the legal validity of electronic records and stipulates that an electronic signature meets the legal requirements for a signature if the method used to create it can identify the signatory, indicate their intent, and is appropriately reliable for its intended purpose. Importantly, the ETA distinguishes between a general 'electronic signature' and a 'secure electronic signature.' A secure electronic signature is typically implemented through mechanisms such as digital signatures backed by certificates issued by accredited certification authorities. Only such secure electronic signatures are granted statutory presumptions of authenticity and integrity equivalent to handwritten (wet ink) signatures. The ETA was further amended in 2021 to adopt UNCITRAL's Model Law on Electronic Transferable Records (MLETR), thereby extending its scope to cover transferable documents such as electronic bills of lading. This provides a critical legal foundation for supporting trade digitalisation and strengthening end-to-end traceability.

(2) Challenges

While the legal framework itself has been progressively established, these measures are primarily concentrated on CIIs and a limited number of large-scale operators. For small and medium-sized enterprises (SMEs) in port and logistics sectors, as well as companies heavily dependent on international cloud services, the question of 'how far and to what depth they should be subject to regulation and audits' remains a challenge in terms of defining boundaries and setting priorities.

Regarding the incident report, its obligations for CII operators under the Cybersecurity Act and personal data breach reporting obligations under the PDPA are relatively mature, but the framework remains largely focused on CII. For SMEs in the port and logistics sector, as well as businesses relying on international cloud services, certain points remain somewhat unclear. For example, at what stage a cyber incident that does not involve personal data, but halts logistics operations should be reported, which authority should be prioritised for notification, and what level of technical detail is required in the report.

Furthermore, Singaporean logistics companies expanding regionally face a redundant compliance burden. Because Singapore's rigorous CII audits are not yet mutually recognised by other ASEAN regulators (due to the lack of a Cybersecurity MRA), Singaporean firms operating regional hubs in Thailand or Viet Nam must undergo duplicative security audits for the same digital infrastructure, increasing their operational costs.

Criteria 4-2. Governmental/Public organisation responsible for ensuring data security

(1) Current State

The Singaporean government has established the Cyber Security Agency of Singapore (CSA) as its national cybersecurity authority. The CSA functions as the national Computer Security Incident Response Team (CSIRT), overseeing and responding to domestic and international cyber threats. It actively promotes the protection of Critical Information Infrastructure (CII) and drives information sharing and capacity building with the private sector. The AMEICC Report commends the CSA for its active involvement in cybersecurity cooperation within the ASEAN region, contributing to enhanced regional trust.

Furthermore, the Personal Data Protection Commission (PDPC), the enforcement body for the Personal Data Protection Act (PDPA), regulates and establishes a trustworthy framework for cross-border data flow. The functionality of these agencies is exceptionally high, representing one of the most advanced governance structures internationally. The PDPC proactively enforces the revised PDPA, which includes substantial financial penalties, effectively ensuring the security of the government's digital trade infrastructure.

Notably, Singapore is ranked in Tier 1 (the highest group) in the ITU's Global Cybersecurity Index (GCI) 2024, achieving the maximum score of 20 for the organisational measure pillar.

(2) Challenges

While Singapore has established a leading position in the region, there is a continuous need to align its rigorous security and data protection standards (PDPA) with the diverse legal frameworks of other countries with varying levels of digital maturity.

The disparity in data protection standards amongst member states poses a structural impediment to achieving secure and seamless cross-border data flow. Moreover, while promoting international data fluidity through Digital Economy Agreements (DEAs), continuous calibration is necessary to ensure that existing strict domestic regulations do not become potential barriers to the introduction of new trade technologies utilising AI and blockchain.

In the interviews with the Customs, security was discussed in terms of balancing compliance and facilitation. Customs noted the need to further streamline clearance processes by collecting upstream information digitally to strengthen electronic risk management and profiling, while re-examining Customs procedures to secure necessary data. Also, during interview, a Singapore-based academia emphasised the critical need to strengthen cybersecurity across ASEAN and noted that each country must manage and protect its own cybersecurity, as ASEAN cannot assume this responsibility on their behalf. However, suggested that ASEAN could develop a regional-level coordination system that connects national systems while clearly defining rules and governance, specifically, determining what responsibilities belong to ASEAN and what remain under national control. Such an approach would help build trust amongst member states and facilitate secure, interoperable data exchange.

The next important step might be actively engaged in collaboration with corresponding government agencies and regulatory authorities in other countries, to strategically reduce institutional and data silos at both bilateral and regional levels. Considering Singapore's role as a major transshipment hub, ensuring the integrity of supply chain data requires going beyond domestic compliance to secure mutual recognition of security standards and authentication mechanisms with trading partners, such as electronic signatures and verifiable credentials.

Criteria 4-3. Appropriate cybersecurity environment and operational status

(1) Current State

Singapore is strongly promoting paperless and automated supply chains by placing its National Digital Identity (NDI), Singpass, at the core of its trade infrastructure.

User authentication and consent flows for the National Trade Platform (NTP) and TradeNet are all based on Singpass (NDI), with corporate users accessing via Corppass.

As a result, Singpass has become the de facto standard for identity and authentication across the NTP, which serves approximately 6,500 companies (as of 2024).[18] The entire process, from login, consent presentation (via Authorise API), to remote electronic signing using Sign with Singpass, which serves as Singapore's real-world implementation of legally recognised e-signatures under the ETA, is fully integrated.

Since 2021, major trade activities such as customs clearance, licensing, and certificate issuance have been standardised through Singpass login, ensuring document integrity and delivery at the platform level. The sign with Singpass feature represents a shift to cloud-based signing, utilising an Authorise API that allows users to sign documents remotely via mobile apps without needing physical hardware tokens. This lowers the barrier to entry compared to hardware-centric PKI models used elsewhere in the region.

[18] Singapore Customs, Networked Trade Platform – WTO Webinar (2024).

This three-layer integration, legal (ETA amendments ensuring reliability of electronic transferable records), infrastructure (NDI/signature APIs), and operations (NTP/TradeNet/ASW) ensures a highly mature level of paperless, automated, and auditable supply chain procedures.

(2) Challenges

While Singapore has established an integrated model centred on Singpass, its high level of maturity presents challenges in international interoperability.

Secure electronic signatures via Singpass Sign are well established domestically but maintaining legal and technical interoperability of signature assurance levels (LoA) with other ASEAN countries remains a challenge.

Corporate delegation of authority is managed via Corppass but standardising the granularity of consent (scope and purpose of data use) and enabling international technical coordination are still pending.

Additionally, digital disparities amongst SMEs, due to technical costs and integration complexity, pose barriers to full adoption of NTP and Corppass.

2. Malaysia

PILLAR 1: Domestic Process Efficiency

Criteria 1-1. Digital Infrastructure Readiness

(1) Current State

Malaysia is rapidly advancing the development of its 5G networks, cloud infrastructure, and data centres, positioning itself as a central player in the digital economy of Southeast Asia. These efforts are steadily laying the foundation for the digitalisation of trade and supply chains. In the IMD World Digital Competitiveness Ranking 2024,[19] which evaluates and compares countries' capabilities and readiness in adopting and utilising digital technologies across economic and social sectors, Malaysia ranked 36th overall and 34th in the 'Technology' sub-factor, placing it in the mid-range globally.

The Malaysian government has set a target to increase the digital economy's contribution to GDP to 25.5% by 2025, under national strategies such as MyDIGITAL and Malaysia Digital.[20] In 2025, the government also launched the National Cloud Computing Policy (NCCP), aimed at correcting the previously siloed approach to cloud adoption and promoting a nationally integrated strategy. This effectively operationalises a cloud-first approach for the public sector, mandating agencies to prioritise cloud solutions to enhance e-government resilience and scalability, mirroring regional best practices.

Key initiatives under these strategies include:

- Nationwide broadband expansion through the National Fiberisation and Connectivity Plan (NFCP) and JENDELA.
- Development of ICT infrastructure in both urban and rural areas.

[19] IMD, IMD World Digital Competitiveness Ranking 2024.
[20] Malaysia Ministry of International Trade and Industry, Digital Economy.

- Cloud adoption support for SMEs (e.g. Smart Automation Grant).
- Promotion of investment in green data centres and cybersecurity.

Malaysia's 5G rollout has been led by Digital Nasional Berhad (DNB), a government-owned entity operating under a single wholesale network model. As of 2025, 5G population coverage has reached 82.4%,[21] a significant increase from just 4% in 2021. This infrastructure will support the future real-time logistics data exchange and the use of IoT, contributing to the advancement of supply chain efficiency. Recently, the government announced a shift from the DNB model to a multi-network approach, aiming to encourage private sector participation in infrastructure development and accelerate competition and deployment.

In the area of cloud and data centres, Malaysia received record-breaking investments totalling approximately US$16.9 billion from global tech giants such as Amazon Web Services (AWS), Microsoft, and Google between 2023 and 2024. These investments are believed to be driven by Malaysia's low natural disaster risk, stable power supply, and geographic proximity to Singapore. Notably, AWS is investing US$6.2 billion to establish a new cloud region, while Microsoft and Google have announced investments of US$2.2 billion and US$2.0 billion, respectively, to develop the country's first domestic data centres and cloud regions. These developments are expected to significantly enhance the secure and efficient processing of trade-related data.

Together with the development of electronic trade platforms, these initiatives are expected to elevate Malaysia's digital trade capabilities, strengthen cross-border data integration, and streamline trade procedures.

(2) Challenges

While Malaysia has attracted large-scale investments from global tech giants such as AWS, Microsoft, and Google, the development of data centres and 5G infrastructure remains heavily concentrated in urban areas, particularly in Cyberjaya and Johor. This urban-centric development has raised concerns over regional disparities. While 5G expands in cities, rural connectivity remains largely dependent on 4G networks, creating a significant speed and latency gap that disadvantages rural logistics hubs. Furthermore, the rapid expansion of data centres brings sustainability challenges. Despite the push for green data centres, the national power grid remains heavily reliant on fossil fuels. Ensuring a stable, renewable power supply to meet the surging energy demand of these facilities is becoming a critical infrastructure bottleneck, similar to challenges faced by Singapore.

The adoption rate of cloud services amongst small and medium-sized enterprises (SMEs) remains relatively low. In rural areas especially, barriers such as limited ICT skills, high implementation costs, and concerns over cybersecurity hinder adoption. As a result, the benefits of digitalisation and operational efficiency through cloud utilisation have yet to be fully realised. These regional disparities and the need to promote SME adoption have also been highlighted in reports by the World Bank.

[21] Prime Minister's office of Malaysia Official Website (2025), KEYNOTE ADDRESS BY YAB PRIME. MINISTER: SMART CITY EXPO KUALA LUMPUR (SCEKL 2025).

Criteria 1-3. Presence of National Single Window (NSW)

(1) Current State

In Malaysia, the National Single Window has been operational since 2009, with myTRADELINK serving as the gateway platform that enables businesses to submit and share trade-related data through a single electronic interface. The system is overseen by the Ministry of Finance and operated by Dagang Net Technologies, a government-appointed entity. It comprises six core modules such as e-Declare, e-Payment, e-Manifest, e-Permit, e-PCoO, and e-PermitSTA which collectively support the main functions of trade facilitation.

Under the WTO Trade Facilitation Agreement (TFA), Malaysia officially notified the implementation of its Single Window (Article 10.4.3) as a Category A commitment, effective 22 February 2017, thereby establishing the NSW's institutional and international legitimacy.

Operationally, the Ministry of International Trade and Industry (MITI) provides a comprehensive overview of domestic B2G electronic application processes, including preferential Certificates of Origin (e-PCoO) and various permit-related services (e-Permit). For regional integration, Malaysia has continuously updated its guidelines, FAQs, and procedural documents related to the exchange of ATIGA e-Form D via the ASEAN Single Window (ASW), aligning with the ASEAN-wide transition to electronic Form D as of 1 January 2024.

According to the UN Digital & Sustainable Trade Facilitation Survey, Malaysia received an overall score of 90.32%, with 100% in transparency, 92.59% in paperless trade, [22] positioning it as a top-tier performer in the region alongside Singapore and Indonesia.

In summary, Malaysia's NSW aligns well with the 'ideal state' for domestic operations, with its six-module architecture ensuring comprehensive digital integration of trade procedures.

(2) Challenges

Malaysia's myTRADELINK functions as a mature NSW under the supervision of the Ministry of Finance. However, the mechanisms for inter-agency coordination still require improvement. There is a need to institutionalise coordination frameworks, clarify change management processes, and define roles and responsibilities more explicitly to enhance the overall Institutional Arrangement.

In terms of penetration, while the digitalisation of major domestic procedures is largely achieved, exception processes such as customs refunds remain undigitised, preventing full end-to-end digitalisation. Standardisation of data dictionaries and formats is essential to improve interoperability.

Insights from interviews further illustrate how these institutional and technical gaps translate into operational challenges. Authority of Malaysia noted in the interview that despite the existence of the NSW, many parts of the trade ecosystem, including customs documentation, container booking workflows, and even manpower deployment, continue to rely on manual processes. For example, manpower assignments at ports were still recorded manually until recently, and paperwork remains prevalent across customs and

[22] UN, Global Survey on Digital and Sustainable Trade Facilitation.

intermodal logistics. These observations indicate that while Malaysia's digital infrastructure is in place, the transition to truly digital workflows across agencies and industry actors remains incomplete.

PILLAR 2: Seamless Cross-border Connectivity and Interoperability

Criteria 2-1. Technical Interoperability

(1) Current State

At the same time, the international data standards are evident in the customs and trade-facilitation domain. Malaysia Customs (RMCD) has formally adopted the WCO Data Model (WCO DM) as the basis for its national customs declaration and NSW data elements. Malaysia's NSW technical documentation, particularly those relating to u-Customs and the NSW–ASW gateway, references the use of the WCO DM for message structures, data elements, and code sets to ensure interoperability with ASW protocols.

At the regional level, Malaysia participates in the ASW, which mandates interoperability through WCO DM–aligned XML schemas for ATIGA e-Form D and ASEAN Customs Declaration Document (ACDD) electronic exchange.

The National Data Sharing Committee (NDSC) has indicated that future developments may include collaboration with the private sector and the formulation of API standards. Malaysia's initiative toward API standardisation under the National Data Sharing Committee aims to create uniform technical rules for how government and private-sector systems exchange data. Standardised APIs would define common data, authentication rules, message formats, etc. This enables consistent data exchange internationally because APIs aligned with global models (e.g. WCO Data Model, UN/CEFACT standards), allowing Malaysian systems to map and interpret foreign data in a compatible way. In addition, Malaysia has advanced technical interoperability at the cross-border level through its collaboration with Singapore, linking SGTraDex and MYEG to enable trusted data exchange and more seamless regulatory processes between the two countries. This also marks a strategic shift away from traditional closed, vendor-specific systems toward an open, standardised API architecture that enables broader business-to-business integration.

On the other hand, in the context of NSW/ASW integration, operational issues have arisen, such as disruptions in the ASW Gateway affecting the transmission of e-Form D and display errors on the Exchange Hub. These disruptions are not merely technical inconveniences; they frequently force traders to revert to manual, paper-based fallback procedures, significantly undermining trust in the digital system. Consequently, improvements are expected in system robustness (availability, monitoring, exception handling), centralised management of code lists and vocabularies, and loosely coupled API design between Malaysia Maritime Single Window and NSW/ASW.

(2) Challenges

While Malaysia has legally established data sharing amongst public institutions, system failures in ASW integration have led to fallback measures using paper-based processes. This highlights the need to enhance operational robustness rather than merely focusing on technical specification design. To realise seamless cross-border connectivity, improving

system reliability and enabling businesses to benefit from digitalisation are essential.

From a technical interoperability perspective, Malaysia already has functional channels for cross-border exchange of e-invoices and electronic bills of lading (e-BLs), but these rely on different international standards and therefore face distinct limitations.

For e-invoices, Malaysia's Peppol International Invoice (PINT) specification enables interoperability with other Peppol jurisdictions. Cross-border transmission works technically when foreign partners also use Peppol. However, operational implementation requires mapping between MyInvois (a centralised system provided by the Malaysian tax authority (IRBM) for the creation, issuance, validation, and storage of e-Invoices) and Peppol for alignment of identifiers and registration with Access Points. This indicates that technical interoperability exists but depends on proper integration.

For e-BLs, pilots involving Malaysian traders and banks have confirmed smooth cross-border transfers using blockchain-based platforms. However, interoperability remains confined within the same platform, as cross-platform standards have not yet been established, and public systems (NSW/ASW) do not support e-BL protocols. Thus, technical interoperability assumes to be platform-specific and largely confined within individual platforms, making operational arrangements essential.

Criteria 2-2. Organisational Interoperability

(1) Current State

Malaysia, through the Royal Malaysian Customs Department, shares the collective responsibilities of the ASW Steering Committee while also taking on key leadership roles within the system. It has historically chaired the Technical Working Group, which develops business processes, harmonises trade and customs data, and designs the technical architecture that turns regional policy into operational digital systems.

Domestically, responsibilities for the NSW are coordinated under the Ministry of Finance through the National Single Window Steering Committee, while the MITI oversees broader trade facilitation policies and international engagement. Malaysia's wider digital policy direction is set by the National Digital Economy and Fourth Industrial Revolution Council (MED4IR Council), supported by MyDIGITAL Corporation, which provides strategic guidance on data governance and cross-border data flows. Complementing these initiatives, the Malaysia Maritime Single Window (MMSW) platform under the Ministry of Transport enhances port-community information exchange and establishes a foundation for future interoperability with regional maritime systems.

In the port sector, Malaysia builds on the existing Malaysia National Single Window (MNSW) and uses common legal frameworks to clarify inter-organisational processes and responsibilities. Additionally, in response to technical disruptions in ASW operations, Ministry of International Trade and Industry officially announced shared alternative procedures amongst authorities, businesses, and trade partners. These efforts aim to reduce operational uncertainty by establishing not only technical specifications but also common administrative procedures for data lifecycle management and sharing.

(2) Challenges

The challenge Malaysia faces in fully integrating into the ASW stems primarily from the limited inter-agency collaboration and the inconsistent application of law amongst

domestic ministries, such as Health, Agriculture, and Customs. Because each new document exchange agreed upon at the regional level (ASWSC) involves a different national permit-issuing agency, Malaysia must first align that agency's specific regulations and procedures with its common NSW framework. This phased domestic alignment is time-consuming and acts as a bottleneck, slowing the pace at which the country can finalise its internal systems, successfully participate in regional testing, and ultimately join the exchange of additional ASW documents with other ASEAN Member States.

Criteria 1-2. Digital Format Readiness

(1) Current State

Malaysia has made steady progress in the digitalisation of trade-related documents, both in terms of institutional design and practical implementation. According to the UN Global Survey on Digital and Sustainable Trade Facilitation, Malaysia scored 96.3% in 'Paperless Trade',[23] indicating a high level of digitalisation, though not yet fully paperless.

By document type:

Commercial invoices are being progressively mandated under the e-Invoice system. The scope of application to cross-border transactions has been clarified in official FAQs, and full-scale implementation by taxpayer category is scheduled between 2025 and 2026.

Certificates of origin can now be applied for and issued online under various Free Tade Agreement (FTA) schemes through the e-PCoO system operated by Dagang Net and Ministry of International Trade and Industry. Furthermore, from 2024, the ATIGA e-Form D has been fully implemented across ASEAN, with electronic issuance and acceptance becoming the standard.

Customs declarations are fully digitalised through e-Declare, under the National Single Window (NSW), along with e-Manifest and e-Payment. The entire process from application to review and approval is now stably managed through digital systems.

Packing lists are generally submitted electronically as part of customs documentation. For example, in Malaysia, private platforms such as TNETS Global's online customs system or Malaysia-compliant freight forwarding ERPs (e.g. Logi-Sys) enable traders and customs brokers to prepare and submit customs declarations and supporting documents, including packing lists, electronically. However, there is no formal national standard institutionalising this practice.

Phytosanitary certificates show clear institutional direction, with Malaysia actively participating in international frameworks and hosting related meetings. However, detailed operational procedures for regular electronic exchanges with partner countries are limited, suggesting that implementation is still partial and transitional.

Bills of lading (e-BLs) are gaining traction globally, and Malaysia is responding to this trend. However, the country has yet to officially adopt legislation aligned with the Model Law on Electronic Transferable Records (MLETR), placing it in a transitional phase in terms of establishing legal equivalence for such documents.

Document map findings (Appendices 6): In Malaysia's domestic procedures for both imports and exports, customs declarations are fully digitalised and submitted through the

[23] UN, Global Survey on Digital and Sustainable Trade Facilitation.

Malaysia National Single Window via e-Declare. As for other key documents such as commercial invoices, certificates of origin, packing lists, and bills of lading, while paperless processing has been achieved, they are not fully digitalised and are instead exchanged in electronic form, typically uploaded to NSW as attachment. Physical copies of commercial invoices, packing lists, and other supporting documents may still be required during customs inspection and the release of goods.

In summary, Malaysia has made significant strides in the digitalisation of 'declaration, certification, and invoicing' processes through systems such as e-Declare, e-Manifest, e-PCoO, and e-Invoice, laying a solid foundation for improved operational efficiency and convenience. However, the lack of legal infrastructure for e-BLs remains a bottleneck to broader adoption.

Going forward, legislative measures to ensure the legal certainty of e-BLs will be key to achieving nationwide digitalisation.

(2) Challenges

While Malaysia has established a solid foundation for digitalisation in the areas of e-Declare, e-Manifest, e-PCoO, and e-Invoice, the following challenges remain:

Packing lists are currently handled electronically only as attachments to customs declarations. There is no independent standard or full paperless implementation.

e-BLs lack domestic legislation aligned with MLETR, and legal equivalence for transferable documents has not yet been established.

In short, while domestic digitalisation is progressing at the operational level, there is still a lack of legal infrastructure and transparency in international interoperability.

Criteria 2-3. Legal interoperability

(1) Current State

Malaysia has not yet fully adopted MLETR. For now, electronic transferable records like e-BLs are handled through contractual arrangements and choice of applicable law.

In 2025, the Cross-Border Personal Data Transfer (CBPDT) Guide was introduced, clarifying conditions such as adequacy, consent, and contractual safeguards. Revisions to the e-invoicing roadmap and e-commerce regulations have made business procedures (e.g. storage, display, audit) more transparent.

Overall, while legislative progress on ETR remains slow, Malaysia enhances operational interoperability through MCC/SCC-based contracts and integration with tax, accounting, and audit systems.

As for the DFFT, the concept is beginning to shape policy design rather than specific trade procedures. The Malaysia Digital Economy Blueprint, together with government-linked studies on generative AI, highlight mechanisms such as the APEC Cross-Border Privacy Rules (CBPR), Data Free Flow with Trust (DFFT), ISO/IEC 27701 and the ASEAN Model Contractual Clauses for Cross-Border Data Flows as reference models for trusted cross-border data movement.

Ongoing regulatory developments, including consultations and the issuance of Cross-Border Personal Data Transfer Guidelines under the Personal Data Protection Act, are steering Malaysia toward a structured approach combining adequacy findings, contractual safeguards and certification mechanisms.

While DFFT is not codified as a binding trade rule, it increasingly informs Malaysia's policy orientation on cross-border data governance that supports digital trade.

(2) Challenges

Malaysia's adoption of the Model Law on Electronic Transferable Records is still incomplete, meaning the legal validity of electronic transferable records continues to rely on contractual terms and choice-of-law arrangements. Advancing MLETR legislation is important to reduce this dependence and strengthen legal certainty. At the same time, progress in integrating electronic records with tax, accounting, and audit systems requires further institutionalisation through stronger public-private collaboration to improve standardisation and transparency.

Malaysia's Personal Data Protection Act adds another layer of complexity: cross-border data transfers must meet safeguards equivalent to domestic requirements, and while the 2025 guidelines allow mechanisms such as corporate rules, contractual protections, and certification schemes, regional frameworks like the APEC CBPR are adopted by only a few economies. As a result, companies managing multi-jurisdictional data flows must rely on multiple overlapping tools and controls, increasing legal and operational burdens.

PILLAR 3: End-to-end Unit-level Traceability and Resilience

Criteria 3-1. Real-time Cargo Tracking

(1) Current State

The Malaysian government is promoting logistics digitalisation through national strategies such as the National eCommerce Strategic Roadmap and the National Transport Policy 2019–2030. While there are emerging signs of cargo tracking systems utilising IoT and RFID, current efforts are primarily focused on monitoring within ports, warehouses, and cold chains. It is expected that these capabilities will gradually expand across the entire supply chain.

For example, at Port Klang, various digital solutions have been introduced to enhance port operations, including the Port Community System (PCS), CargoMove, Haulier Booking, Remote Gate, and Remote Reefer Monitoring. These systems enable digital acquisition of location and status events within the port and facilitate collaboration amongst logistics operators. Notably, Remote Reefer Monitoring was officially launched in February 2023, allowing for real-time monitoring and alerts on temperature, humidity, and CO_2 levels.

At Northport's Terminal 149, services such as terminal tracking, booking, and real-time updates on gate-in/gate-out activities have been implemented. These enable visibility into the 'what, where, and when' of cargo within the port, contributing to reduced dwell times and optimised cargo handling.

In parallel, the Royal Malaysian Customs Department has begun studying and testing electronic security seals (e-seals) attached to containers moving along key domestic corridors, such as between Port Klang and inland checkpoints. The e-seal technology is

intended to replace traditional lead seals and expected to enable Customs to monitor container movements via an application from the port to the declared destination, improving cargo security, traceability and the ability to detect suspicious stops or potential tampering during transit.

These developments are further supported by government incentives. The Malaysian Investment Development Authority (MIDA) introduced the Smart Logistics Complex (SLC) incentive in the 2025 national budget. This programme offers up to 100% investment tax allowance for smart warehouse projects utilising technologies such as IoT, AI, and RFID. According to MIDA, SLCs aim to enhance inventory management, warehouse operations, and real-time delivery by leveraging automation and digital technologies like robotics, IoT, and AI. This initiative is expected to promote real-time tracking systems and attract high-quality smart logistics infrastructure projects to Malaysia, thereby accelerating the development of the domestic logistics and digital economy and expanding value chain activities.

As a reference, Malaysia scored 3.7 on the Logistics Performance Index (LPI) Timeliness indicator, above the global average of 3.2, ranking just behind Singapore in ASEAN in terms of reliability in scheduled deliveries.

(2) Challenges

While efforts to integrate real-time tracking data into port PCS and the NSW are underway, many aspects remain under development. API integration between government-led SSO platforms such as MyDigital ID and private logistics platforms is still in transition. Although Malaysia has relatively mature institutional and infrastructural foundations, challenges remain in achieving cross-sectoral data integration and widespread adoption amongst private sector stakeholders. This data integration challenge stems from the lack of a unified standard for unit-level identifiers and event vocabularies, which prevents seamless cargo tracking across the entire supply chain, from ports to private logistics.

Moreover, the full benefit of real-time cargo tracking and digital logistics integration remains a significant burden for Small and Medium Enterprises (SMEs). Many SMEs will likely find it difficult to secure the necessary funds to implement advanced tracking devices and other related equipment. While ports and customs authorities adopt sophisticated digital systems, SMEs, which include small-scale transporters and shippers, often lack the expertise and technical resources required to handle API integration and data format standardisation necessary for seamless coordination with these systems.

Interviews with Malaysian authorities highlighted the need for greater standardisation and visibility in key areas of trade operations, including traceability, system compatibility, connectivity, and data utilisation. Authorities emphasised that achieving these improvements would bring concrete benefits across multiple aspects of supply chain management. Detailed container information, for instance, enables better tracking and more effective risk assessment. Access to real-time vessel operation data supports timely decision-making and enhances operational coordination amongst port, customs, and logistics stakeholders. Additionally, advance cargo information allows for proactive risk management and expedited customs clearance procedures. These findings underscore that harmonised systems and standardised data practices are essential to enhance efficiency, transparency, and responsiveness in customs processes.

Criteria 3-2. Management Capability for Tracking Data

(1) Current State

Malaysia launched the *Malaysia Maritime Single Window (MMSW)* at Port Klang in 2024 and is expanding it nationally to major ports. Customs authorities are piloting GPS-based e-Seals to detect tampering and monitor deviations during inland transport. As seen in the phased mandatory implementation of electronic invoicing (e-invoices) data standardisation and real-time visibility seems enhancing. E-Invoice standardisation is one of key elements for real-time tracking since it contains data that can be used as common identifier linking commercial to logistics and transportation data. While institutional frameworks are progressing, disparities in implementation amongst enterprises remain.

The development of major national digital initiatives, such as the Malaysia Maritime Single Window (MMSW), is typically based on close collaboration between public authorities and private technology providers. For MMSW and related trade facilitation systems, the government engages companies such as Dagang Net and Kale Logistics Solutions to design, implement and operate the platforms, leveraging private-sector expertise, technology and investment capacity. These partners also contribute to system design, implementation details and performance metrics, helping to ensure that digital tools for tracking operational data.

In addition, Malaysia's logistics and trade community increasingly recognises the importance of more granular, unit-level data standards to achieve end-to-end supply chain visibility. While such standards are not yet mandated for all logistics transactions, industry initiatives promote the use of global identifiers for logistics units, such as the Serial Shipping Container Code (SSCC), to identify and track pallets, cartons and other transport units.

(2) Challenges

A key challenge is the continuous organisational and technical integration of port information and inland transport tracking data amongst related parties, enabling seamless event coordination amongst ports, customs, transporters, and shippers. Technical, human resource, and financial support must be strengthened to enable SMEs to connect and operate their systems. Institutional momentum must be translated into deeper operational implementation through the development of SOPs and SLAs.

Criteria 3-3. Supply Chain Diversification: Overview of Trade Structure

Malaysia is actively diversifying its trade markets and supply chains. In 2024, exports reached RM1.507 trillion, with exports to the United States growing by 23.2% year-on-year, surpassing those to China.[24]

Imports and products are also diversified, reducing dependency risks. With 16 FTAs covering around 67% of trade,[25] Malaysia is expanding global market access.

Additionally, Malaysia has shown a proactive stance toward international cooperation for supply chain resilience by signing the Indo-Pacific Economic Framework for Prosperity

[24] JETRO, Business News (2025).
[25] JETRO, Trade and Investment Report of Malaysia (2024).

(IPEF) agreement.

Despite its robust and diversified trade infrastructure, the following characteristics highlight challenges in supply chain diversification:

- China remains a major trade partner, accounting for 21.6% of imports and 12.4% of exports,[26] especially in electronics, posing concentration risks.
- FTA utilisation remains low amongst SMEs and regional businesses, hindering broader supply chain diversification.

Malaysia's digital trade systems (e.g. MMSW and the e-invoice system currently being implemented) can be assessed as being exposed to a dual risk of geographic and industrial concentration. First, this constitutes geographic concentration risk, as unilateral changes in a partner country's customs procedures or data protection laws could disrupt the flow of essential manufacturing components, causing cascading delays across Malaysia's digitised supply chains. Second, the high dependence on the electronics sector amplifies industrial concentration risk. As a result, digital platforms originally designed primarily for efficiency are now increasingly required to prioritise risk visibility and compliance agility.

PILLAR 4: Trustworthy and secure infrastructure

Criteria 4-1. Cybersecurity Legal Framework

(1) Current State

Malaysia's development of its cybersecurity legal framework has been highly regarded internationally, being classified as Tier 2 (upper group) in the ITU Global Cybersecurity Index.

Legally, the Personal Data Protection Act (PDPA) 2010 is already in place, and its 2024 amendment strengthened requirements for data-breach response and consent management. As a result, the legal framework for personal data protection has been reinforced.

However, a comprehensive Cybersecurity Act has yet to be enacted, and cybersecurity issues are currently addressed in a fragmented manner through the existing Communications and Multimedia Act (CMA) and the National Cyber Security Policy (NCSP).

At the national-strategy level, cybersecurity standards and regulations are being harmonised and strengthened under the Malaysia Digital (MD) initiative, a broad digital-economy strategy. The Malaysia Digital Economy Corporation (MDEC) leads these efforts, developing sector-specific cybersecurity standards in areas such as digital trade, finance, smart cities, and healthcare.

In addition, the National Cyber Security Centre (NCSC) has been established to serve as the national focal point for incident response, audits, and standards development, providing Malaysia with a coordinated institutional framework for cybersecurity management.

Furthermore, the fundamental legal framework for electronic signatures is primarily established under the Digital Signature Act (Digital Signature Act 1997) and the Electronic Commerce Act (ECA 2006). The Digital Signature Act provides detailed regulations on digital signatures using public key cryptography and digital certificates issued by licensed

[26] JETRO, Business News (2025).

certification authorities (CAs). When these signatures meet the requirements of the Digital Signature Act, they are granted the same legal validity as traditional 'wet ink' signatures. Meanwhile, the ECA offers broad legal recognition for electronic communications and general electronic signatures, ensuring that contracts cannot be invalidated solely because they are in electronic form.

Together, these two laws systematically provide the legal certainty necessary for digital transactions. Furthermore, the high reliability requirements stipulated by the Digital Signature Act tend to be adopted for applications where non-repudiation and integrity are particularly critical, such as government filings, high-value commercial transactions, and digital trade documents.

(2) Challenges

Malaysia's strong legal foundation (Digital Signature Act 1997) faces challenges in horizontally expanding the new national ID infrastructure and reconciling legacy practices.

Also, to achieve 'an integrated legal framework that enables end-to-end operations from strategic planning to standard-setting, auditing, and incident response,' it is necessary to resolve overlaps and inconsistencies with the existing Communications and Multimedia Act, various guidelines, and the National Cyber Security Policy. Governance design that allows companies to clearly identify applicable laws and their priorities briefly is still in progress. Moreover, the Cyber Security Act 2024 framework primarily focuses on National Critical Information Infrastructure (NCII). How to raise the audit and incident response capabilities of downstream SMEs in the supply chain and local public institutions to the same level remains a key challenge.

Malaysia's incident reporting protocol, compared to other ASEAN Member States, imposes an extremely strict six-hour rule for NCII entities, but its structure remains complex and difficult to navigate for non-NCII businesses. Specifically, following the PDPA amendment, there is a separate notification regime for personal data breaches, resulting in a framework that is both NCII-centric and dual-layered. For SMEs in sectors such as ports, logistics, and manufacturing that are not designated as NCII, it can be unclear whether they should voluntarily follow the same timeline as the CSA, rely solely on data breach reporting under the PDPA, or adhere to sector-specific regulations. Consequently, operational cyber incidents that do not neatly fall under 'NCII disruption' or 'personal data breach' but could significantly disrupt supply chains risk being underreported. This reflects the broader regional challenge of operational immaturity in incident reporting, where legal timelines (e.g. Malaysia's 6-hour rule) do not yet align with the proposed ASEAN standardised protocols.

Criteria 4-2. Governmental/Public organisation responsible for ensuring data security

(1) Current State

Malaysia's establishment of public agencies for data security is steadily progressing toward international standards, though institutional and technical challenges persist. The National Cyber Security Agency (NACSA), the supreme authority for national cybersecurity, was established in 2017 and operates under the National Security Council (NSC) as a core body for policy coordination and strategy formulation.

Additionally, Cyber Security Malaysia (CSM) provides technical support to the National

Cyber Security Agency, and the Personal Data Protection Department (PDPD) enforces the Personal Data Protection Act (PDPA).

Other related agencies, such as the Malaysia Digital Economy Corporation (MDEC), which have functions comparable to IMDA or CSA, also drive the development of security standards and regulations across the digital sector.

Malaysia is also ranked in Tier 1 in the ITU's Global Cybersecurity Index 2024,[27] with a score of 18.82 against the maximum score of 20 for the organisational measure pillar.

(2) Challenges

The need for a central coordinating function has been repeatedly highlighted due to the fragmentation of responsibilities within the government, which can lead to siloed implementation of policies, reporting, and auditing. To address this, the National Cyber Security Strategy (NCSS) has been formulated. The focus now shifts to the rapid and uniform deployment of this plan across the entire government and the broader industrial sector, requiring the effective allocation of budget and resources.

Criteria 4-3. Appropriate cybersecurity environment and operational status

(1) Current State

Malaysia has developed infrastructure for fully paperless cross-border trade documents through early enactment of the Digital Signature Act and integration with national systems.

The connection between Malaysia's NSW and ASW is secured by high-assurance digital signatures (PKI) under the Digital Signature Act 1997 (Digital Signature Act 1997), ensuring non-repudiation, delivery management, and mutual recognition of electronic documents such as e-CO and e-permits.

The phased rollout of MyDigital ID is converging government procedures toward single sign-on (SSO), with consent and authorisation gradually shifting from ministry-specific systems to a cross-government layer.

The Cyber Security Act 2024 strengthens oversight of National Critical Information Infrastructure (NCII), including ports, customs, and financial systems connected to ASW, enhancing the resilience of digital trade platforms.

Together, high-assurance signatures (Digital Signature Act), government ID (MyDigital ID), and NCII oversight (CSA 2024) form a robust institutional framework supporting the reliability and continuity of trade platforms.

(2) Challenges

Despite the legal strength of PKI digital signatures, standardising their use alongside simpler electronic signatures and managing the cost of PKI implementation in trade-related businesses remain bottlenecks.

Malaysia's MyDigital ID rollout is currently centered on government services, and extending its use to private-sector applications in trade and logistics remains a significant future challenge. Broad public awareness and education for both citisens and businesses

[27] ITU, Global Cybersecurity Index 2024.

are also necessary to ensure smooth adoption. At the regional level, the absence of standardised consent-management practices amongst ASEAN members could become a major obstacle to future interoperability. Without common rules for how consent is obtained, recorded, and shared, enabling secure cross-border exchange of tracking data through digital IDs becomes more complex, potentially slowing regional digital integration.

In addition, when introducing highly reliable signature systems based on digital IDs and PKI, technical and financial burdens for SMEs are unavoidable. For Malaysia to successfully roll out MyDigital ID to the private sector, particularly SMEs in trade and logistics with limited resources, it will likely need to provide low-cost, easy-to-use API integration solutions and enhance digital skills, similar to the measures Singapore had to implement. Unlike some regional peers where SMEs are left to bear the full cost, Malaysia offers support mechanisms such as SME digitalisation grants. However, bridging the gap between grant availability and actual adoption remains a critical hurdle.

During interview, Malaysian authority emphasised the need for a collective maritime security pact – a regional framework that positions digital trust as a shared strategic priority. The interviewee proposed establishing common data trust protocols to define what data can be shared, under what conditions, and implementing secure port ledger initiatives to record container movements and anomalies in a tamper-proof format. Interviewee also highlighted the importance of creating maritime cyber resilience labs to simulate breaches and co-design mitigation strategies, as well as conducting cross-border sandbox trials with technology providers in Japan, Malaysia, and Thailand to test security layers before live deployment. These measures were seen as essential to strengthen cybersecurity and build confidence in digital integration across ASEAN's maritime trade ecosystem.

3. Thailand

PILLAR 1: Domestic Process Efficiency

Criteria 1-1. Digital Infrastructure Readiness

(1) Current State

Under the 'Thailand 4.0' strategy, Thailand is promoting nationwide trade digitalisation by attracting foreign investment in 5G networks, cloud computing, and data centres, supported by proactive government policies. In the IMD World Digital Competitiveness Ranking 2024,[28] which evaluates and compares countries' capabilities and readiness in adopting and utilising digital technologies across economic and social sectors, Thailand ranks 37th overall, just behind Malaysia, and 21st in the 'Technology' sub-factor, indicating that its digital infrastructure is relatively well-developed.

The Thai government positions the promotion of the digital economy as a core pillar of its national strategy under 'Thailand 4.0.' According to JETRO (2025), the Thailand Board of Investment (BOI) offers tax incentives for digital-related investments, with a particular focus on attracting foreign capital in data centres and cloud services. Furthermore, the AMEICC (2024) report notes that the Electronic Transactions Development Agency (ETDA) has outlined a national-level roadmap for digital infrastructure development, demonstrating strong government commitment to advancing this agenda.

[28] IMD, IMD World Digital Competitiveness Ranking 2024.

In terms of specific technologies, Thailand was amongst the first ASEAN countries to commercialise 5G, launching services in major cities as early as 2020. Telecommunications providers such as AIS, True, and DTAC have rolled out 5G networks, which are increasingly being utilised especially in the manufacturing and there are some testing cases in logistics sectors. For example, AIS has already deployed a 5G private network in a major automotive parts manufacturer's factory, where the use of 3D-vision robots for automated picking and other applications has reportedly doubled inbound and outbound logistics efficiency.[29] Regarding cloud services, global players such as AWS, Google Cloud, and Microsoft Azure have entered the Thai market, and hybrid cloud environments are being developed in collaboration with local enterprises.

As for data centres, companies such as True IDC, NTT, and Huawei have established facilities in Thailand. Notably, True IDC has announced the construction of an AI hyperscale data centre, which is expected to integrate renewable energy sources, highlighting the country's commitment to sustainability. Additionally, with support from the BOI, efforts are underway to develop decentralised data centres in regional cities, further promoting balanced digital infrastructure development across the country.

(2) Challenges

Thailand possesses relatively advanced digital public infrastructure within the ASEAN region, with high mobile internet penetration in urban areas. However, to advance nationwide digitalisation, narrowing the urban–rural digital divide remains an urgent challenge.

First, there are infrastructure disparities and delays in 5G deployment in rural areas. While mobile internet penetration is high in urban centres, rural regions still face issues such as slower connection speeds and unstable connectivity. For example, the World Bank report points out the urban-rural divide in digital infrastructure.[30] Also based on ITU statistics, Internet usage in Thailand in 2024 stands at 93.5% in urban areas, but only 88.6% in rural areas.[31] While factors other than infrastructure development are likely involved, the state of digital infrastructure significantly influences this usage disparity. Specifically, 5G network deployment has been concentrated in major cities like Bangkok, while many rural areas continue to rely on 4G or lower-grade networks.

Although the Thai government is actively promoting cloud adoption, the cloud utilisation rate amongst small and medium-sized enterprises (SMEs) remains low. Regional disparities in data storage and processing capabilities are a growing concern. Most data centres are concentrated around Bangkok, limiting access to high-reliability and high-availability cloud services in rural areas.

Furthermore, the rapid expansion of data centres brings sustainability challenges. Despite the push for renewable energy integration, the national power grid remains heavily reliant on fossil fuels. Ensuring a stable power supply to meet the surging energy demand of hyperscale facilities without compromising carbon reduction goals is becoming a critical infrastructure bottleneck.

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[29] Thailand Development Research Institute (TDRI)/ Electronic Transactions Development Agency (ETDA), The application of business AI in the manufacturing industry and other sectors in Thailand,

[30] World Bank, Gender and Digital Development in Thailand (2023).

[31] ITU, Datahub, Individuals using the Internet.

Criteria 1-2. Digital Format Readiness

(1) Current State

Thailand has made clear progress in the digitalisation of trade-related documents, both in terms of institutional development and practical implementation. According to the UN Global Survey on Digital and Sustainable Trade Facilitation, Thailand scored 88.89% in 'Paperless Trade',[32] reflecting a relatively high level of digitalisation.

By document type:

Commercial invoices: The government is promoting the adoption of e-Tax Invoices and e-Receipts through tax incentives (available until the end of 2025). While the use of electronic issuance is expanding amongst businesses, nationwide mandatory implementation has not yet been introduced.

Certificates of origin: With the digital transmission and receipt of ATIGA e-Form D, all ASEAN Member States, including Thailand, have moved to a system where paper-based forms are no longer accepted in principle.

Customs declarations: Online submission via e-Customs and the National Single Window (NSW) has become the standard. Features such as e-Tracking on the customs portal have enabled routine online management of declarations and related information.

Packing lists: Electronic submission and attachment via e-Customs have become standard practice. Government and semi-government operational guides clearly outline procedures for submitting documents such as invoices, packing lists, bills of lading, and certificates of origin through e-Customs. However, in practice, printed copies are still sometimes required.

Phytosanitary certificates: Since the official launch of e-Phyto in 2022, Thailand has aimed for full digitalisation through B2B e-Phyto Exchange, led by the National Bureau of Agricultural Commodity and Food Standards (ACFS), by 2025. The exchange framework via the IPPC Hub is functional, and pilot exchanges have been conducted with countries such as Australia, New Zealand, and the United States.

Bills of Lading (e-BLs): Although there is growing momentum for adoption, domestic legislation aligned with the Model Law on Electronic Transferable Records (MLETR) is still under development. In 2025, Thailand is scheduled to host UN forums such as UNESCAP, where discussions on legal and operational frameworks are expected to continue.

Document map findings (Appendices 6): In Thailand's domestic procedures for both imports and exports, customs declarations can be submitted in digital form through e-form. Other key documents exchanged between forwarders and customs such as commercial invoices, certificates of origin, packing lists, and bills of lading are not yet fully digitalised, and are typically submitted as electronic files attached to the customs system. For exports, it has been noted that commercial invoices and packing lists are still required in paper form for submission to customs.

Interviews with shippers and consignees in the automobile industry highlighted significant technical interoperability challenges across supply chain partners. While in-house ERP systems can interconnect smoothly within a single organisation, interviewees reported difficulties when working with suppliers that use different ERP, such as SAP, Oracle, or

[32] UN, Global Survey on Digital and Sustainable Trade Facilitation.

custom-built systems. These differences require data adaptation or conversion to achieve interoperability and shared processing. In the absence of government-mandated file format standards, private entities have relied on AI and conversion tools, such as transforming PDF documents into Excel files, to enable cross-system data exchange. In addition, many Tier 2 and Tier 3 suppliers operate as small or family-run businesses without digital tools and continue to depend on manual communication and document transmission.

In summary, Thailand has established near-complete digital operations in three key areas: customs declarations (NSW/e-Customs), certificates of origin (ATIGA e-Form D), and e-Phyto. Digitalisation has also advanced in terms of visibility and online inquiry functions. However, nationwide mandatory implementation of e-invoicing remains a future issue, and the use of printed packing lists persists. For e-BLs, it is essential to ensure interoperability with other framework such as TradeTrust through both institutional and technical alignment, alongside the development of MLETR-aligned legislation, to enable full-scale operational adoption.

(2) Challenges

While Thailand has made progress in digitalisation through e-Customs/NSW, ATIGA e-Form D, and e-Phyto (including B2B initiatives), the following challenges remain:

Nationwide mandatory implementation of e-invoicing has not yet been introduced. Clear legislation, official notifications, and a transition schedule are needed.

Continued use of printed packing lists in practice.

For e-BLs, domestic legislation aligned with MLETR is still under development. Although the foundational systems and frameworks are in place, finalising the legal certainty, mandatory implementation, and interoperability mechanisms is essential to accelerate adoption.

Also, during the interview, Shippers/Consignees pointed out that despite progress in digitalisation, hardcopy documents are still required as digital files are often not recognised as original. These observations highlight that beyond digitalisation itself, operational practices are equally critical to achieving meaningful digital transformation.

Criteria 1-3. Presence of National Single Window (NSW)

(1) Current State

Thailand's NSW, known as THAI NSW, is operated by National Telecom Public Company Limited (NT) and facilitates G2G, G2B, and B2B data exchange between government agencies and private entities. The official website presents electronic document categories such as e-Manifest, licenses and certificates, customs declarations, payments, tracking, and preferential tariffs. Monthly message statistics are published to visualise actual operations. Under the WTO TFA, Thailand notified the implementation of its Single Window (Article 10.4.3) as a Category A commitment effective 22 February 2017, confirming its institutional foundation.

Operationally, the THAI NSW portal provides specifications for document categories, e-services of relevant agencies, NSP/ASP information, and connectivity details for financial and logistics service providers. Regionally, Thailand has implemented the exchange of

ATIGA e-Form D via ASW, which is reflected in its UN evaluation.

According to the UN Digital & Sustainable Trade Facilitation Survey, Thailand scored 88.17% overall, with 93.33% in transparency, 100% in procedural simplification, 88.89% in paperless trade. While E-Single Window, electronic declaration, and payment are fully implemented, cross-border exchange of Certificate of Origin and Sanitary and Phytosanitary documents remain partial. Electronic refund procedures are still in the planning stage. The Institutional Arrangement & Cooperation score (66.67%) is relatively low, indicating the need for stronger domestic coordination frameworks.

Overall, Thailand has reached the 'established and operational' level for domestic digital integration, and ASW connectivity is in the process of expansion.

(2) Challenges

Although THAI NSW is well-established as a domestic digital infrastructure, challenges remain in inter-agency coordination and institutional clarity. The Institutional Arrangement & Cooperation score is lower than in other countries, and standardisation of data management responsibilities and service-level agreements (SLAs) is lacking. Transparency is also limited regarding the operational performance, incident response, and improvement plans of the NSW operator, National Telecom. Furthermore, SME access remains only partial, and the number of players truly benefiting from the NSW is still limited.

While domestic functions such as electronic declaration and payment are mature, the digitalisation of ancillary processes remains incomplete. Complex exception workflows such as duty drawback claims, customs appeal, and the management of financial guarantees often still require manual intervention.

These structural and governance challenges are reflected in practical operational issues, as illustrated by the automotive sector. An automobile sector stakeholder in Thailand has commented during the interview that despite the presence of NSW, domestic G2G data integration remains incomplete. For instance, vehicle import and registration processes still require printed NSW documents for manual stamping. Although recent reforms have enabled direct data sharing and eliminated physical document submission, the absence of clear institutional guidelines leaves the system vulnerable to reverting to old procedures. Similar issues appear in automotive parts importation, where Thai Industrial Standard Institute (TISI) license numbers must still be manually entered into the Customs system, highlighting fragmented data flows that impede the full realisation of NSW digitalisation. Freight forwarder in Thailand also pointed out the need for NSW to cover wider range of documents such as commercial invoices, packing lists, or banking transactions, but these are not included due to a lack of mandate.

PILLAR 2: Seamless Cross-border Connectivity and Interoperability

Criteria 2-1. Technical Interoperability

(1) Current State

Thailand has been progressively developing the National Digital Trade Platform (NDTP), which operates alongside the Thailand National Single Window (NSW). NDTP is designed to standardise common data elements in trade documents and facilitate API connectivity, aiming to serve as a hub for both B2B and B2G transactions.

First, centred on the Thai NSW, efforts have been made to develop a data model aligned with international standards and a secure communication infrastructure. Specifically, the Thai NSW adopts XML/ebXML-based message specifications referencing international standards such as the WCO Data Model, UN/EDIFACT, and ISO, along with a secure gateway structure using PKI, digital signatures, and CA-to-CA interoperability. This enables B2G and B2B connections with ministries, financial institutions, and port systems.

Building on this domestic foundation, Thailand has implemented electronic exchanges of ATIGA e-Form D and the ASEAN Customs Declaration Document (ACDD) via the ASW. In addition, for e-Phyto, the Department of Agriculture (DOA), ACFS, Customs, and the NSW operator (NT) are collaborating to advance the exchange of electronic phytosanitary certificates within ASEAN and with other regions. As a result, cross-border data exchange based on a common data model, standardised XML messages, and a mutually authenticated PKI infrastructure is gradually being realised.

Furthermore, Thailand is promoting the digitalisation of trade and transport documents through the privately led NDTP, in line with international standards (UN/CEFACT). NDTP, in collaboration with the Trade Document Registry, enables verification of document authenticity and checks for duplicate financing, while serving as a gateway for cross-border B2B connectivity designed for technical integration with Singapore's NTP and Japan's TradeWaltz.

As a result, both regulatory systems (NSW/ASW) and private platforms (NDTP) are being equipped with data models and message specifications aligned with international standards, increasing the potential for future interoperability between NSW and private platforms, as well as across platforms.

(2) Challenges

Thailand's National Digital Trade Platform (NDTP) is positioned as a core infrastructure for connecting domestic and cross-border digital trade; however, several NDTP-specific challenges remain from a technical interoperability perspective. NDTP is still at a pilot or early-deployment stage: although proof-of-concept projects with Singapore's NTP and Japan's TradeWaltz have demonstrated technical feasibility, NDTP's cross-border connectivity also remains dependent on bilateral integrations with individual foreign platforms, each of which applies its own data structures, API specifications and workflow rules. This prevents NDTP from functioning as a truly multilateral interoperability layer.

Additionally, while the NDTP utilises modern APIs, the broader government ecosystem is still in a transition phase, moving from legacy, closed-loop interfaces to open, standardised API architectures. During this transition, minor data mismatches between systems often trigger unexplained rejections, forcing traders to revert to manual intervention.

These limitations reflect a broader structural issue: while NDTP experiments with emerging technologies such as distributed ledger and advanced analytics, it must also ensure consistency with international frameworks such as UN/CEFACT and the UN Framework Agreement on Cross-border Paperless Trade (CPTA). The core challenge is not the adoption of AI or blockchain itself, but rather the integration of such technologies with legacy domestic systems and legal frameworks while maintaining interoperability with regional and global standards.

This is particularly evident in the handling of electronic transferable records (ETRs), including e-BLs, which require alignment with Thailand's ongoing Electronic Transactions

Act reform and eventual compliance with MLETR principles. Without this legal-technical synchronisation, NDTP's international implementation will continue to face structural constraints.

Without this legal-technical synchronisation, NDTP's international implementation will continue to face structural constraints. This challenge is echoed by industry stakeholders: during an interview, a Thai freight forwarder noted that trade digitalisation remains fragmented, with banks, customs, shippers, and shipping lines operating on separate systems. No single entity has been empowered to act as a cross-platform data integrator, leaving data exchange dependent on manual processes in many cases.

Criteria 2-2. Organisational Interoperability

(1) Current State

Thailand is represented in the ASEAN Single Window Steering Committee (ASWSC) by the Thai Customs Department, which has hosted ASWSC meetings and serves as the lead agency for Thailand's engagement in ASW-related technical and operational coordination.

Domestically, responsibilities for the NSW are anchored in the Ministry of Finance, with the Thai Customs Department operating the NSW platform and coordinating with other line ministries and border agencies.

In parallel, Thailand is piloting the National Digital Trade Platform (NDTP), a public–private initiative led by the Joint Standing Committee on Commerce, Industry and Banking (JSCCIB) and the financial sector, supported by the government, to digitalise business-to-business trade processes and explore interoperability with foreign trade platforms. While NDTP is primarily focused on B2B trade and trade finance, its use of common data standards positions it to complement, over time, government-led single window and ASW-related processes.

(2) Challenges

Thailand's efforts to regulate dominant private digital platform companies (digital gatekeepers) to ensure interoperability may lead to significant governance friction. Applying common policies such as API disclosure and data portability across regulatory authorities and market entities requires a delicate balance between maintaining fair competition and avoiding innovation suppression. Finding this balance is a key challenge for inter-organisational collaboration.

Regarding this inter-organisational collaboration, in Thailand's case, the need to synchronise the Thai NSW with various sector-specific systems operated by different line ministries illustrates how aligning domestic business processes with cross-border ASW procedures remains a demanding task. This domestic coordination burden interacts with region-wide consensus requirements and can affect the pace at which ASW document coverage is extended.

Furthermore, in Thailand, institutional coordination issues can arise where sector-specific financial-stability regulations intersect with broader data-governance discussions. Agencies overseeing credit information and financial supervision require certain forms of data management to ensure system integrity. While these requirements serve important supervisory objectives, they may need to be reconciled with regional or international approaches that promote more flexible cross-border data usage in the digital economy.

This reflects the broader challenge of balancing sector-specific regulatory mandates with emerging regional data-governance principles.

A freight forwarder in Thailand highlighted in the interview that in ASEAN, member states struggle to designate a trusted coordinating body to manage interconnectivity, largely due to concerns over sensitive data ownership, security, and accountability. While this perspective comes from Thailand, similar governance and coordination gaps are observed across ASEAN, making these challenges a region-wide issue.

Criteria 2-3. Legal interoperability

(1) Current State

Although MLETR has not been adopted, a 2024 amendment proposal outlines domestic requirements for uniqueness and control, crucial for e-BLs.

For cross-border data transfers, regulatory authorities have developed whitelists and BCR approval procedures, enabling official channels for intra-group data transfers. Alongside the operation of the ASW, practical approaches combining contracts and governance are expanding.

In 2025, Thailand completed accession to the Framework Agreement on Facilitation of Cross-border Paperless Trade (CPTA), marking a step toward treaty-based mutual recognition of electronic documents. Thailand is also strongly focused on advancing the ASEAN Digital Economy Framework Agreement (DEFA), particularly as it chairs the ongoing negotiations. It positions DEFA as a key driver of regional digital integration and actively facilitates consensus-building amongst member states, mainly aiming to establish common digital trade rules and enhance legal interoperability across borders.

Furthermore, the government has positioned the assurance of technical interoperability as a key policy objective in its digital trade transformation. The Electronic Transactions Development Agency (ETDA) has drafted the Digital Platform Economy Act (DPEA), which proposes interoperability obligations for gatekeeper platforms, including API disclosure and support for multi-homing. ETDA also leads the development of PromptBiz and PromptTrade, public-private digital trade infrastructures that have demonstrated interoperability through NDTP-based document exchange.

As for the DFFT, Thailand has not explicitly embedded the DFFT label in its trade or data protection statutes, but its cross-border data transfer regime under the Personal Data Protection Act (PDPA) reflects a 'trusted flow' logic. In parallel, Japan–ASEAN policy dialogues and DFFT-focused seminars have increasingly framed ASEAN, including Thailand, as a partner in promoting trusted cross-border data flows, suggesting that DFFT principles are being internalised at the level of policy coordination even if they are not yet directly referenced in NSW/ASW operational guidelines.

(2) Challenges

The formal adoption of MLETR remains pending, and completing the legal framework for electronic transferable records is a critical issue. Although a BCR approval system exists, corporate understanding and practical implementation are still limited. Therefore, accumulating operational experience and promoting awareness are essential to enhance the effectiveness of the system. While practices combining contracts and governance are expanding, further standardisation and development of guidelines are necessary to reduce

dependency on the counterpart's readiness, further providing international legal certainty and interoperability.

Furthermore, Thailand has not yet participated in the APEC CBPR System or the Global CBPR Forum. As a result, Thai organisations engaging in cross-border data flows with CBPR-certified partners cannot rely on a shared certification framework for mutual legal recognition and must instead combine PDPA-based mechanisms such as adequacy assessments, ASEAN Model Contractual Clauses and Binding Corporate Rules with bespoke contractual safeguards. This increases the fragmentation of applicable rules across jurisdictions and raises the complexity of achieving interoperable compliance in practice.

Interviews with shipper/consignee in automobile industry also highlighted persistent legal interoperability challenges in trade processes. For example, although the Customs Department permits electronic filing for tax refund requests by domestic manufacturers receiving international payments, the actual procedures still require submission of paper documents, including extensive data tables and certificates. This discrepancy arises because existing regulatory frameworks have not been updated to fully accommodate digital processes, creating inefficiencies, increasing administrative burden, and limiting the effectiveness of digital trade facilitation. Addressing such gaps is essential to align domestic electronic procedures with broader international frameworks like MLETR.

PILLAR 3: End-to-end Unit-level Traceability and Resilience

Criteria 3-1. Real-time Cargo Tracking

(1) Current State

Thailand's Customs Department offers an e-Tracking system that enables online tracking of customs-related events. This system has the potential to serve as an institutional foundation for future public-private data exchange of real-time tracking information, including location, temperature/humidity, seal status, and gate movements.

Efforts to enhance visibility at the operational level are also progressing at Laem Chabang Port's Terminal D, autonomous electric trucks have been deployed in live operations. These vehicles are equipped with GPS, LiDAR, and cameras, and are integrated with Terminal Operating Systems (TOS) through AI-based control systems that automatically plan optimal routes. In highly automated terminals, GPS and sensor data from vehicles are integrated into the TOS to optimise traffic flow and enable real-time alerts. This significantly improves visibility of cargo and vehicle movements within the port, helping to reduce congestion and optimise workforce allocation. These capabilities are akin to real-time fleet management within the port, enabling immediate visualisation of yard-to-quay operations and enhancing overall operational efficiency.

From a regulatory perspective, the combination of the NSW and e-Tracking systems has established a solid foundation for customs and procedural visibility. On the technological front, real-time visibility at ports, airports, and private logistics facilities is expanding rapidly.

However, a nationwide, cross-border, unit-level real-time tracking system has yet to be fully realised.

As a reference, Thailand scored 3.6 on the Logistics Performance Index (LPI) Timeliness

indicator, above the global average of 3.2, ranking third in ASEAN after Singapore and Malaysia in terms of reliability in scheduled deliveries.

(2) Challenges

Despite various ongoing initiatives, many aspects of development and implementation remain in progress. The deployment of RFID and GPS sensors between ports and logistics hubs is still limited. Standardisation of real-time tracking data and its integration into the ASEAN Single Window (ASW) have not yet been achieved. Currently, tracking remains primarily container centric, focusing on the movement of the box itself. Moving toward a product centric model that integrates detailed tracking at the unit or serial number level and encourages participation across industries, SMEs, will be essential for achieving greater granularity and broader visibility.

Criteria 3-2. Management Capability for Tracking Data

(1) Current State

Thailand is concurrently deploying Customs' e-Tracking, Port Community Systems (PCS), and the National Digital Trade Platform (NDTP) through public-private collaboration. These initiatives are laying the groundwork for integrating customs, port, and commercial data. The intent to adopt visibility solutions is clear, and the institutional and technical components are gradually coming together. However, end-to-end operations and unit-level event integration are still in the development phase.

The NDTP is structured as a private-sector-led initiative with strong government support, characterised by leadership from the Joint Standing Committee on Commerce, Industry and Banking (JSCCIB), which initiated and has driven the platform's establishment. This private initiative is supported by key government agencies, notably the Office of the Public Sector Development Commission (OPDC), which has been mandated by the Cabinet to coordinate relevant public bodies and work with JSCCIB on the NDTP. Through this arrangement, the government provides policy coordination and alignment with public-sector systems and processes, while the private sector drives the design and implementation of the platform. This structure helps to combine agile, market-driven development with official endorsement and consistency with regulatory frameworks.

(2) Challenges

To enable daily operations across NDTP, NSW, and PCS, it is necessary to clarify SLAs and exception-handling rules. Additionally, integrating detailed tracking data at the lot or serial number level and encouraging participation across industries, including SMEs, will be essential to achieving both granularity and breadth of visibility.

Criteria 3-3. Supply Chain Diversification: Overview of Trade Structure

Thailand's import and export markets are relatively diversified, though dependency on China persists. As of 2025, FTA coverage stands at roughly 60%, with total trade with around 18 countries amounting to US$96.9 billion.[33]

[33] JETRO, Business News (2025).

Thailand participates in multilateral agreements such as CPTPP, RCEP, AANZFTA, ACFTA, and ATIGA.

Regarding supply chain diversification, the following characteristics are notable:

- Continued dependence on China, with around 25% of imports and over 11% of exports linked to China,[34] particularly in electronic components and fruit.
- Limited FTAs with Latin America, Africa, and the Middle East, making expanded access to emerging markets a key issue.

A high level of import dependence on specific countries or regions implies that digital platforms such as the National Digital Trade Platform (NDTP) carry inherent geographic concentration risk. In such a regionally skewed context, if a partner country were to unilaterally tighten cross-border data transfer regulations or customs data standards, Thailand's digitised supply chains could experience severe delays and increased operational burdens, potentially degrading the functionality of certain advanced digital integrations.

Moreover, the heavy reliance on electronic components and electrical-related intermediate goods amplifies industrial concentration risk. Therefore, digital platforms must go beyond mere efficiency improvements and place greater emphasis on risk visibility and high agility to respond swiftly to global export control requirements. Specifically, it is critical to implement capabilities that enable real-time, unit-level tracking to identify potentially regulated components early and prevent production bottlenecks.

Additionally, institutional linkages regarding mutual recognition of electronic certificates of origin (e-CO) and data standards remain limited with certain emerging markets outside ASEAN. As a result, even as trade diversification progresses in the future, transactions with these markets may still involve reliance on paper-based procedures and manual processes despite the existence of well-developed domestic digital systems, creating operational friction risks.

PILLAR 4: Trustworthy and secure infrastructure

Criteria 4-1. Cybersecurity Legal Framework

(1) Current State

Thailand has made significant progress in establishing its cybersecurity framework and is currently classified as Tier 3 (middle group) in the ITU Global Cybersecurity Index, indicating that while its legal and institutional foundations are in place, operational capacity and international collaboration are still being strengthened.

Thailand enacted the Cybersecurity Act in 2019, which provides a legal basis for the protection of information infrastructures related to national security, including provisions for risk assessment, auditing, reporting obligations, and incident response mechanisms.

In addition, the Personal Data Protection Act (PDPA), modelled after the EU's GDPR, was fully enforced in 2022, clearly defining corporate responsibilities concerning data collection, use, disclosure, and penalties for violations.

As for the legal foundation for electronic signatures and electronic transactions in Thailand

[34] WITS - World Integrated Trade Solution.

is established under the Electronic Transactions Act B.E. 2544 (2001), with subsequent amendments further clarifying the legal validity of electronic documents and electronic signatures. The ETA stipulates that documents or signatures cannot be denied legal effect solely because they are in electronic form and recognises both general electronic signatures and digital signatures based on Public Key Infrastructure (PKI). For transactions requiring a high level of non-repudiation and integrity, digital signatures supported by digital certificates issued by certification authorities (CAs) accredited by the Electronic Transactions Development Agency (ETDA) are widely adopted and recommended in practice. These frameworks provide the necessary legal certainty and integrity for electronic documents and form the backbone supporting national digital platforms such as the NDTP and the use of electronic customs documentation.

(2) Challenges

For the government to 'integrate strategy, standards, auditing, and incident response,' it is essential to improve understanding of CII designation criteria, the roles of supervisory authorities, and the scope of obligations. While the PDPA has been fully enforced and administrative sanctions and fines for violations have increased, raising regulatory standards rapidly, many SMEs and regional businesses lack the personnel and systems to comply effectively, often resulting in merely formal compliance.

In Thailand, an incident reporting framework for critical information infrastructure organisations has been established under the Cybersecurity Act, and the Personal Data Protection Act requires personal data breaches to be reported within 72 hours. However, the system remains centred on critical infrastructure and split between cybersecurity and data protection laws. For logistics operators, port-related small and medium-sized enterprises, and digital trade platform participants where critical infrastructure status is unclear, key questions remain unresolved, including whether system outages or ransomware incidents without personal data fall under mandatory reporting, how notifications should be coordinated amongst the National Cyber Security Agency, sector regulators, and the Personal Data Protection Committee, and how reported incidents feed into risk assessments for the national digital trade platform and the electronic customs ecosystem. This domestic 72-hour timeline also differs from the emerging expectations of the ASEAN Regional CERT protocol, creating a timeline mismatch in which a cross-border supply chain incident may be reported domestically only after it has already affected regional partners.

Criteria 4-2. Governmental/Public Organisation Responsible for Ensuring Data Security

(1) Current State

Thailand, led by the Ministry of Digital Economy and Society (MDES), prioritises the strengthening of CII security through a national strategy to ensure digital trade reliability. The National Cybersecurity Agency (NCA) is responsible for formulating the national cybersecurity strategy and regulations, coordinating the protection of Critical Information Infrastructure (CII), and managing the cyber threat vigilance and response system.

Furthermore, the Personal Data Protection Committee (PDPC) oversees the Personal Data Protection Act (PDPA), and the Electronic Transactions Development Agency (ETDA) ensures the trustworthiness of electronic transactions, establishing a system where

multiple organisations share jurisdiction to safeguard data and information reliability. While the legal framework is in place following the establishment of the NCA and PDPC, the effective enforcement of the PDPA and the widespread compliance amongst enterprises require further resources and time.

Thailand is ranked in Tier 1 in the ITU's Global Cybersecurity Index 2024, with a score of 19.22 against the maximum score of 20 for the organisational measure pillar.

(2) Challenges

Since the NCA and PDPC were established and began operations only in the last few years, they are in the phase of establishing their authority and credibility in relation to existing ministries and in exercising their enforcement powers over regulated entities. Moreover, although the NCA and PDPC are legally established, the track record of applying specific and effective sanctions for large-scale data breaches under the PDPA remains limited.

It is expected that efforts will be intensified to enhance the incentives for compliance within the private sector. In this context, Thailand industry stakeholders have also stressed the importance of clear leadership in data governance at both national and regional levels. Interviews with Thai forwarding agents emphasised that national customs departments are well positioned to take the lead in data management at the country level. At the very least, this is the case for Thailand, where these agencies already possess most of the relevant trade data. They are considered neutral, well-regulated, and capable of ensuring secure and accountable data handling. Additionally, interviewee noted that if a universal trade platform were to be implemented at the ASEAN level, connecting country-specific systems would be easier if the overseeing authorities in each country hold similar positions and authority within the trade structure. According to these views, implementation should begin at the national level. Each country must first designate a responsible entity to lead its digital integration efforts. Once national systems are in place, the next phase should involve establishing a neutral regulatory body capable of overseeing and safeguarding sensitive data exchanges amongst ASEAN Member States.

Criteria 4-3. Appropriate Cybersecurity Environment and Operational Status

(1) Current State

Thailand is accelerating NSW/ASW integration by clarifying electronic signature requirements for trade documents, centred around its National Digital Identity (NDI).

In the NSW/ASW workflow, electronic signatures compliant with the Electronic Transactions Act (ETA) are attached to application data, ensuring legal validity and reliability of electronic documents.

NDI, initially adopted in the financial sector through e-KYC (Know Your Customer), is now expanding as the standard for identity verification in related trade services such as freight forwarding, insurance, and trading companies.

The licensing system for ID and authentication services under the 2022 Royal Decree has contributed to improving service quality, including consent and delegation of authority based on OAuth2/OIDC models.

Overall, Thailand has established an environment that enables the elimination of paper-based dependencies and digitisation of verification processes in the supply chain through

three key elements: differentiated signature operations under ETA, remote identity verification via NDI, and full electronic operation of NSW/ASW.

(2) Challenges

Thailand is extending NDI, originally established in the financial sector, into the trade domain, but challenges remain in cross-sectoral consent management and SME-level technical adoption.

The 2022 Royal Decree designated ID proofing, credential lifecycle, authentication, and ID federation as licensable activities, but unifying the authorise API across sectors remains a future task.

Moreover, it is essential to establish a comprehensive, cross-government framework for electronic signatures, authentication, and identity verification.

In addition, Thailand fully enforced its Personal Data Protection Act (PDPA) in 2022, establishing the clear requirement of obtaining explicit consent from data subjects as a fundamental principle in data processing. However, structural challenges remain between this stringent domestic regime and regional data integration across ASEAN. While Thailand's PDPA imposes strict consent requirements, there are still not sufficiently harmonised legal and technical standards amongst ASEAN Member States regarding consent record-keeping, the exercise of withdrawal rights, and data security requirements. In trade supply chains, when cross-border exchange of tracking data and commercial documents inevitably involves personal data, this lack of standardised consent management increases legal risks and operational complexity for Thai companies seeking to receive data lawfully and continuously from foreign partners. As a result, achieving secure and seamless cross-border traceability remains difficult. To successfully expand NDI into the trade sector, it will be crucial not only to unify domestic frameworks but also to strengthen international cooperation toward establishing an interoperable consent management framework across ASEAN.

Through interviews with representatives from shippers/consignees in Thailand's automotive industry, strong concerns about cybersecurity weaknesses in government systems were revealed. Interviewee noted that user authentication often relies on simple usernames and passwords, with no differentiation between corporate and individual accounts, and lacks robust mechanisms such as device identification or login tracking. Commented that the absence of systemic rigor and enforceable technical standards continues to undermine trust in the integrity of government platforms. To address these issues, interviewee recommended mandating uniform authentication protocols across agencies, including compulsory two-factor authentication, differentiated access levels, and device-based login identification. They also called for standardised technical controls through enforceable guidelines, such as a centralised inter-agency cybersecurity mandate, cross-agency data security standards, and embedded audit checkpoints within trade digitalisation frameworks such as ASW and NSW.

4. Indonesia

PILLAR 1: Domestic Process Efficiency

Criteria 1-1. Digital Infrastructure Readiness

(1) Current State

Development of 5G networks, cloud infrastructure, and data centres in Indonesia is progressing primarily in urban areas. With strong policy support and the entry of global companies, the expansion of digital infrastructure is expected to accelerate further.

The Indonesian government has formulated the 'Digital Indonesia Roadmap', led by the Ministry of Communication and Information Technology (Kominfo), to promote digitalisation through four key pillars: (1) development of digital infrastructure (5G, cloud, data centres), (2) cultivation of digital talent, (3) promotion of the digital economy (including support for startups and enhancement of e-commerce), and (4) strengthening of digital governance (such as e-government and digital ID). In 2024, Kominfo announced a new national strategy titled 'Vision Indonesia Digital (VID) 2045', which aims to further develop ICT infrastructure and promote the digital economy. This aligns with the broader national development vision 'Indonesia Emas (Golden Indonesia)', which outlines the country's aspirations for its centennial in 2045. The vision emphasises expanding investment in digital infrastructure to enhance international competitiveness and fostering collaboration with domestic and international companies to develop human resources in the ICT sector.

In terms of specific technologies, 5G deployment has been rolled out gradually, starting in urban areas. Since Telkom Indonesia first introduced 5G in 2021, commercial services have been launched in major cities such as Jakarta, Surabaya, and Bandung. Regarding cloud services, the government is promoting domestic cloud adoption as part of the VID 2045 strategy, and foreign players such as AWS and Google Cloud have entered the Indonesian market. The data centre market is also experiencing rapid growth, with a concentration of facilities around Jakarta. As of 2023, Indonesia's total data centre capacity reached 514 megawatts, making it one of the largest in ASEAN.

However, in the IMD World Digital Competitiveness Ranking 2024, Indonesia ranks 43rd overall and 59th in the 'Technology' sub-factor.[35] In particular, the country ranks low in Internet bandwidth speed, indicating that while government initiatives are underway, the digital transformation process remains in progress.

(2) Challenges

Although the government has presented its vision and roadmap, specific investment plans and key performance indicators (KPIs) have yet to be clearly defined. Additionally, the lack of clarity surrounding data localisation regulations and legal frameworks for cross-border data transfers may pose barriers to the entry of foreign companies. Government Regulation No.71/2019 is ambiguous about whether private electronic system operators must remain establishing data centre locally, while Ministerial Regulation No.20/2016 imposed burdensome procedural requirement for cross-border personal data transfer.[36] Therefore, prompt formulation and public disclosure of these elements are urgently needed.

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[35] IMD, IMD World Digital Competitiveness Ranking 2024.

[36] ERIA, Between Trade and Trust: Rethinking Indonesia–US Cross-Border Personal Data Transfer.

Going forward, strategic government support and active participation from the private sector will be essential to sustaining growth.

Interviews with Indonesian authorities highlight that uneven infrastructure remains a major obstacle to nationwide digital integration. Smaller and regional ports outside Java often lack reliable digital systems, and many SMEs lack resources to adopt them. Connectivity gaps persist as 5G expansion is concentrated in major cities like Jakarta, while rural areas still rely on slower 4G networks, limiting real-time data processing in remote logistics hubs. Moreover, unlike Singapore, Indonesia lacks a mandatory cloud-first policy; cloud adoption under VID 2045 is encouraged but not required, resulting in inconsistent migration across ministries and slowing the resilience of e-government infrastructure.

Criteria 1-2. Digital Format Readiness

(1) Current State

In Indonesia, the digitalisation of trade-related documents has advanced significantly, both in terms of institutional design and practical implementation, with the Indonesia National Single Window (INSW) serving as the central platform. In certain areas, the country has reached a stage of 'early adoption and institutionalization.'

According to the UN Global Survey on Digital and Sustainable Trade Facilitation, Indonesia scored 96.3% in 'Paperless Trade',[37] indicating that domestic digitalization is progressing.

By document type:

Commercial invoices: The widespread use of the e-Faktur system has made electronic issuance the de facto standard in practice.

Certificates of origin: With the digitalisation of the ATIGA e-Form D, paper-based Form D is no longer accepted in principle. Indonesia is expected to continue aligning with this trend.

Customs declarations: The INSW enables centralised electronic processing, including pre-arrival declarations (e.g. Pemberitahuan Impor Barang or PIB), improving the efficiency of the declaration process.

Packing lists: Submission and attachment of electronic data as supporting documents through INSW and electronic customs declarations have become standardised. However, in some ports or for certain goods, printed documents are still required.

Phytosanitary certificates: Indonesia has transitioned to a system capable of electronic exchange through the IPPC e-Phyto Hub.

Bills of lading (e-BLs): Although there is growing momentum for adoption through private platforms, domestic legislation aligned with the Model Law on Electronic Transferable Records (MLETR) has not yet been finalised, leaving gaps in the legal framework.

Document map findings (Appendices 6): In Indonesia's domestic procedures for both imports and exports, customs declarations can be submitted in digital form through Customs Excise Information System and Automation (CEISA). Other key documents exchanged between forwarders and customs such as commercial invoices, certificates of origin, packing lists, and bills of lading are not yet fully digitalised, and are typically

[37] UN, Global Survey on Digital and Sustainable Trade Facilitation.

uploaded to CEISA as electronic file attachment. For exports, it has been noted that commercial invoices and packing lists are required either in electronic or paper form for submission to customs.

In summary, Indonesia has established digitalisation in both institutional and operational aspects for e-invoices (e-Faktur), customs declarations (INSW), and certificates of origin (ATIGA e-Form D). However, the continued use of printed packing lists, and the lack of legal infrastructure for e-BLs remain challenges. In particular, the domestic adoption of MLETR-aligned legislation and enhanced interoperability between platforms are essential to fully institutionalise digitalisation.

(2) Challenges

While Indonesia has achieved a stable level of digitalisation in key areas such as INSW, e-Faktur, and ATIGA e-Form D, the following challenges remain:

Packing lists are still often carried in printed form at the operational level.

e-BLs have yet to be supported by domestic legislation aligned with MLETR, meaning that while private adoption is increasing, legal equivalence at the national level has not been established.

Criteria 1-3. Presence of National Single Window (NSW)

(1) Current State

Indonesia's NSW is known as INSW, and its official TFA documentation highlights centralised and synchronised data submission, unified notification and permit issuance, and integration with ministerial systems. Under the TFA, Article 10.4 was notified as a Category A commitment effective 22 February 2017, confirming institutional establishment.

Domestically, the Directorate General of Customs and Excise (DJBC) is progressively mandating the use of CEISA 4.0 as the core customs system, with several Director General decisions in 2024–2025 expanding its full application. It highlights two-tier operation maintained by Indonesia.

Regarding the one-stop process, INSW provides a front-end portal offering online application, permit inquiry, user registration, and access to FAQs and online forms. However, the coverage and completeness of these functions vary by ministry and agency, and not all permit types or workflows are fully end-to-end digitalised through the INSW portal. In practice, traders often still interact with sectoral systems (e.g. ministerial licensing platforms), meaning that the one-stop service functions are available but not yet comprehensive or uniformly integrated across all procedures. Regionally, Indonesia joined the ASEAN-wide transition to electronic ATIGA e-Form D from 1 January 2024.

The UN Digital & Sustainable Trade Facilitation Survey rated Indonesia 89.25% overall, with 96.3% in paperless trade.

(2) Challenges

Indonesia has established a solid domestic digital foundation through INSW and CEISA 4.0, but governance remains fragmented. Cross-ministerial change management and audit

mechanisms are not unified, and it is recommended to consolidate the operation of INSW and customs systems under a single Change Advisory Board. Technical and legal harmonisation of electronic signatures and timestamps also remains a challenge. Furthermore, in Indonesia as well, SME's access is only at the early stage, the number of players truly benefiting from the NSW is still limited.

In fact, during an interview with a freight forwarder having active business in Indonesia, it was pointed out that many players still lack access to the NSW. This includes not only small-scale operators but also local administrative authorities. As a result, whenever data sharing is required, processes often revert to manual, paper-based methods.

PILLAR 2: Seamless Cross-border Connectivity and Interoperability

Criteria 2-1. Technical Interoperability

(1) Current State

Indonesia has been implementing advanced procedures and external connectivity through CEISA 4.0, using INSW as the gateway. Since 2024, mandatory adoption has been phased in, with Phase 19 officially announced in May 2025. CEISA 4.0 incorporates new functionalities such as retroactive verification of certificates of origin, advancing the digitalisation of import services. The exchange of e-Form D via ASW continues to be operational.

Regionally, the Ministry of Communication and Informatics (KOMDIGI) promotes alignment between domestic regulations and ASEAN standards in areas such as AI, fintech, digital identity, and e-Invoicing. The nationwide e-Faktur system mandates electronic invoicing for VAT-registered entities. e-Faktur invoices are issued in XML format with embedded QR codes and are linked in real time with the Directorate General of Taxes (DGT), supporting technical interoperability.

Furthermore, Indonesia is steadily adopting international data standards for customs and trade processes. The Indonesia National Single Window (INSW) has been aligning its data structures with international reference models such as the WCO Data Model (WCO DM) in customs declarations and related datasets. Recent updates to the CEISA 4.0 schema, aligned with ASW requirements, help ensure that key data such as HS codes, trader IDs, and certificate of origin fields can be exchanged in formats largely compatible with the WCO DM.

Also, to improve interoperability, Indonesia is expanding API access across border agencies. INSW and CEISA 4.0 have introduced a service-oriented architecture and are rolling out standardised APIs for document submission, status tracking, and inter-agency data sharing. The Directorate General of Customs (DG Customs) and Directorate General of Taxes (DG Taxes) now offer various API-based services that are designed to be consistent with the e-Government's SPBE-based digital interoperability framework. This enables more consistent and automated data exchange amongst domestic and regional stakeholders. This also marks a strategic transition phase for Indonesia, moving away from closed, legacy connections toward a standardised open API architecture that facilitates broader B2B integration.

(2) Challenges

Nationwide mandates for electronic invoicing (e-Faktur) and the advancement of CEISA 4.0 are progressing. However, there is a risk that these tax authority-led data standards may not be fully technically aligned with vocabularies used in other trade sectors such as ports and logistics. Additionally, system reliability remains a primary concern. Frequent system downtime and timeout issues in the ASW Gateway often disrupt data transmission, forcing traders to revert to manual fallback procedures and undermining trust in the digital ecosystem.

From a cross-border technical perspective, Indonesia's e-Faktur operates under a domestic clearance architecture and is primarily used as a domestic system rather than being integrated into any ASEAN-wide technical interoperability framework. ASEAN does not yet operate a fully-fledged, region-wide shared technical infrastructure (such as a common messaging gateway) for e-invoice exchange, and current regional initiatives under the ASEAN Digital Masterplan and digital trade standards work focus mainly on designing common data schemas and governance models, while live cross-border interconnections are still at an early or pilot stage. As a result, technical mapping and translation layers would likely still be required if e-Faktur data were to be exchanged cross-border.

For transport documents, global digital platforms used by carriers and logistics operators which Indonesia Customs has joined can handle e-BL transactions involving Indonesian shipments. However, these exchanges occur within platform-specific technical ecosystems, and publicly available technical documentation does not yet indicate a direct API integration with INSW or CEISA 4.0. In the absence of a publicly documented, unified API gateway or message-routing mechanism linking Indonesia's national trade platforms to external e-BL networks, any data integration would currently rely on custom or proprietary connections rather than standardised national APIs, resulting in fragmented technical interoperability across systems.

Technical interoperability challenges are also evident at the industry level. According to interview with Indonesian stakeholders, while many member companies have adopted their own digital systems, functionality varies widely: 60% of small players handle mainly payments, 30% of medium-sized enterprises have basic interfaces supporting document upload and tracking, and only 10% operate international-class platforms. This variation limits seamless data exchange across system and border, highlighting the need for standardised interfaces and end-to-end interoperability, particularly for SMEs.

Criteria 2-2. Organisational Interoperability

(1) Current State

Indonesia is advancing the Indonesia National Single Window (INSW) and the National Logistics Ecosystem (NLE), a cross-government and public-private integration framework. NLE aims to standardise and connect processes from arrival to storage and delivery across ports, airports, ministries, and businesses, and is being rolled out nationwide in phases. According to WCO publications, by 2024, NLE had been deployed at 46 seaports and 6 airports, indicating substantial progress in nationwide cross-organisational

operations.[38]

Indonesia's INSW has a unique structure. Unlike other countries, it is not under the jurisdiction of customs but rather managed by a Steering Committee composed of multiple ministries (currently 21 ministries), chaired by the Coordinating Ministry for Economic Affairs. The focus here is on the comprehensive management of both 'Trade' and 'Transportation.' While other countries only deal with the 'Trade' aspect, integrating transportation is key to making NSW an efficient system.

INSW, operated by the Indonesia National Single Window Agency (Lembaga National Single Window, LNSW) under the Ministry of Finance, functions as the main national gateway for trade-related regulatory data exchange and supports electronic communication with foreign counterparts. LNSW works with ASEAN partners on ASW messaging formats, testing of electronic exchanges and the recognition of electronic documents, in line with agreed regional technical specifications and guidelines.

Also, regionally, since ASEAN has ASEAN Single Window Steering Committee (ASWSC), Indonesia is by the Directorate General of Customs and Excise (Indonesia Customs).

(2) Challenges

Indonesia's presidential directive to promote NLE involves integrating processes across a wide and complex range of supply chain stakeholders (customs, ports, Ministry of Transport, private businesses). While participation in common processes is mandated, this often requires changes to existing authorities and procedures, leading to organisational resistance and coordination difficulties. Friction may arise between vertical authority structures and horizontal process integration.

Moreover, In Indonesia, institutional frictions arise from the coexistence of multiple regulatory mandates governing data. While sector-specific rules issued by Ministry of Communication and Digital Affairs (KOMINFO) for Electronic System Operators (ESOs) and by Financial Services Authority (OJK) for financial data emphasise domestic data management and certain localisation-leaning requirements, these frameworks may not always align smoothly with emerging regional approaches that aim to facilitate efficient cross-border data flows. Because several ministries impose differing compliance requirements, coordination becomes complex, and this can make it more challenging to ensure consistent incorporation of regional data-governance principles.

Interview from Indonesian authority highlighted the distinctive feature of Indonesia's system which is governed by allies of ministries (currently 21 ministries) instead of being under not under the jurisdiction of customs. It noted that while this structure promotes inclusivity and ensures that diverse regulatory perspectives are considered, it also faces challenges in interoperability and policy coherence, as each participating ministry formulates its own regulations and develops its own systems, making coordination and alignment very challenging.

In addition, recent analyses[39] underscore that ASW advancement is constrained by regulatory divergence and uneven readiness across ASEAN members, compounded by governance and inter-agency coordination gaps. This matter has long been identified as a

[38] World Customs Organization, *WCO News 105 – Issue 3/2024*.

[39] ERIA, Follow-up ASEAN Seamless Trade Facilitation Indicators (2025), Journal of Principles Management and Business (2025).

concern. In Indonesia, the ongoing modernisation of INSW and the need to harmonise procedures amongst many licence-issuing agencies, each operating its own information systems, illustrate how national-level fragmentation can complicate readiness for adopting new ASW-related documents. These domestic challenges, combined with ASEAN's consensus-based decision model, shape Indonesia's timeline for deeper ASW integration.

Criteria 2-3. Legal Interoperability

(1) Current State

Indonesia has not adopted MLETR. Electronic documents like e-BLs are currently managed through contractual provisions.

The Personal Data Protection (PDP) Law came into full effect in 2024, organising cross-border data transfers around adequacy, contracts, and consent. However, cross-border data exchange remains in a gradual expansion phase.

(2) Challenges

The MLETR has not been adopted, and the legal validity of electronic documents is currently managed through contractual arrangements, thus highlighting reliance on counterpart's readiness. While the enactment of Indonesia's Personal Data Protection (PDP) Law has provided clearer legal principles for cross-border data transfers, overall legal certainty remains limited because the implementing regulations and the supervisory authority have yet to be established.

Moreover, Indonesia is not currently participating in the APEC CBPR System or the Global CBPR Forum, whose membership is limited to a small group of jurisdictions such as Singapore, Malaysia, and the Philippines. As a result, Indonesian organisations engaging in cross-border data flows cannot rely on a shared certification framework for mutual recognition with CBPR-certified partners and must instead navigate the tiered conditions under Article 56 of the PDP Law. This contributes to a fragmented legal and governance landscape and increases the complexity of achieving interoperable compliance across jurisdictions.

In addition, during the interview with shipper/consignee, it was noted that recently, quota restrictions for raw materials and import permits is adding uncertainty, slowing supply and sales. This reflects how geopolitical and institutional factors can undermine the efficiency of digital trade. The issue highlights the importance of regional cooperation in developing common rules and coordinated approaches to mitigate such disruptions.

Regarding the DFFT, Indonesia PDP Law is intended to support trusted data exchange but compared with more permissive regimes it may involve additional compliance steps for firms engaging in cross-border digital trade and logistics. In this sense, DFFT currently seems to function more as a guiding principle in Indonesia's international digital policy discourse and long-term direction than as a detailed operational standard embedded in customs systems, trade platforms and logistics data-sharing arrangements.

PILLAR 3: End-to-end Unit-level Traceability and Resilience

Criteria 3-1. Real-time Cargo Tracking

(1) Current State

Indonesia has begun introducing smart port technologies at major hubs such as Tanjung Priok, Tanjung Perak, and Cikarang Dry Port, including pilots of real time cargo tracking using IoT devices and electronic seals. However, a fully integrated nationwide tracking system that links documents and cargo through GPS, QR codes, and IoT has not yet been achieved.

At Tanjung Priok, GPS equipped electronic seals have been used since 2016 to monitor container movements and conditions, expanding from 241 devices in the 2015 pilot to 710 units by the end of that year. Some logistics companies have also adopted RFID tags to automate the recording of cargo movements in warehouses.

In 2024, a pilot project between Japan's TradeWaltz and Indonesia's HAKOVO enabled real time sharing of electronic shipping documents using QR codes, demonstrating significant reductions in clearance times. At Cikarang Dry Port, electronic seals with RFID and geofencing capabilities were being used on about 789 devices by 2023 through the ECTS system.

Indonesia also plans to deploy IoT sensors, GPS systems, autonomous vehicles, drone surveillance, and other smart technologies across major ports, although current tracking remains largely limited to port assets and containers. Efforts are underway to integrate these developments into the national logistics system, but a unified national platform with document level integration is still in progress.

According to the World Bank's Logistics Performance Index, Indonesia's timeliness score of 3.0, which is below the global average and the lowest amongst the six ASEAN countries in this study, indicates that additional time and effort are required to fully institutionalise these initiatives.

(2) Challenges

Indonesia's archipelagic geography results in significant regional disparities in the availability of IoT devices and communication infrastructure. Bidirectional API connection to integrate dynamic and static data between the Indonesia National Single Window (INSW) and port PCS systems has yet to be standardised. Additionally, the frameworks for stable real-time data operations remain limited. Ensuring technical availability and sustainable operations remains a challenge. Tracking today is still container centric, focusing on the box rather than the product. Moving toward a product centric model with unit or serial number level data is necessary to achieve end-to-end visibility, even though efforts are underway to align with the WCO Data Model.

These constraints are particularly burdensome for SMEs. Analyses by ASEAN[40] note that Indonesia is a 'mid-stage' ASEAN economy where SMEs still need more coordinated support and tailored business services to adopt advanced technologies and connect to international markets. In practice, smaller logistics firms and shippers often face limited broadband connectivity outside major urban areas, gaps in digital skills, and higher relative investment and compliance costs when implementing IoT-based tracking and

[40] ASEAN/OECD/ERIA, SME Policy Index: ASEAN 2024.

data-sharing solutions. As a result, even where digital platforms for real-time cargo tracking exist, many Indonesian SMEs find it difficult to integrate their systems and fully benefit from end-to-end visibility.

Interviews with Indonesian authorities highlighted that while the National Logistics Ecosystem (NLE) envisions a fully integrated end-to-end logistics system, from port entry to the final consignee, the current scope of NLE remains focused on the middle mile. Authorities noted that system integration requires data format standardisation across platforms. In B2B operations, data formats and technical protocols differ significantly amongst logistics service providers. Efforts are underway to align these systems using international frameworks such as the WCO Data Model.

Criteria 3-2. Management Capability for Tracking Data

(1) Current State

Indonesia is promoting integration amongst ministries, ports, and logistics providers through the National Logistics Ecosystem (NLE), a presidential-level initiative. As of 2024, NLE has been deployed at 46 seaports and 6 airports, supported by the smart port roadmap of the state-owned port group Pelindo. Indonesia demonstrates strong policy execution capacity in building wide-area visibility infrastructure, though regional disparities in operational quality remain a challenge.

The implementation of NLE is being advanced under government leadership, primarily by the Coordinating Ministry for Maritime Affairs and Investment (Kemenko Marves). However, its promotion requires extensive collaboration with private-sector stakeholders such as port operators (e.g. Pelindo), shipping lines, logistics providers, and digital platform companies. This collaborative model enables the government to integrate regulatory and administrative processes while leveraging the operational expertise and digital technologies of the private sector.

Regarding Unit-Level Standardization, achieving true end-to-end data tracking requires standardisation that goes beyond container-level and cargo-level visibility to identify more granular transport units. Currently, NLE focuses mainly on optimising government-to-business (G2B) processes such as customs, port, and vessel procedures, and data standards for these more detailed transport units remain in the early stages. Domestically, voluntary adoption of international identifiers such as the Serial Shipping Container Code (SSCC) and Global Trade Item Number (GTIN) is being promoted through GS1 Indonesia and industry-led initiatives. However, these standards are not yet legally mandated across the entire logistics sector.

(2) Challenges

Infrastructure, human resource, and investment disparities, typical of archipelagic nations, hinder uniform operational quality and data accuracy. Strengthening basic operational practices such as standard compliance, data quality management, and cybersecurity is essential. Expanding use cases across regions and industries will be key to improving the reliability of visibility. In addition, while the National Logistics Ecosystem (NLE) has progressively integrated key domestic stakeholders such as Customs, ports and Pelindo to enhance intra-national visibility and speed up procedures, a significant challenge remains in achieving seamless, real-time interoperability with international partners. At this stage, NLE's core focus is on simplifying and digitising the domestic side of cross-

border trade processes. By contrast, the arrangements for cross-border digital data exchange are still limited and fragmented, and foreign shipping lines, overseas banks and trading partners often rely on diverse, sometimes proprietary, systems. This creates 'digital friction' at the international border: data generated within Indonesia's domestic platforms are not yet routinely exchanged with foreign systems in a fully automated, secure and legally harmonised manner, and frequently require manual intervention or ad-hoc data translation. As a result, there is still a gap between the relatively advanced visibility achieved within Indonesia and the realisation of truly end-to-end global supply chain visibility.

Indonesia's National Logistics Ecosystem (NLE) is still evolving and actively expanding into the B2B space. Key logistics platforms such as Online DO, SP2, tracking, and depot systems are being developed or integrated. Through the interview, it was found that NLE is collaborating actively with private providers to promote digital adoption, especially amongst smaller firms. Standardisation efforts using models such as the WCO Data Model aim to improve interoperability, though technical gaps and uneven digital readiness remain challenges.

However, while actively promoting digital adoption, particularly amongst SMEs, it remains fragmented due to pronounced regional disparities and digital literacy gaps. A significant portion of Indonesian SMEs, especially those outside major logistics hubs on Java, lack the basic digital infrastructure (reliable internet connections, suitable hardware) and human resource capacity to integrate their internal systems with the NLE or to utilise advanced tracking platforms. The high initial capital investment required for system integration and the need for specialised training to navigate new digitised processes constitute prohibitive barriers for many SMEs, limiting the network effects of the NLE and contributing to a persistent gap in digital maturity between larger players and many smaller firms within the Indonesian logistics sector.

Criteria 3-3. Supply Chain Diversification: Overview of Trade Structure

Indonesia is diversifying its supply chains, with exports distributed across China, the United States, and India. In the first half of 2025, exports to the U.S. increased by 20.7%,[41] while exports to India declined. Key export items include palm oil and steel, indicating a shift toward higher-value goods.

Imports are also diversified, mainly from China, Japan, and the U.S., focusing on machinery and electronics to support domestic industrial upgrading.

Indonesia has activated FTAs such as RCEP, IK-CEPA, IUAE-CEPA, and JIEPA, and is negotiating with the EU, South America, and Africa to expand market access and reduce regional dependency.

In terms of supply chain diversification, the following characteristics are notable:

- Approximately 28% of imports and 25% of exports are linked to China,[42] with high dependency in resources, steel, and electronics, raising concerns about vulnerability to external shocks.
- FTAs with Latin America, Africa, and the Middle East are limited, making expanded

[41] JETRO, Business News (2025).
[42] WITS - World Integrated Trade Solution.

access to emerging markets a critical challenge.

- SME export participation remains low. While support from the Ministry of Trade is underway, more effective measures are needed.

Substantial trade linkages with specific countries or regions imply that Indonesia's National Logistics Ecosystem (NLE) carries a high level of geographic concentration risk. In such a regionally skewed context, unilateral regulatory changes by partner countries regarding cross-border data restrictions or customs protocols could disrupt imports of critical industrial inputs, such as machinery, electronic equipment, and steel, even if domestic digitalisation is advanced, potentially causing cascading delays and additional costs throughout the supply chain.

Moreover, institutional linkages and FTAs with certain emerging markets, such as those in Latin America and Africa, remain limited in both number and scope, which could increase barriers to diversification. In the event of disruptions requiring supply chain shifts, transactions with these emerging partners often lack sufficiently established legal frameworks for mutual recognition of electronic certificates of origin (e-CO) and standardised data transfer protocols. As a result, paper-based documentation and manual verification may still be necessary to facilitate trade, leaving room for operational friction. Consequently, the digital efficiency built within the NLE framework faces the risk of being undermined.

PILLAR 4: Trustworthy and Secure Infrastructure

Criteria 4-1. Cybersecurity Legal Framework

(1) Current State

Indonesia's development of its cybersecurity legal framework remains at an early stage, and the country is classified as Tier 4 (lower group) in the ITU Global Cybersecurity Index.

In 2022, the Personal Data Protection Law (PDP Law) was enacted, establishing clear provisions on data subjects' rights, corporate obligations, and penalties, marking some progress in building a legal framework for personal data protection.

However, there is still no comprehensive law dedicated to cybersecurity, and legal provisions regarding the protection of Critical Information Infrastructure (CII), audit obligations, and incident-reporting systems remain unclear or incomplete.

Regarding the protection of trade secrets, it is regulated under Law No. 30 of 2000, but it has not yet been sufficiently embedded in day-to-day corporate practice, and employees' understanding of legal compliance is insufficient. As a result, the effectiveness of information management is low, which increases the risk of data and information leaks.

The legal foundation for electronic transactions and electronic signatures is primarily established under the Law on Electronic Information and Transactions (ITE Law). The ITE Law grants legal validity to electronic documents and electronic records and recognises electronic signatures provided that the system used is reliable, the signature can identify the signatory and indicate their intent, and it is verifiable. For applications requiring high reliability, an 'accredited electronic signature' based on a certified electronic certificate issued by an electronic certification service provider (PSrE) authorised by the Ministry of Communication and Digital (Komdigi) is positioned as a core mechanism to ensure legal recognition and non-repudiation. This accreditation process enhances integrity and

traceability, forming the foundation for the reliability of official submissions to government agencies and critical commercial documents within the National Logistics Ecosystem (NLE). However, despite the existence of such a legal framework, the practical adoption and consistent use of accredited electronic signatures across all sectors remain a challenge.

(2) Challenges

A law equivalent to a comprehensive Cybersecurity Act that governs cybersecurity across sectors still does not exist, and the definition and designation process for CIIs remain unclear. The Electronic Information and Transactions Law (ITE Law), telecommunications regulations, and sector-specific rules exist in a patchwork manner. Consequently, elements such as CII definition and designation, audit obligations, and unified incident reporting and sharing mechanisms are not yet established as a systematic framework. As for the incident reporting protocol, the PDP Law introduces a GDPR-style obligation requiring notification to both data subjects and the authority (Komdigi) within 72 hours in the event of a personal data breach. At the same time, the ITE Law, various MOCD (Ministry of Communication and Digital) regulations, and sector-specific rules impose separate reporting requirements on electronic system operators, and a single, cross-sector CII incident reporting regime has yet to be fully established, like those in Singapore or Malaysia. As a result, logistics companies and NLE participants may find it unclear under which law they should classify and consistently report incidents that do not involve personal data but have a significant impact on the availability and integrity of operational systems to the relevant regulators.

Criteria 4-2. Governmental/Public Organisation Responsible for Ensuring Data Security

(1) Current State

Indonesia has made some progress in establishing public agencies for data security, but it has not yet reached an optimal state. The National Cyber and Crypto Agency (BSSN) was established as the central body for national strategy formulation and incident response, tasked with the identification, detection, protection, response, and monitoring of national infrastructure security.

The government has prioritised investment in building effective defence mechanisms and enhancing operational response capabilities, such as launching the Cyber Threat Intelligence Program (CTIP) by the BSSN. However, coordination with the trade sector remains limited, posing challenges to the practical effectiveness of data security in economic activities. For personal data, while the legal foundation is established by the enactment of the Personal Data Protection (PDP) Law, the focus moving forward will be on establishing the enforcement structure and overseeing body.

Indonesia is ranked in Tier 1 in the ITU's Global Cybersecurity Index 2024,[43] achieving the maximum score of 20 for the organisational measure pillar.

[43] ITU, Global Cybersecurity Index 2024.

(2) Challenges

It is recommended that BSSN strengthens collaboration with private sector CERTs and establishes a real-time coordination system amongst ASEAN CERTs to enhance incident response capabilities.

Furthermore, given the increase in sophisticated cyber-attacks, the cyber threat intelligence and response capabilities of the BSSN need to be further upgraded, requiring continued investment in technology and human resource development.

The roles and authority of multiple agencies, including BSSN, the Ministry of Communications, and the Financial Services Authority, are also not clearly defined. As a result, the ideal model of the government operating strategy, standards, auditing, and response in an integrated manner remains distant, both institutionally and operationally.

Freight forwarders in Indonesia showed strong concern over such situations. Through the interview a strong need to identify a neutral and trusted party to manage key aspects of the digital trade ecosystem, including data storage, cybersecurity, and system maintenance was emphasised. Regarding security and trustworthiness, another interviewee from an authority stressed that trust in a shared digital system cannot be built overnight. They pointed out the need for sufficient time, iterative development, and practical testing environments to gradually establish confidence amongst participating agencies and private-sector users.

Criteria 4-3. Appropriate Cybersecurity Environment and Operational Status

(1) Current State

Indonesia is advancing the digitalisation of its National Single Window (INSW) based on the spread of digital signatures issued by the government certification authority (BSrE) and mobile digital ID (IKD).

INSW and related systems (procurement and administrative procedures) require certificates and signatures from BSrE (under BSSN, the National Cyber and Crypto Agency) for user registration and application submission.

This has facilitated paperless and auditable processes for certificates of origin (CO), licensing, and customs applications.

The spread of IKD (NDI) is expected to strengthen online KYC implementation in the future, contributing to authentication and identity verification in B2B platforms and trade-related services.

(2) Challenges

In Indonesia, electronic signature services from BSrE and private providers and the digital version of the IKD are progressing, but adoption of IKD remains limited and the e-KTP is still the main identity tool. As a result, identity verification and single sign-on based on IKD are not widely integrated into public services or systems such as the National Single Window. The parallel issuance of electronic certificates by BSrE and private providers also makes it difficult to maintain consistent processes for verification and validation, creating challenges for interoperability across ministries and agencies.

The Personal Data Protection Law provides a basis for processing and transferring personal data abroad, but ASEAN countries vary widely in the maturity of their data

protection rules, and regional standardisation of consent and record-keeping remains limited. Because trade transactions involve personal information, these gaps create practical burdens for coordinating cross-border data sharing through systems like the National Single Window. Regional mechanisms for mutually recognising assurance levels for electronic signatures and digital IDs are also still under development, making interoperability with partners such as Singapore difficult and highlighting the need for stronger alignment.

Moreover, while the technical infrastructure required for IKD, electronic signatures, and INSW integration is advancing, many SMEs face constraints in IT personnel, funding, and cybersecurity capabilities. Specifically, the annual cost of maintaining valid electronic certificates issued by PSrE (Certification Authorities) creates a recurrent financial barrier for smaller firms. This makes certificate management and API connectivity relatively more burdensome compared to large enterprises. The lack of sufficient standardisation in authentication/authorisation methods and API specifications also raises the barrier for SMEs to connect to INSW, and this structural gap is a factor undermining the uniformity of digital security across the entire supply chain.

5. Philippines

PILLAR 1: Domestic Process Efficiency

Criteria 1-1. Digital Infrastructure Readiness

(1) Current State

The Philippine government, led by the Department of Information and Communications Technology (DICT), has launched a series of digital infrastructure policies. One of the flagship initiatives is the Philippine Digital Infrastructure Project (PDIP), approved in 2024 with a total investment of approximately US$288 million, funded by a World Bank loan. The project aims to enhance nationwide broadband connectivity, particularly in underserved areas, and to strengthen cybersecurity. It includes the completion of the National Fiber Backbone, expansion of domestic submarine cables to connect the Visayas and Mindanao regions, and the deployment of 772 free Wi-Fi sites, especially in Mindanao's Regions XI and XIII, where internet penetration remains below 17%.[44]

In terms of 5G infrastructure, major telecom providers Globe Telecom and PLDT/Smart began offering 5G services in 2020. By 2023, 5G coverage had expanded across key urban centres such as Metro Manila, Cebu, and Davao. Globe Telecom alone had deployed over 2,000 5G base stations in Metro Manila. However, 4G remains dominant in rural areas, and nationwide 5G expansion will require further infrastructure investment and policy support.

To promote digital government services, the 'Cloud First Policy' was introduced in 2020. Under this policy, government agencies are transitioning to cloud-based systems to improve data management efficiency and disaster resilience. In the private sector, global cloud providers such as AWS, Microsoft Azure, and Google Cloud have entered the Philippine market, and cloud adoption is expanding amongst both enterprises and public institutions. For SMEs, cloud services are increasingly seen as cost-effective IT solutions.

Furthermore, while data center investment is growing, the Philippines faces a critical power constraint. The country has some of the highest electricity rates in ASEAN and a

[44] https://pco.gov.ph/

grid heavily reliant on fossil fuels. Ensuring a stable, affordable, and green power supply to meet the surging energy demands of hyperscale facilities remains a significant bottleneck for sustainable infrastructure growth.

Regarding data centres, the government has positioned their development as a national strategic priority. Incentives such as tax breaks and land provision are accelerating growth in this sector. Numerous new projects have been launched in Metro Manila, with both domestic firms (e.g. PLDT, Globe, ePLDT) and foreign investors (e.g. ST Telemedia, SpaceDC) actively investing in the market.

However, in the IMD World Digital Competitiveness Ranking 2024, the Philippines ranks 61st out of 67 countries overall, and 53rd in the 'Technology' sub-factor.[45] Particularly low scores in communication technology and secure internet services highlight the need for further development and investment in digital infrastructure.

(2) Challenges

As in many countries, the Philippines faces a significant digital infrastructure gap between Metro Manila and rural areas and between large enterprise and SMEs. This is due to many factors such as slow and unstable internet connection, high infrastructure development cost for it being archipelago, challenge in last-mile connectivity, issues with secure internet services, lack of local IT skills, amongst others. For SMEs, barriers such as underdeveloped infrastructure, a shortage of digital talent, and cost constraints hinder digital adoption.

The government is aware of these challenges and is implementing support programmes such as the 'Digital Cities 2025 Program', which aims to foster the growth of the IT-BPM (Information Technology and Business Process Management) sector in regional cities and promote digitalisation amongst local SMEs.

While the government's digitalisation efforts have so far focused primarily on administrative services, expanding these initiatives to include logistics, trade, and digital certification will be essential for broader economic impact.

In interviews with Philippine authorities, infrastructure-related constraints were highlighted as a major barrier to advancing nationwide digital connectivity. Officials noted that the archipelagic nature of the Philippines creates inherent disparities in digital infrastructure, with smaller or remote ports often experiencing unreliable or limited internet connectivity compared to major ports. These gaps significantly hinder the ability to implement unified digital processes and achieve comprehensive digitalisation across all regions of the country.

Criteria 1-2. Digital Format Readiness

(1) Current State

Current Status and Key Initiatives

The digitalisation of trade-related documents in the Philippines has shown steady progress in both institutional and operational aspects. According to the UN Global Survey on Digital and Sustainable Trade Facilitation, the Philippines scored 81.48% in 'Paperless Trade,[46] indicating that digital infrastructure is being developed at a comparable level both

[45] IMD, IMD World Digital Competitiveness Ranking 2024.
[46] UN, Global Survey on Digital and Sustainable Trade Facilitation.

domestically and internationally.

By document type:

Commercial invoices: In February 2025, the Bureau of Internal Revenue (BIR) issued Revenue Regulation RR 11-2025, restarting the expansion of mandatory electronic invoicing. This has accelerated the transition to the Electronic Invoicing System (EIS), with various operational guidelines and updates aligning with this direction.

Certificates of origin: As in other ASEAN countries, the Philippines has transitioned to electronic transmission and receipt of ATIGA e-Form D, with paper-based Form D no longer accepted in principle.

Customs declarations: Through the Electronic-to-Mobile (E2M) Customs System by Bureau of Customs (BOC), many customs procedures, including electronic lodging of import declarations, are now processed electronically. The next-generation National Single Window (NSW-ITFP) is currently being redeveloped under a PPP/BOT model, with infrastructure being prepared for future system integration.

Packing lists: Electronic submission and transmission have expanded based on official circulars requiring online submission of export documents. However, in practice, printed copies are still sometimes required, indicating that full paperless implementation has yet to be achieved.

Phytosanitary certificates (e-Phyto): The Bureau of Plant Industry (BPI) operates electronic exchanges via the e-Phyto Hub and has reported strengthened bilateral exchanges with countries such as Australia and Thailand. These bilateral initiatives are expected to expand further in the future.

Bills of lading (e-BLs): While global adoption is increasing, the Philippines has not yet implemented domestic legislation aligned with UNCITRAL's Model Law on Electronic Transferable Records (MLETR). Although e-BLs can be used on private platforms, legal equivalence at the national level remains unclear.

Document map findings (Appendices 6): In Philippine's domestic procedures for both imports and exports, customs declarations can be submitted in digital form through e-form. Other key documents exchanged between forwarders and customs such as commercial invoices, certificates of origin, packing lists, and bills of lading are not yet fully digitalised, and are typically submitted as electronic files attached to the customs system. For exports, it has been noted that commercial invoices and packing lists are still required in paper form for physical inspection by customs.

In summary, certificates of origin and customs declarations have reached a level of operational digitalisation, with full implementation of ATIGA e-Form D and routine use of E2M. E-invoicing and e-Phyto are in an 'expansion phase,' with the BIR's renewed push for mandatory adoption and Bureau of Plant Industry's enhanced bilateral exchanges contributing to improved operational efficiency and visibility for businesses. However, challenges remain, including the continued requirement for printed packing lists and the lack of MLETR-aligned legislation for e-BLs. These gaps in institutional and operational practices may hinder full paperless trade and data interoperability at the national level.

Ultimately, the full-scale launch of the next-generation NSW (NSW-ITFP) will be key to integrating the various digitalisation efforts into a cohesive system. By connecting documents, events, and payments across platforms, the Philippines can significantly

enhance the overall efficiency and reliability of its supply chains.

(2) Challenges

While the Philippines has made progress in digitalising key trade documents, particularly the full digitalisation of certificates of origin and the widespread use of E2M for customs declarations, the following challenges remain:

E-invoicing is still in the early stages of expanded mandatory implementation, and operational stability for broad application is needed.

Packing lists can be submitted online, but printed copies are still required in some cases.

e-BLs are not yet supported by MLETR-aligned legislation, and legal equivalence has not been established at the national level.

Criteria 1-3. Presence of National Single Window (NSW)

(1) Current State

In the Philippines, TradeNet (Philippine Trade Facilitation Gateway) serves as the core of the NSW, aiming to interconnect 73 trade-related government agencies (TRGAs). The system is developed and operated by Department of Information and Communications Technology and DOF, and the portal provides account setup guidance, system structure, and governance information including the NSW Task Force, Steering Committee, and Technical Working Groups. The WTO TFA officially references TradeNet as the country's Single Window, confirming its institutional basis.

The Bureau of Customs (BOC) describes NSW as a web-based platform for electronic submission and storage of regulatory information and documents related to imports, exports, and transit. Operationally, TradeNet integrates automated licensing, permits, clearances, and certifications, and supports inter-agency interoperability and governance through committees and working groups. ASW integration is supported by customs circulars on ATIGA e-Form D, with ongoing improvements through technical meetings.

The UN Digital & Sustainable Trade Facilitation Survey rated the Philippines 91.4% overall, with 100% in transparency, procedural simplification, and institutional cooperation. However, paperless trade scored 81.48%. E-Single Window is rated as 'Partially Implemented,' with CO issuance and customs refund procedures still incomplete.

(2) Challenges

While the institutional design of TradeNet is progressing, the UN survey indicates that the E-Single Window remains at the 'Partially Implemented' stage. Full institutionalisation requires complete connectivity of all 73 TRGAs and formal definition of SLAs and change management procedures. In addition, integration with the B2B domain remains insufficient, and adoption of NSW-related processes amongst SMEs is still limited, which constrains broader ecosystem-wide interoperability. Transparency in the governance and performance of the ongoing NSW-ITFP (Integrated Trade Facilitation Platform) PPP project also needs to be strengthened.

Exception processes such as refunds, appeals, and guarantees remain undigitised, preventing full end-to-end digitalisation.

As a Philippine authority noted in the interview, that a truly digitalised NSW should involve

all government agencies, whereas the current system remains customs-driven and highlighted the need for integration beyond customs.

PILLAR 2: Seamless cross-border connectivity and Interoperability

Criteria 2-1. Technical Interoperability

(1) Current State

The Philippines is enhancing interoperability through its accession to the United Nations Cross-Border Paperless Trade Agreement (CPTA) and the expansion of its National Single Window (NSW). The country joined CPTA in 2019, and integration with ASW has since been strengthened. In March 2025, the Philippine Trade Facilitation Committee (PTFC) discussed a roadmap focused on data standardisation and interoperability. This includes initiatives to enhance data verification and security using AI and blockchain, and to ensure alignment with the WCO Data Model and UNTDED.

The Bureau of Customs (BOC) is advancing automation of customs procedures using AI, IoT, and cloud technologies. The electronic exchange of e-Form D and the CPTA framework are contributing to the establishment of an internationally interoperable trade environment.

Furthermore, the NSW is undergoing a major overhaul through a public-private partnership model known as NSW-ITFP (Integrated Trade Facilitation Platform). This initiative promotes data standardisation and API integration, with connectivity to regional and global platforms such as ASW as a core objective.

(2) Challenges

The Philippines' accession to the UN Framework Agreement on Facilitation of Paperless Trade (CPTA) and adoption of the WCO Data Model demonstrate its commitment to international 'principles.' However, the country must concurrently integrate emerging technologies such as AI and blockchain into the new NSW-ITFP system and implement international standards technically requiring substantial capacity for parallel execution.

Joining the CPTA (UN Framework Agreement on Paperless Trade) and adopting the WCO Data Model demonstrate alignment with international 'principles.' However, under the new NSW-ITFP, there is a need for technical capacity to simultaneously advance the integration of emerging technologies such as AI and blockchain and the technical 'implementation' of international standards. Additionally, system reliability remains a primary concern. Frequent connectivity timeouts between Value-Added Service Providers (VASPs) and the Bureau of Customs' electronic systems often disrupt daily operations. These operational instabilities force traders to revert to manual troubleshooting, significantly undermining trust in the digital clearance process.

At the same time, the Philippines through the Bureau of Customs is gradually introducing Pre-border Technical Verification (PTV) and Cross-border Electronic Invoicing (CEI), establishing a regulatory framework that requires foreign exporters to register with the CEI system and submit electronic invoices before shipment. However, the structured data format for electronic invoices is based on proprietary specifications (such as XML) defined by the Philippines, and publicly available information does not indicate direct connectivity with ASEAN common specifications or PEPPOL-type regional platforms. Consequently, foreign businesses still need data mapping and custom system integration, and there is

no official confirmation so far that CEI messages are exchanged via ASW.

Regarding electronic bills of lading (e-BL), the Philippines participates indirectly through international private platforms rather than through government-to-government exchange via NSW or ASW. Major carriers and logistics operators have adopted global e-BL platforms, including blockchain-based systems, and since these carriers operate numerous routes to and from the Philippines, e-BL processing for Philippine trade can occur on these platforms. However, these arrangements rely on platform-specific interfaces amongst carriers, shippers, and financial institutions, and publicly available technical information does not confirm integration with TradeNet/NSW or ASW standard messages.

During the interview, representative from the Philippine authorities noted that technical interoperability remains a key challenge in the implementation of digital platforms for port and trade operations. While a centralised, 'one-stop' electronic submission system is envisioned to handle vessel clearances and trade-related documents, other agencies and stakeholders currently operate on different digital platforms, limiting seamless data exchange. The authorities highlighted that future system designs aim to be API-ready, allowing integration with business partners' systems, with the Bureau of Customs' national trade platform, and potentially with ASEAN-wide platforms. Achieving these technical connections is seen as essential for enabling end-to-end digital workflows, improving operational efficiency, and facilitating compliance with international obligations.

Criteria 2-2. Organisational Interoperability

(1) Current State

The country is planning to reconstruct its National Single Window (NSW-ITFP) through a PPP/BOT model, with public documentation clarifying roles, contracts, SLAs, and cost-sharing between public and private entities. The Bureau of Customs (BOC) continues to disseminate operational information on international connectivity and regional collaboration, aiming to integrate ASW and NSW-ITFP into a unified system. Furthermore, BOC also represents the ASW Steering Committee (ASWSC) which has chaired some recent ASW SC meetings and serves as the focal agency for regional NSW–ASW coordination.

Domestically, responsibilities are shared with the Philippine Trade Facilitation Committee (PTFC), which serves as the country's National Trade Facilitation Committee mandated under the WTO Trade Facilitation Agreement. The PTFC brings together agencies such as the Department of Finance, Department of Trade and Industry and the BOC to coordinate domestic and cross-border trade-facilitation measures. These bodies work with ASEAN counterparts to implement ASW exchanges such as the ATIGA e-Form D and the ASEAN Customs Declaration Document (ACDD), and to roll out new electronic documents, including the e-Phyto certificate and other digital trade certificates.

As for the DFFT, the Philippines has taken notable steps toward operationalising DFFT-style 'trusted flows' in its data governance framework. The National Privacy Commission (NPC) plays an active role in international discussions on building trust in cross-border data flows and, in the context of its hosting of the 2025 Global CBPR Forum Workshop in Boracay, has described the DFFT principle as an approach that promotes the secure movement of information without sacrificing privacy rights. In practice, while NSW/ASW operations remain largely document-centric, the broader regulatory environment now

incorporates privacy certifications and accountability frameworks that are consistent with DFFT-style trusted cross-border data flows and can support the development of international digital trade and services.

(2) Challenges

The Philippines leverages international obligations such as the WTO-TFA to promote inter-organisational collaboration through Philippine Trade Facilitation Committee (PTFC). However, the challenge lies in maintaining and updating simplified common process policies at a concrete operational level across numerous stakeholders (customs, agriculture, FDA, etc.). Ensuring sustained agreement on authority and process harmonisation amidst political and technical fluctuations is critical to achieving interoperability.

Moreover, barriers such as the time-consuming nature of consensus-based decision-making for ASW integration have long been pointed out. In the Philippines, the transition from the previous NSW platform to the new NSW-ITFP system has required aligning multiple domestic agencies and redesigning data-exchange procedures. This internal restructuring creates additional coordination challenges when introducing new ASW-related functionalities and combined with ASEAN's consensus-based implementation cycle, further slows the overall pace of ASW integration.

Interview insights from Philippine authorities further highlighted organisational interoperability challenges at the agency level. While the Maritime Single Window (MSW) is being developed as a centralised platform for vessel-related submissions in line with international maritime obligations under the IMO FAL Convention, its institutional mandate differs from that of the Bureau of Customs, which oversees the NSW for trade facilitation. This separation of roles leads to fragmentation, as each agency advances its own system based on distinct regulatory requirements and operational priorities. Although the MSW is envisioned to interconnect with both the future ASW and the Bureau of Custom's system, the absence of a unified coordinating mechanism and clearly defined responsibilities across agencies hinders seamless data exchange and process alignment.

Criteria 2-3. Legal interoperability

(1) Current State

While MLETR has not been adopted, the National Privacy Commission published MCC implementation guidelines in 2024, providing a contractual pathway for lawful cross-border data transfers.

Although there is no formal BCR approval system, companies can achieve substantial protection levels through a combination of contracts and organisational controls (e.g. internal policies, audits).

(2) Challenges

Philippines adoption of MLETR is still pending, and the legal framework for electronic transferable records remains underdeveloped. Additionally, the absence of a formal BCR approval system means that while protection levels are maintained through contracts and organisational controls, the lack of institutional backing limits international credibility.

From a business perspective, many Philippines SMEs appear to lack dedicated legal or compliance units and frequently rely on ad-hoc arrangements or external advice. This

limited in-house capacity makes it more difficult for smaller firms to navigate overlapping domestic, regional and international privacy- and data-protection frameworks.

Also, although the Philippines participates in the APEC CBPR System and is now a full member of the Global CBPR Forum, CBPR certifications streamline recognition only amongst participating economies; transfers to non-CBPR jurisdictions still require the use of other tools such as model contractual clauses or economy-specific safeguards. This fragmented landscape means that organisations engaged in digital trade must often maintain multiple parallel compliance mechanisms, increasing the complexity and the cost of managing cross-border data flows.

PILLAR 3: End-to-end Unit-level Traceability and Resilience

Criteria 3-1. Real-time Cargo Tracking

(1) Current State

Although the Philippines is still in the early stages of port modernisation, the country recognises the strategic importance of enhancing port infrastructure to support economic growth and connectivity across its more than 7,600 islands. As such, various initiatives are underway, including the consideration of real-time tracking systems.

The Bureau of Customs (BOC) is advancing the implementation of the E-TRACC system, which uses GPS-enabled electronic container seals (ECS) to monitor inland container movements in real time. This system tracks location, detects tampering, and issues deviation alerts. In 2024, Customs Memorandum Order 09-2024 formally expanded the scope of E-TRACC, specifying its purpose as enabling 'real-time and accurate tracking of container movement and location through linked tracking devices.' As of August 2024, the system's coverage was extended to include barges and domestic shipping cargo, enhancing its tracking capabilities.

The Philippine Ports Authority (PPA) is also considering the establishment of a centralised Port Operations Management Centre to consolidate data and improve coordination amongst port stakeholders. This includes various digitalisation initiatives aimed at enhancing cargo tracking, management, and automation to improve efficiency and competitiveness. One such initiative is iPORTS (Internet-Based Port Operations and Receipting for Terminals System), a comprehensive online platform designed to streamline import/export processes. It aims to provide services such as online registration, real-time tracking, and data analytics.

However, clear roadmaps for these initiatives remain unpublished, making the path to widespread implementation uncertain. While the expanded scope of E-TRACC is documented in Customs Memorandum Order 09-2024, detailed port-specific or year-by-year implementation plans have not been disclosed. Although iPORTS is operational, its real-time tracking component is still in the early stages. According to PPA's Administrative Order AO 005-2025 (effective 21 August 2025), the system is expected to be interoperable with Terminal Operating Systems (TOS) to enable real-time monitoring and storage fee assessments. Full-scale implementation is anticipated to begin this year.

Given the current state of digital infrastructure in the Philippines, real-time tracking is likely to be rolled out gradually over the coming years. Full automation of container terminals at major ports may remain a long-term objective.

According to the World Bank's Logistics Performance Index, the Philippines scored 3.2 on the Timeliness indicator[47], aligning with the global average.

(2) Challenges

The implementation of dynamic traceability using IoT and GPS remains limited. While the institutional framework has been designed, the path to implementation remains unclear. The following points can be cited as underlying factors:

First, in the Philippines, 'dynamic data' derived from IoT/GPS, such as cargo location information and changes in condition during transport, relies primarily on systems operated by private logistics providers. The operational and technical infrastructure needed to seamlessly integrate these dynamic data with document data from the public sector is still under development. Therefore, achieving end-to-end cargo tracking leaves room for improvement in designing and operating protocols that can consistently link both types of data.

International standards for unit-level identifiers and event terminology, such as the WCO Data Model and UN/CEFACT codes, exist but are not consistently implemented across ports, shipping lines, and logistics providers. Variations in how identifiers and event codes are used and updated add work for API integration and data mapping. More fundamentally, tracking remains container centric. Moving toward a product centric model with unit or serial number-level data is essential for consistent end-to-end visibility and highlights the wider regional challenge of achieving granular data standardisation.

Moreover, the Philippines' unique geographic conditions are critical when considering nationwide deployment of real-time tracking. Significant disparities in broadband connectivity and power supply exist between urban areas and rural or island regions, and these infrastructure gaps are treated as prerequisites for overall logistics digitalisation. Since stable communication and power environments are essential for real-time tracking (IoT/GPS), these regional infrastructure disparities can become a latent factor that makes nationwide traceability uniformity difficult.

Finally, the burden on SMEs in adopting digital technologies cannot be overlooked. SMEs generally have limited financial, human, and technical resources for digitalisation investments. Introducing advanced logistics digital tools, including real-time tracking, often requires securing initial investment, adapting to cloud-based systems and API integration, and understanding data governance requirements. Differences in company size can easily lead to disparities in readiness. This digital divide amongst SMEs remains an institutional and technical challenge for enhancing data integration across the entire supply chain.

Criteria 3-2. Management Capability for Tracking Data

(1) Current State

The Philippines has institutionalised real-time tracking using GPS/e-Seals through the *E-TRACC* system, expanding its scope to domestic and coastal shipping under Customs Memorandum Order 09-2024. Also in the Philippines, the project to rebuild the traditional National Single Window into the National Single Window–Integrated Trade Facilitation Platform (NSW-ITFP) is being promoted as a Public-Private Partnership (PPP) under a

[47] World Bank Logistics Performance Index

Build-Operate-Transfer (BOT) scheme. On the government side, the Department of Information and Communications Technology (DICT) has been designated as the Implementing Agency, working in coordination with the PPP Center and trade regulatory agencies (TRGAs), including the Bureau of Customs (BOC), to advance institutional design and procurement. On the private side, a joint venture between JAMC Holdings Corp. and Ascent Solutions Philippines Inc. has been recognised as the Original Proponent (OP), with the final private partner to be selected through a competitive proposal process involving other bidders. Under this scheme, the private partner will be responsible for designing, developing, operating, and transferring an integrated digital platform that connects trade-related businesses and logistics providers with multiple government agencies. This collaborative approach is expected to materialise a new data integration framework through joint efforts by the public and private sectors.

On the other hand, progress in unit-level data standardisation (at the product, case, and pallet level) remains partial. For FDA-regulated products such as pharmaceuticals, item identification using the Global Trade Item Number (GTIN) and GS1 barcodes has been formally adopted under Food and Drug Administration (FDA) Circular 2014-011, enabling tracking at the item level. In addition, GS1 Philippines is working to expand the use of GS1 identification codes such as 2D barcodes and the Serial Shipping Container Code (SSCC), primarily in the healthcare and retail sectors. However, such standardisation is still limited to specific sectors and has not yet reached mandatory implementation across the entire logistics chain. As a result, while container-level visibility through Electronic Tracking of Containerized Cargo (E-TRACC) and public–private data integration via NSW-ITFP are advancing, nationwide unit-level traceability remains in a developmental stage.

(2) Challenges

Concerns have been raised about the cost and operational burden of E-TRACC. Optimal operational design is needed to balance regulatory objectives with field-level efficiency. For NSW-ITFP, clarifying rules for intergovernmental data sharing, API response and retry protocols, and establishing integrated event flows across ports, customs, and commercial logistics are core challenges for realising traceability.

Furthermore, SMEs face disproportionately high barriers when adopting digital tracking and traceability solutions. Unlike large enterprises, the numerous SMEs that underpin the Philippine economy have limited access to capital for acquiring the necessary hardware and software. They also suffer from a marked shortage of digital literacy and IT specialists required to operate and maintain advanced business systems that can integrate with NSW or E-TRACC. As a result, many SMEs continue to rely on manual and paper-based processes, creating data gaps and delays across the supply chain. These structural gaps constitute a critical constraint to achieving the seamless end-to-end digital visibility and traceability that the nation aims for.

Interviews with shipper/consignee based in Philippines further highlighted management-related obstacles at the operational level. Interviewee noted that adjustments in system settings and required changes to operational processes, along with user resistance to system enhancements, pose additional hurdles. These findings emphasise that effective traceability depends not only on technical systems but also on strong organisational management and user adoption.

Criteria 3-3. Supply Chain Diversification: Overview of Trade Structure

The Philippines is working to diversify its supply chains, with export markets relatively evenly distributed across the U.S., China, Japan, ASEAN, and the EU. Exports are increasingly reliant on tech products, especially electrical equipment, which accounts for 45.3% of total exports.[48]

On the import side, China remains the largest supplier, with continued dependence on specific items. Institutionally, the Philippines participates in major regional trade agreements such as ASEAN FTA, AJCEP, JPEPA, and RCEP. However, it lacks FTAs with the EU, Latin America, and Africa, making expanded access to emerging markets a key future challenge.

In terms of supply chain diversification, the following characteristics are notable:

- Approximately 23% of imports and 14% of exports are related to China,[49] with high dependence in sectors such as electrical equipment and semiconductors, raising concerns about vulnerability to external demand fluctuations.
- The absence of FTAs with the EU, Latin America, and Africa presents structural barriers, and institutional support for market diversification remains limited.
- Exports are heavily concentrated in specific tech products, limiting flexibility in response to changes in the external environment.

As it has been described, Philippine exports are heavily dependent on electronic products, primarily electrical equipment and semiconductors, with electronics accounting for most total merchandise exports. This extreme concentration implies that the country's digital tracking infrastructure (e.g. NSW-ITFP) carries a significant industrial concentration risk. Therefore, digitalisation efforts must shift their focus from mere trade facilitation and efficiency improvements toward more robust risk management. Continuous system updates are required to ensure compliance agility in response to sudden international export controls or rapid technological obsolescence of components.

To achieve effective traceability, it is crucial to enable real-time, highly granular (unit-level) data tracking to quickly identify and manage regulated or restricted high-tech inputs, thereby preventing disruptions in key manufacturing processes.

Furthermore, the lack of fully implemented free trade agreements with the EU, many Latin American economies, and most African partners, where negotiations remain ongoing or exploratory, continues to pose constraints on broader market diversification.

PILLAR 4: Trustworthy and Secure Infrastructure

Criteria 4-1. Cybersecurity Legal Framework

(1) Current State

The development of the cybersecurity legal framework in the Philippines remains partial and fragmented, and the country is classified as Tier 4 (lower group) in the ITU Global Cybersecurity Index.

The Data Privacy Act of 2012 provides a certain level of structure for personal data

[48] JETRO, Trade and Investment Report of the Philippines (2024).
[49] JETRO, Trade and Investment Report of the Philippines (2024).

protection; however, it is largely implemented through government-issued circulars and administrative guidelines, with limited applicability and enforcement toward private-sector entities. As a result, practical compliance and effectiveness at the corporate level remain limited.

A comprehensive cybersecurity law has not yet been established, and legal clarity is lacking regarding the protection of Critical Information Infrastructure (CII), mandatory audits, and incident-reporting mechanisms.

The current legal framework is fragmented, and this lack of an integrated, overarching legal structure makes it difficult for the country to implement a strategic, national-level approach to cybersecurity governance.

The legal basis for the recognition of electronic signatures and electronic documents in the Philippines is the Electronic Commerce Act of 2000. This law grants legal validity to electronic documents, communications, and signatures, stipulating that a document cannot be denied legal effect solely because it is in electronic form. While the Act recognises the use of electronic signatures in general, it provides a higher level of certainty and non-repudiation for digital signatures. The Electronic Commerce Act provides the legal foundation for digital trade and commercial transactions. However, achieving widespread and consistent adoption of accredited digital signatures across all private sectors, including small and medium-sized enterprises, remains a persistent challenge due to cost and technical requirements.

(2) Challenges

As explicitly stated in the explanatory notes of a recently submitted House bill, 'The Philippines lacks an overarching cybersecurity law, and the absence of a legal framework for identifying, managing, and regulating CII constitutes a significant gap.'[50] This issue is clearly recognised as a major concern. The National Cybersecurity Strategy (NCSP) 2023–2028 sets the enactment of a new cybersecurity law as a policy goal. However, at present, operations remain fragmented, relying mainly on the Data Privacy Act (DPA) and circulars/guidelines, with incident reporting and auditing tending to be reactive and sector-based rather than systematic.

Regarding the incident reporting protocol, the Philippines mandates personal data breach notification within 72 hours under the Data Privacy Act and NPC circulars, aligning with global standards. However, the national cybersecurity framework is fragmented across separate laws (data protection, cybercrime, sectoral rules). A unified incident reporting mechanism focused on Critical Information Infrastructure (CII), similar to the EU's NIS2 Directive or Singapore's Cybersecurity Act, does not yet exist. For SMEs in the port/logistics sectors connected to the NSW-ITFP, it is unclear how to report cyber incidents that disrupt cargo tracking (even without personal data) and how such reports are centrally aggregated for national governance.

[50] Republic of the Philippines, House of Representatives, House Bill No. 4381 'Cybersecurity Act'.

Criteria 4-2. Governmental/Public Organisation Responsible for Ensuring data Security

(1) Current State

The development of public agencies for data security in the Philippines is still in progress, both institutionally and operationally.

The Department of Information and Communications Technology (DICT) is responsible for ICT infrastructure and policy, leading the National Cybersecurity Plan (NCSP) and actively promoting security enhancement through the digitalisation of the trade supply chain. The National Privacy Commission (NPC) was established to oversee the Data Privacy Act of 2012, enhancing its functionality through prompt response to and monitoring of data breaches, thereby managing the personal data protection framework. While the Philippines CERT (PH-CERT) handles incident response, these organisations operate independently, and a centralised national cybersecurity agency (equivalent to the NCSA) has not yet been established. Consequently, functions such as policymaking, technical response, and auditing are dispersed, making unified national management challenging.

The Philippines is ranked in Tier 2 in the ITU's Global Cybersecurity Index 2024,[51] with a score of 19.51 against the maximum score of 20 for the organisational measure pillar.

(2) Challenges

The Philippines faces structural challenges of resource scarcity and infrastructure vulnerability alongside the progress of digitalisation. Although the National Privacy Commission (NPC) conducts active monitoring, a significant challenge is the shortage of highly skilled technical professionals needed to cope with the rapidly expanding digital economy. Furthermore, the establishment of a robust collaboration system with ASEAN CERTs is necessary and expected to enhance incident response capabilities.

Also, one of the structural challenges in the Philippines' cybersecurity governance is the siloed structure amongst government agencies. Regulatory authority is distributed across multiple bodies, such as the National Privacy Commission (NPC) and the Department of Information and Communications Technology (DICT), making it difficult to establish fully consolidated implementation standards that is similar to NIS2 or Singapore for defining Critical Information Infrastructure (CII), security audit criteria, and incident reporting obligations. This fragmentation can hinder real-time information sharing between agencies and potentially delay national-level threat awareness and rapid response.

During the interview, shippers/consignees in the automobile sector in Philippines, highlighted that frequent turnover of personnel with system access poses a significant trust challenge. Interviewee noted that when staff change, it becomes difficult to maintain clear oversight of who has access and responsibility within the platform. To ensure the system remains reliable, they emphasised the need for constant sharing and updating of the designated Person-in-Charge (PIC) information between suppliers and clients.

[51] ITU, Global Cybersecurity Index 2024.

Criteria 4-3. Appropriate Cybersecurity Environment and Operational Status

(1) Current State

The Philippines is promoting trade hub digitalisation by combining its national ID (PhilSys) with signature verification functions and the Government Public Key Infrastructure (PNPKI).

TradeNet (NSW) integrates domains under the Bureau of Customs (BOC) and all the stages such as application, attachment, and receipt are based on electronic signatures issued and verified by PNPKI.

In practice, NSW/ASW operations rely on SSO integration with e-Gov PH (a unified government service app), institutional ID-based login/authentication, and PNPKI-based electronic signatures to ensure document authenticity.

PhilSys's QR signature verification function (PhilSys Check) is expected to streamline identity verification at service counters, warehouses, and financial services, ensuring authenticity in multi-party document exchanges involving brokers and shippers.

As a result, the integration of electronic signatures (PNPKI), e-ID/authentication (PhilSys×SSO), and NSW/ASW electronic exchange ensures the authenticity, integrity, and delivery of supply chain documents.

(2) Challenges

Although the electronic authentication infrastructure based on PhilSys and PNPKI is being developed, traditional business practices centred on handwritten signatures remain deeply entrenched in the trade sector, limiting the widespread adoption of electronic signatures. While Department of Information and Communications Technology (DICT) has established external usage guidelines, challenges persist in achieving broad integration into workflows and raising awareness amongst private companies and local governments. Moreover, although technical components such as SSO APIs and PhilSys Check are being introduced, additional technical integration is required to ensure consistent operation with NSW/TradeNet.

The DPA sets relatively detailed requirements for personal data processing and cross-border transfers, but differences in the maturity of data protection laws and cross-border transfer rules exist amongst ASEAN countries, and consent acquisition, record-keeping methods, and technical implementation are not standardised. Furthermore, mechanisms for organising and mutually recognising assurance levels (LoA) for electronic signatures and digital IDs within a common regional framework are still under development, making technical and legal mapping to align the Philippines' schemes with those of other countries a future challenge in cross-border electronic transactions.

Although digitalisation using PNPKI and SSO APIs is progressing, implementation and operation require a certain level of technical knowledge and internal resources. Many SMEs face constraints in IT personnel and cybersecurity capabilities, making tasks such as applying for and renewing PNPKI certificates, designing signature workflows, and configuring API integration with NSW/TradeNet relatively burdensome. Crucially, the Philippines' unique reliance on the VASP model imposes a specific financial burden: transaction fees. Unlike direct-to-government systems in some other ASEAN nations, Philippine SMEs must often pay per-transaction fees to private middleware providers to access customs systems. This cumulative cost barrier further discourages smaller players from fully digitising their trade workflows.

6. Viet Nam

PILLAR 1: Domestic Process Efficiency

Criteria 1-1. Digital Infrastructure Readiness

(1) Current State

Under the National Digital Strategy (2025), the Vietnamese government is comprehensively promoting digital transformation through the development of ICT infrastructure, the cultivation of digital talent, and the enhancement of cybersecurity. Notably, data localisation regulations require foreign enterprises to establish data centres within Viet Nam, which has become a key factor in attracting foreign investment.

Regarding 5G, nationwide deployment is being carried out under the Digital Viet Nam 2030 strategy. Pilot operations began in 2020 in major cities such as Hanoi, Ho Chi Minh City, and Da Nang, and by 2023, leading telecom operators including Viettel, VNPT, and Mobifone had launched limited commercial 5G services. In 2024, a 5G frequency auction was conducted, and the government aims to achieve over 70% population coverage by 2025.

Cloud services play a central role in the National Digital Transformation Program (2025). The government is actively promoting cloud-first approach for public agencies, and as of 2023, approximately 60% of central ministries and agencies had adopted cloud-based systems. In the private sector, domestic providers such as FPT, CMC, and VNG Cloud are joined by global players like AWS, Microsoft Azure, and Google Cloud, with cloud adoption particularly advancing in the finance, manufacturing, and e-commerce sectors.

The data centre market is also experiencing rapid growth. In 2023, the market was estimated at US$500 million, with projections indicating a compound annual growth rate (CAGR) of over 12% through 2028. Major domestic players include FPT Telecom, VNPT, and CMC Telecom, with facilities concentrated in Ho Chi Minh City and Hanoi. In 2023, foreign investors such as NTT, ST Telemedia, and Gaw Capital announced new investments, contributing to the construction of Tier III or higher reliability facilities.

It is worth noting that Viet Nam is not included in the IMD World Digital Competitiveness Ranking 2024,[52] which evaluates and compares countries' capabilities and readiness in adopting and utilising digital technologies across economic and social sectors.

(2) Challenges

Despite these developments, regulatory ambiguity and complex administrative procedures continue to pose barriers to foreign investment. There is also a significant digital infrastructure gap between urban and rural areas, with 5G base station deployment lagging in rural regions and limited access to cloud and data centre services. Furthermore, the rapid expansion of data centres faces sustainability constraints. Ensuring a stable power supply remains a challenge, with reliance on fossil fuels and seasonal power shortages posing potential risks to the continuous operation of hyperscale facilities.

Moreover, small and medium-sized enterprises (SMEs) face challenges such as insufficient funding and a shortage of digital talent. To address these issues, the government is expected to expand support measures, including subsidies and training programmes, to promote digital adoption amongst SMEs.

[52] IMD, IMD World Digital Competitiveness Ranking 2024.

In interviews, Vietnamese stakeholders noted that the country's roughly 20 container terminal operators, including several joint ventures with foreign firms, use diverse IT systems at different stages of development. This fragmentation limits the ability to achieve consistent and fully integrated digitalisation across terminals.

Criteria 1-2. Digital Format Readiness

(1) Current State

Viet Nam has been advancing the digitalisation of trade-related documents across institutional, infrastructural, and operational dimensions. However, according to the UN Global Survey on Digital and Sustainable Trade Facilitation, Viet Nam scored 77.78% in 'Paperless Trade',[53] indicating that both domestic and cross-border digitalisation are still in progress compared to other major ASEAN countries.

By document type:

Commercial invoices: The General Department of Taxation (GDT) mandated e-invoicing for all taxpayers starting 1 July 2022. Since then, the system has become well established through updated operational guidance. As of 2025, the principle of nationwide mandatory implementation has been reaffirmed, and adoption by businesses appears to be progressing.

Certificates of origin: All ASEAN Member States, including Viet Nam, have implemented electronic transmission and receipt of ATIGA e-Form D, with paper-based Form D no longer accepted in principle. This has facilitated the digitalisation of origin procedures in Viet Nam's intra-ASEAN trade.

Customs declarations: The VNACCS/VCIS system, operational since 2014, is used by customs offices nationwide. Through the Viet Nam National Single Window (VNSW), electronic submission of applications and supporting documents has become a routine process.

Packing lists: Electronic submission and attachment of packing lists as supporting documents through VNSW and electronic customs declarations have been standardised. In principle, the infrastructure allows for full electronic handling, although printed copies may still be used in some operational settings.

Phytosanitary certificates (e-Phyto): Viet Nam's National Plant Protection Organization (NPPO) is integrated into the IPPC e-Phyto Hub framework. Preparations for electronic exchanges via the Hub are progressing, and a national workshop was held in 2025 to promote domestic implementation and adoption.[54] While differences in implementation remain depending on partner countries and commodities, the institutional and technical foundations are in place.

Bills of lading (e-BLs): As Viet Nam has not yet adopted domestic legislation aligned with the Model Law on Electronic Transferable Records (MLETR), the legal and institutional framework for recognising e-BLs as transferable documents remains incomplete. As a result, current implementation largely depends on the adoption status of counterparties and platforms.

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[53] UN, Global Survey on Digital and Sustainable Trade Facilitation.

[54] APAARI Press Release.

Document map findings (Appendices 6): In Viet Nam's domestic procedures for both imports and exports, customs declarations are digitalised through e-Customs for shipments routed through the yellow lane, whereas shipments routed through the red lane still require the submission of physical documents. Other key documents exchanged between forwarders and customs such as commercial invoices, certificates of origin, packing lists, and bills of lading can be submitted electronically by attaching files to the customs system for yellow lane shipments, but physical copies remain mandatory for red Lane shipments. For exports, it has been noted that commercial invoices and packing lists are still required in paper form for submission to customs.

In summary, customs declarations, certificates of origin, and e-invoicing have reached a level of near full digitalisation in both institutional and operational terms or are supported by well-developed infrastructure. On the other hand, e-Phyto implementation is progressing through preparations for international hub connectivity but practical use remains dependent on the readiness of partner countries and the scope of commodities covered. E-BLs lack legal equivalence due to the absence of MLETR-aligned legislation. For further enhancing the implementation of the documents, the focus should be on strengthening e-Phyto interoperability by enhancing implementation design (e.g. ID linkage, data vocabulary, API standards) and establishing a legal framework for e-BLs to achieve full cross-border digitalisation of trade documents.

(2) Challenges

While Viet Nam has achieved near-complete digitalisation of key trade documents through VNACCS/VCIS, VNSW, ATIGA e-Form D, and the nationwide implementation of e-Invoicing, the following challenges remain:

Packing lists are increasingly submitted electronically, but printed copies are still used in some operational settings.

e-Phyto is progressing in terms of framework development and promotion, but operational differences remain depending on partner countries and commodities.

e-BLs have not yet been supported by MLETR-aligned legislation, and legal certainty for international transfer of rights is not yet established.

Criteria 1-3. Presence of National Single Window (NSW)

(1) Current State

Viet Nam's NSW is the Viet Nam National Single Window (VNSW), through which businesses submit export/import declarations and related documents via a single portal, with automated processing. The official TFA description mentions integration of 13 ministries and 174 procedures, with 30,900 companies and 2.3 million transactions processed.

The system is operated by the General Department of Customs (Ministry of Finance), which also serves as the secretariat of the national NSW steering committee. The VNTR (Viet Nam National Trade Repository), operated by the Ministry of Industry and Trade, highlights the online implementation of 188 procedures across 13 ministries, and VNACCS supports customs automation in coordination with VNSW.

Viet Nam notified its Single Window (Article 10.4.3) as a Category C commitment,

implemented on 31 December 2021, indicating a phased development. Domestically, VNSW consolidates Customs Licensing Procedures applications, customs declarations, and support services into a single portal. According to VNTR, nearly all customs licensing procedures and customs procedures can be submitted and paid online. Regionally, Viet Nam participates in ATIGA e-Form D exchange via ASW.

The UN Digital & Sustainable Trade Facilitation Survey rated Viet Nam 77.42% overall, with 86.67% in transparency, 75% in procedural simplification, 77.78% in institutional cooperation, and 77.78% in paperless trade.[55]

(2) Challenges

Viet Nam's VNSW integrates 13 ministries and 174 procedures, approaching the ideal state for domestic digitalisation. However, discrepancies exist between the number of procedures listed in VNTR (188) and VNSW (174), requiring clarification and improved update management. The Institutional Arrangement & Cooperation score (77.78%) suggests the need for standardised governance documentation and decision-making processes.

Support for SMEs and regional businesses is also limited, and mechanisms for user education and cost assistance should be introduced to promote broader adoption.

Additionally, while core declarations are digitised, exception processes such as customs refunds, appeals, and the management of financial guarantees often remain undigitised, preventing full end-to-end automated workflows.

In conclusion, Viet Nam has reached the 'established and operational' level for domestic digital integration, but harmonisation of procedural coverage between VNTR and TFA documentation remain key challenges.

PILLAR 2: Seamless Cross-border Connectivity and Interoperability

Criteria 2-1. Technical Interoperability

(1) Current State

Viet Nam operates its NSW centred on the VNACCS/VCIS system, officially connected to ASW. Integration of airport and seaport systems, including VASSCM, is progressing. The country is building a national-level paperless trade infrastructure and has implemented ASW/NSW connectivity in compliance with the WCO Data Model. In addition, Viet Nam's VNSW stipulates that, to share and integrate specialised data from ministries and sectors with localities, state agencies shall publish open data in accordance with the law, and most of the master data shall be stored in machine-readable format and shared as an API service. However, compared to regional leaders, this API framework is currently more focused on internal G2G integration (emerging stage) rather than a fully mature, open developer governance model for the private sector.

The enactment of Decree 70/2025/ND-CP in June 2025 significantly strengthened the e-Invoice regime. The decree mandates real-time integration with Point of Sale (POS) systems and foreign enterprises, enabling immediate data transmission to the General Department of Taxation (GDT). Foreign entities engaged in e-commerce and cloud services are also required to issue digitally signed e-Invoices. The system is based on XML format

[55] UN, Global Survey on Digital and Sustainable Trade Facilitation.

and incorporates standardised vocabularies and classification schemes, supporting technical interoperability.

(2) Challenges

Viet Nam's trade facilitation framework is anchored in the National Single Window (VNSW), which is connected to the ASW technical architecture and complies with ASW specifications for cross-border data exchange. Through this connection, Viet Nam participates in the electronic exchange of documents such as the ATIGA e-Form D and the ASEAN Customs Declaration Document (ACDD) and is preparing for the wider deployment of e-Phyto certificates. By operating within this shared digital framework, the VNSW portal supports coordination amongst domestic agencies involved in border procedures and contributes to more transparent and efficient regulatory processing.

Domestically, Viet Nam operates an integrated national platform centred on the customs system (VNACCS/VCIS) and has implemented nationwide electronic invoicing in accordance with Ministry of Finance regulations. These foundations provide unified rules for data generation, submission and verification across tax authorities, enterprises and accredited service providers, helping ensure consistency and compliance throughout the system.

Regarding electronic bills of lading (e-BL), Viet Nam is connected indirectly to global digital shipping ecosystems rather than through its national platforms. Ports such as Cai Mep International Terminal (CMIT) have joined blockchain-based platforms like TradeLens, enabling digital exchange of shipping data with overseas stakeholders. However, these e-BL transactions occur within platform-specific environments. As a result, customs and other border agencies do not yet have a standardised way to automatically consume e-BL data from these platforms, requiring additional bilateral or manual integration, which constrains seamless cross-border interoperability.

Furthermore, VNACCS/VCIS itself has experienced system disruptions, revealing limitations in system reliability and exception handling. In August 2024, Viet Nam Customs temporarily suspended VNACCS/VCIS due to technical issues, and even after restoration, slow performance reportedly persisted. During this period, the General Department of Customs issued Official Letter No. 3748/TCHQ-GSQL to provincial and municipal customs offices, outlining contingency procedures for handling export and import declarations during system outages, and instructed 24-hour operations to prevent interruptions in clearance processes.

Also, interviews with authorities revealed that the absence of synchronised information exchange mechanisms between customs and domestic/foreign agencies continues to necessitate manual verification processes between customs and licensing authorities. The authority's concern is that lack of such interoperability not only prolongs clearance procedures but also undermines efforts toward full digital integration.

Criteria 2-2. Organisational Interoperability

(1) Current State

Viet Nam has established a strong institutional governance centred on customs. Coordination is undertaken by the National Steering Committee on ASEAN Single Window, National Single Window and Trade Facilitation, established under Decision No. 1899/QD-

TTg. Under this mechanism, the General Department of Customs represents Viet Nam in regional ASWSC meetings and works with ASEAN partners on ASW-related messaging and implementation. Other ministries, including the Ministry of Industry and Trade, Ministry of Agriculture and Rural Development and Ministry of Transport, participate in line with their respective regulatory mandates related to trade, agriculture, and transport procedures that interface with the NSW.

(2) Challenges

Viet Nam's centralised policies, such as VNACCS/VCIS and mandatory e-invoicing, provide a strong foundation for inter-organisational collaboration. However, interviews with Vietnamese authorities indicate that a lack of synchronised information exchange mechanisms between customs and both domestic and foreign agencies still requires manual checking between customs and licensing authorities, illustrating a gap between policy frameworks and operational reality. The challenge lies in ensuring accurate and consistent compliance with these common policies across a wide range of domestic companies, foreign businesses, and Point of Sale (POS) system providers. The broad scope of policy application requires detailed monitoring and continuous coordination, which imposes significant organisational and technical burdens.

Furthermore, barriers such as the time-consuming nature of consensus-based decision-making for ASW integration have long been pointed out. In Viet Nam, the gradual connection of additional ministerial procedures to the VNSW under Committee 1899 illustrates how domestic alignment is still ongoing, and the coexistence of VNACCS/VCIS with various ministry-specific systems requires continued harmonisation. These national-level processes, together with ASEAN-level consensus requirements, can influence the pace at which Viet Nam adopts new ASW functionalities.

Criteria 2-3. Legal Interoperability

(1) Current State

MLETR has not been adopted, and the handling of e-BLs often depends on the legal framework of counterpart countries. Cross-border data transfers are governed by Decree 13 (2023), which requires impact assessments and prior submissions to authorities. BCRs are generally considered inapplicable because contracts alone cannot fulfil all procedural requirements. Therefore, the operational burden remains relatively high.

(2) Challenges

Viet Nam has not adopted MLETR, and the handling of electronic transferable records still depends on the legal systems of counterpart countries. Regarding cross-border data transfers, Decree 13 imposes strict pre-transfer procedures, and Binding Corporate Rules (BCRs) are generally considered inapplicable. As a result, contractual arrangements alone are insufficient to complete the necessary procedures, leading to relatively high operational burdens.

In practice, however, these requirements are particularly demanding for smaller firms. Domestic reporting notes that, although Viet Nam has issued Decree No. 13/2023/ND-CP on personal data protection, implementation remains challenging and many small and medium-sized enterprises still lack the understanding and resources needed to ensure compliance, especially with respect to cross-border data management and local-server

obligations.

Moreover, Viet Nam is not currently listed amongst the economies participating in the APEC CBPR System or as a member jurisdiction of the Global CBPR Forum. As a result, Vietnamese organisations cannot rely on CBPR-type mutual-recognition certifications when transferring personal data internationally and must instead navigate a more fragmented set of bilateral and jurisdiction-specific rules, which can increase the complexity and cost of cross-border compliance for SMEs engaged in digital trade.

Regarding the DFFT, recent regulatory developments in Viet Nam continue to reflect a 'restricted flow with safeguards' approach rather than a DFFT-style open framework. Decree No. 13/2023/ND-CP on Personal Data Protection introduces stringent requirements for cross-border data transfers, including mandatory impact assessments and notification to the Ministry of Public Security before transfers may occur.

Viet Nam's cybersecurity regime, particularly the Law on Cybersecurity and Decree 53, introduces data localisation and domestic-storage obligations for certain categories of important data and for enterprises that meet defined conditions.

With regards to cross-border data flow, Vietnamese and Japanese experts have begun exploring whether engagement with initiatives such as Data Free Flow with Trust could help Viet Nam align elements of its data-governance framework with emerging international standards and ease frictions in cross-border data transfers.

PILLAR 3: End-to-end Unit-level Traceability and Resilience

Criteria 3-1. Real-time Cargo Tracking

(1) Current State

Viet Nam is making progress in implementing smart port technologies, such as Differential GPS (DGPS), IoT, and electronic seals (e-Seals), at major ports including Hai Phong, Cai Mep, and Ho Chi Minh City. These efforts are improving port management and cargo handling efficiency. However, a nationwide real-time tracking system that integrates cargo and documentation using GPS and QR codes has yet to be established, indicating a gap from the ideal state.

Since 2017, the Ministry of Finance and Viet Nam Customs have been deploying the Viet Nam Automated System for Seaport Customs Management (VASSCM) to automate port customs management. This system has been rolled out to major ports, airports, and bonded warehouses, and is integrated with the National Single Window (NSW) and the VNACCS/VCIS system. It enables customs authorities to monitor cargo entry, exit, and inventory records at ports and warehouses. According to authorities, nationwide deployment was largely completed by 2019.

On the private sector side, Saigon Newport Corporation (SNP), Viet Nam's largest port operator, offers an online platform (e-Port) that allows users to check container numbers, seal numbers, customs clearance status (HQGS), and cargo readiness, thereby enhancing operational visibility.

According to the World Bank's Logistics Performance Index, Viet Nam scored 3.4 on the

Timeliness indicator, slightly above the global average of 3.2.[56]

(2) Challenges

API specifications and event vocabularies for real-time tracking data remain unstandardised. Dynamic data integration between VNSW and the ASEAN Single Window (ASW) is still in the institutional design phase. Additionally, there are disparities in the development of technical infrastructure such as IoT and RFID infrastructure between major ports and inland areas. To achieve nationwide visibility and cross-border interoperability, both technical capacity and human resource development need to be strengthened.

Building on these challenges, the management of unit-level data across the supply chain still needs further refinement. International standards exist, but customs authorities, port operators, and logistics providers continue to use product numbers, serial identifiers, and event definitions in different ways. These inconsistencies complicate API integration with VNSW systems. At a more fundamental level, tracking continues to focus on the container rather than the product. A shift toward a product centric approach that incorporates unit or serial number-level data is necessary to achieve seamless end-to-end visibility.

Moreover, the adoption of real-time tracking technologies imposes significant demands on SMEs. The acquisition of IoT devices, GPS-based trackers, and data-management systems requires upfront investment, and the technical capacity needed to comply with standardised data formats and integration requirements varies widely across firms. As a result, SMEs may not fully benefit from digital automation, contributing to a widening digital gap within the logistics sector. Although government-led capacity-building initiatives exist, their coverage and depth of impact remain limited at the current stage.

Criteria 3-2. Management Capability for Tracking Data

(1) Current State

Viet Nam has advanced the digitisation and standardisation of transaction data through nationwide mandatory e-invoicing since July 2022, necessary for linking commercial data to logistics and transportation data. It has also expanded the use of e-Manifests and strengthened the functionality of VNSW, while promoting smart port and smart border policies. These efforts have yielded progress in customs process digitalisation and procedural efficiency. However, unit-level event integration and cross-border end-to-end tracking are still in the early stages of operational adoption.

The advancement of digital trade infrastructure in Viet Nam is strongly supported by collaborative efforts between the government and the private sector. While government agencies such as the General Department of Taxation (GDT) and Customs establish institutional frameworks and regulatory structures, the private sector plays a critical role in operational implementation and technology provision. For example, although the Viet Nam National Single Window (VNSW) is a government system led by Customs, its operational improvements involve joint initiatives with the Viet Nam Chamber of Commerce and Industry (VCCI) and the USAID Trade Facilitation Program to conduct business satisfaction surveys and identify challenges, fostering cooperation between

[56] World Bank Logistics Performance Index.

Customs and the business community.

(2) Challenges

Many small and medium enterprises and smaller regional logistics firms still lack reliable digital infrastructure, financing, and technical skills, which slows uptake of new systems. The country's port landscape includes multiple terminal operators running heterogeneous IT systems, complicating seamless data exchange and terminal-level integration. Together, these factors limit the network effects of national initiatives and point to a need for targeted investments in connectivity, skills training, and system integration to achieve end-to-end unit-level traceability.

Moving forward, joint institutionalisation of SOPs and SLAs by public and private sectors is necessary, including clear procedures for contingency and recovery, especially for SMEs. Establishing robust data quality and compliance frameworks will be critical to enhancing the continuity and granularity of tracking information, thereby improving the reliability of international visibility.

Criteria 3-3. Supply Chain Diversification: Overview of Trade Structure

Viet Nam is diversifying its supply chains, with record-high exports in 2024 led by the U.S., China, and other key markets. However, exports remain concentrated in electronic components.

Imports are also rising, with heavy reliance on Chinese electronics posing risks.

Viet Nam actively engages in over 15 FTAs, including CPTPP, RCEP, and EVFTA, with about 73% of trade[57] conducted under these agreements – supporting institutional efforts to expand market access.

In terms of supply chain diversification, the following characteristics are notable:

- Viet Nam's exports are highly concentrated in four key products, especially electronic components to the U.S., raising concerns about external demand vulnerability.
- Imports rely heavily on Chinese electronics, posing supply risks.
- FTA usage shows regional disparities, with low participation from SMEs and rural businesses.

Viet Nam's heavy reliance on imports of electronic equipment from specific country or region implies that its digital trade infrastructure such as the Viet Nam National Single Window (VNSW) and electronic manifest (e-Manifest) is exposed to a high level of geographic concentration risk. If there were to unilaterally tighten cross-border data management regulations or customs procedures related to electronic components, this could cause severe delays and cost increases in the flow of essential manufacturing inputs, potentially disrupting Viet Nam's production ecosystem despite advances in domestic digitalisation.

At the same time, the high concentration of exports and imports in electronic components and products escalates the industrial concentration risk for digital systems. Therefore, digitalisation efforts must shift their focus beyond basic efficiency improvements toward

[57] JETRO, Trade and Investment Report of Viet Nam (2023).

proactive risk management. This requires digital platforms to maintain high agility and adaptability to rapidly integrate new global standards and comply with sudden changes in export controls on dual-use technologies.

PILLAR 4: Trustworthy and Secure Infrastructure

Criteria 4-1. Cybersecurity Legal Framework

(1) Current State

In Viet Nam, the Law on E-Transactions (ETL 2023), the general law for electronic transactions, and Decree 130/2018, underpin the reliability and mutual recognition of electronic signatures. However, Viet Nam's development of its cybersecurity legal framework remains partial and incomplete, and the country is classified as Tier 4 (lower group) in the ITU Global Cybersecurity Index.

While the current legal system provides basic frameworks for personal data protection and information security, a comprehensive cybersecurity law has not yet been enacted.

Legal provisions concerning the protection of Critical Information Infrastructure (CII), audit obligations, and incident-reporting mechanisms remain unclear or insufficiently defined.

(2) Challenges

Viet Nam has regulated information security and cyberspace management through the Law on Cyberinformation Security (2015) and the Law on Cybersecurity (2018). However, this dual structure has led to overlapping and conflicting definitions and obligations, creating compliance challenges for businesses. In response, the Ministry of Public Security (MPS) has published a draft of the 2025 Cybersecurity Law, aiming to integrate the existing 2018 and 2015 laws and unify obligations and enforcement mechanisms related to data protection, CII management, and cybercrime prevention. The draft explicitly states that its main purpose is 'to eliminate overlaps and contradictions between the two existing laws and ensure consistency in definitions, obligations, and enforcement.'

Nevertheless, the new law remains in draft form. While it centralises authority under Ministry of Public Security, details on audit and incident reporting obligations for the private sector, and alignment with data laws and personal data protection regulations, will need to be clarified through future decrees and ministerial regulations.

Currently, although frameworks for CII protection and incident response exist, overlapping laws and unclear enforcement structures leave institutional gaps that prevent the government from achieving the ideal of 'integrated operation of strategy, standards, auditing, and response under a unified law.'

Regarding the incident reporting protocol, Viet Nam's incident reporting protocol shows institutional progress compared to some other countries, but the complicated inter-ministerial structure has hindered the centralisation of incident reporting channels. Decree 13 introduced a mandatory 72-hour notification requirement for personal data breaches, and the country is transitioning toward a comprehensive data protection regime under the forthcoming PDPL (Personal Data Protection Law). Concurrently, the Cybersecurity Law and its implementing Decrees establish obligations for critical information system operators. However, in practice, the reporting system is multi-layered and complex, involving the Ministry of Public Security (MPS), the Ministry of Information

and Communications (MIC), and sectoral regulators. For companies utilising the VNSW (Viet Nam National Single Window), e-Manifests, and cross-border cloud services, it remains difficult to discern which incidents fall under the personal data protection regime, which require reporting under the cybersecurity legislation, and how to avoid duplicate or inconsistent notifications.

Criteria 4-2. Governmental/Public Organisation Responsible for Ensuring Data Security

(1) Current State

Public agencies for data security in Viet Nam include the Ministry of Public Security (MPS), which, based on the Cybersecurity Law enacted in 2019, holds regulatory and enforcement authority prioritising data sovereignty and national security, overseeing data management including cross-border data flow.

The Ministry of Information and Communications (MIC) drives digital transformation programmes and technical guidance. Under the Ministry of Information and Communications, the Authority of Information Security (AIS) is responsible for formulating and implementing cybersecurity policies, incident response, and awareness campaigns in Viet Nam.

Although an Incident Response Team (CIRT) exists under the Ministry of Public Security, there are challenges in terms of coordination with the private sector and immediate responsiveness, with a particular need to strengthen sector-specific response capabilities.

Moreover, supervisory authority over personal data protection is primarily centralised within the Ministry of Public Security (MPS), particularly the Cybersecurity and High-Tech Crime Prevention Department (A05). Under the framework of the Personal Data Protection Decree (PDPD) and the new Personal Data Protection Law (PDPL), A05 is designated as the main enforcement and oversight body, responsible for receiving reports of data protection violations, conducting investigations, and applying sanctions. Consequently, for companies using digital platforms such as VNSW, MPS/A05 serves as the primary reporting and supervisory authority in cases of personal data breaches. However, depending on the specific circumstances, coordination with the Ministry of Information and Communications and sectoral regulators may also be required.

Furthermore, for the inclusion of SMEs, access to the Authorized Economic Operator (AEO) system and NSW are either planned or unimplemented, and due to insufficient educational and support systems, the security standards across the supply chain are inconsistent.

Viet Nam is ranked in Tier 1 in the ITU's Global Cybersecurity Index 2024,[58] achieving the maximum score of 20 for the organisational measure pillar.

(2) Challenges

To promote Viet Nam's digital trade, it is essential to eliminate siloed structures amongst organisations. Domestically, authority is divided between the Ministry of Public Security (MPS) for security and the Ministry of Information and Communications for the digital economy, resulting in regulatory requirements being spread across multiple laws and agencies. Such fragmented frameworks make it difficult to ensure consistency in

[58] ITU, Global Cybersecurity Index 2024.

regulatory implementation, and foreign-invested enterprises have pointed out that it is unclear which rules apply to them and how. From this perspective, there is an expectation for organisational adjustment to realise a consistent regulatory policy that balances the national security priority enforced by the Ministry of Public Security and the promotion of the digital economy driven by the Ministry of Information and Communications.

Furthermore, the organisations are required to enhance the transparency of the decision-making process and standards regarding the application of data regulations (e.g. data localisation) to foreign-invested enterprises.

Criteria 4-3. Appropriate Cybersecurity Environment and Operational Status

(1) Current State

Viet Nam is accelerating the digitalisation of trade procedures, driven by the amended Electronic Transactions Law and the rollout of the national digital ID (VNeID). On the Viet Nam National Single Window (VNSW), key processes such as certificates of origin (C/O), licensing applications, and customs declarations are integrated, with authenticity, integrity, and non-repudiation ensured through electronic signatures using digital certificates issued by PCSPs (licensed public certification service providers). These e-signature schemes, together with the mandatory use of e-invoices, form the foundation for real-time verification and traceability of tax and trade data.

Furthermore, high-assurance-level electronic authentication leveraging VNeID is being widely introduced into administrative procedures, and stronger identity assurance and integrated authentication are expected to advance in online application processes for trade-related stakeholders. This is fostering a three-layered structure which are legal frameworks (Electronic Transactions Law and related decrees), trust infrastructure (VNeID and the national root CA), and operational systems (VNSW–ASW) that supports paperless workflows and enhanced auditability in major trade processes.

However, challenges remain in developing cross-cutting operational standards such as common APIs for consent and authorisation, log formats, and audit guidelines, as well as in establishing a unified framework for explaining and mutually recognising assurance levels (LoA) for electronic signatures and digital IDs across borders. Progress in these institutional and technical areas would enable VNSW to function as a regional (ASW) and international interoperability hub, further promoting supply chain throughput and compliance optimisation.

(2) Challenges

Viet Nam's Personal Data Protection Law (PDPL) establishes a relatively strict personal data protection regime, recognising consent as one of the primary legal bases while allowing certain other grounds in specific cases. On the other hand, within ASEAN, the maturity of data protection laws and cross-border transfer rules varies, and although common frameworks such as ASEAN MCCs exist, it is difficult to say that consent acquisition, record-keeping methods, and technical implementation for cross-border data flows are uniformly standardised. These differences can complicate compliance design across national legal systems for personal data, such as contact person information, that may be included in trade tracking data shared via platforms like VNSW, creating practical hurdles to seamless supply chain integration.

While digital authentication and e-signature schemes based on VNeID and licensed electronic signature providers are being developed, ASEAN as a whole is still in the process of establishing mechanisms to organise and mutually recognise assurance levels (LoA) for electronic signatures and digital IDs under a common framework. Consequently, when cross-border use of electronic trade and financial documents becomes more widespread in the future, technical and legal mapping and consensus-building on how to align Viet Nam's e-signature and ID schemes with those of major trading partners will likely become a critical issue.

Furthermore, a specific burden for Vietnamese SMEs is the widespread reliance on hardware USB tokens for digital signatures. Unlike cloud-based signing, the cost of purchasing, managing, and physically securing these hard tokens for every authorised staff member creates a logistical and financial barrier to entry for smaller firms.

Appendix 6. Document Map

Table A5. Step-by-Step Process of Singapore's Import Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Foreign seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP system
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4	Origin port (after loading on ship) / In transit	Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	D	D: Forwarder's system / Carrier portal
5		Arranging with forwarder	Buyer	Forwarder	Booking Request	D	D: Forwarder's platform
6		Confirmation with forwarder	Forwarder	Buyer	Booking confirmation	D	
7	In transit	Pre-arrival notice	Shipping company	PSA Port Operator/ Customs	Manifest, vessel schedule	D	D: PSA Portnet (linked with TradeNet)
8		Request for vessel berthing	Shipping company	PSA Port Operator/ Customs	Vessel particulars, cargo manifest	D	D: PSA Portnet
9	Destination port	Arrival notice	Shipping company	Forwarder	Notice of arrival	D	D: Available through shipping company's system

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
10		Import permit application	Forwarder	Customs	Permit application + supporting docs	D	D: TradeNet / NTP
11		Import declaration and duties payment	Forwarder	Customs	Import declaration form, CI, PL, MBoL, CoO	D	D: TradeNet
12		Customs release	Customs	Forwarder	Permit approval / release note	D	D: TradeNet
13		Unloading of goods from ship to yard	PSA Port	Forwarder	Discharge list, EIR (Equipment Interchange Receipt)	D	D: PSA Portnet
14		Delivery order issuance	Shipping company	Forwarder	Delivery Order (DO)	D	Carrier system / e-DO platforms (e.g. CargoSmart)
15		Haulage booking	Forwarder	Haulier	Container slip, DO	D	Haulier's ERP / NTP logistics service modules
16		Gate pass application	Forwarder	PSA Port	Gate pass application	D	D: PSA Portnet
17		Gate pass issuance	PSA Port	Forwarder. Haulier	e-gate pass	D	D: PSA Portnet
18	Destination port – Customs	Customs inspection and release of goods	Customs	Forwarder	Permit, DO, CI, PL	P/D	D:TradeNet (electronic pre-check) + on-site inspection
19	Buyer's door	Final delivery	Haulier	Buyer	Delivery receipt	P/D	Paper or Haulier's e-POD system
20		Freight settlement	Forwarder	Buyer	Freight invoice	E/D	E: Email D: Forwarder's system

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official)
Source: Developed by Authors using public information and interviews.

Table A6. Step-by-Step Process of Singapore's Export Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP system
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4		Arranging with forwarder	Seller	Forwarder	Shipping details for quotation	D	D: Forwarder's booking platform
5			Forwarder	Buyer	Quotation document	D	D: Forwarder's system
7		Confirmation with forwarder	Buyer	Forwarder	Booking request and confirmation	D	D: Forwarder's system
8		Arranging with shipping company & haulier	Forwarder	Shipping company	Shipping Instructions (SI)	D	D: Shipping company's system
10			Shipping company	Forwarder	Empty container release order	D	D: PSA Portnet / Carrier system
11		Application for export permit	Custom	Forwarder	Export permit application + supporting docs (CI, PL, contracts)	D	D: TradeNet / NTP
13		Export declaration and duties payment	Forwarder	Custom	Export declaration + supporting docs	D	D: TradeNet (linked with e-payment gateway)
17		Container pickup	Forwarder	Haulier / PSA Port	Gate pass application for empty container pickup	D	D: PSA Portnet
18		Gate pass insurance	PSA Port	Forwarder/ Haulier	E gate pass	D	D: PSA Portnet

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
19	Port yard	Container in-gate & stuffing	Forwarder/ Haulier	PSA Port	Equipment Interchange Receipt (EIR), gate pass	D	D: PSA Portnet
20		Customs inspection	Customs	Forwarder	Export permit, CI, PL	P/D	D: TradeNet (pre-check) + on-site if flagged
21	Origin port	Loading of container to vessel	PAS Port / Shipping company	Forwarder	Loading confirmation, readiness notice	D	D: PSA Portnet / Carrier system
22		Issuance of transport documents	Shipping company	Forwarder	Master Bill of Lading (MBoL), House Bill of Lading (HBoL)	D	D: Shipping company system (e-BoL) / Forwarder's ERP
23		Submission of export manifest	Forwarder / Shipping company	Customs	Export manifest	D	D: TradeNet
24	In transit	Ship departure notification	Shipping company	Customs / Port Authority	Departure Notice	D	D: PSA Portnet / TradeNet
25	Post-departure	Preferential Certificate of Origin (if required)	Forwarder	Enterprise Singapore / Customs	PCoO application + CI, PL, BoL	D	D: NTP e-CO system (E-SC / TradeNet)
26		PCoO issuance	Enterprise Singapore	Forwarder	Digital Certificate of Origin (e-CO)	D	D: NTP e-CO
27	Seller's door	Order confirmation	Seller	Buyer	CI, PL, BoL, PCoO (if applicable)	D	D: ERP integration / Forwarder's system

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official)
Source: Developed by Authors using public information and interviews.

Table A7. Step-by-Step Process of Malaysia's Import Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Foreign seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP system with e-tendering function
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4	Origin port (after loading on ship) / In transit	Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	P (HBoL) /E/D	E: Email D: API integration between seller's & buyer's ERP systems (CI, PL, DO, PCoO), forwarder's system that issues eHBoL
5	In transit	Arranging with forwarder	Buyer	Forwarder	Key details for quotation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
6			Forwarder	Buyer	Quotation document	E/D	
7			Buyer	Forwarder	Booking Request	E/D	E: Email D: Forwarder's system
8		Confirmation with forwarder	Forwarder	Buyer	Booking confirmation	E/D	
9			Buyer	Forwarder	Documents from buyer (e.g. CI, PL)	E	Email/Attachments through forwarder's system
					HBoL	P/D	D: eHBoL through forwarder's system
					Seller's forwarder details	E/D	E: Email D: Forwarder's system
10		Requesting for MBoL from seller's	Forwarder	Forwarder	Booking confirmation and relevant supporting documents	E	Email

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
		forwarder					
11		Sending of MBoL	Forwarder	Forwarder	MBoL	M/D	D: eMBoL through shipping company's system
12		Pre-arrival notice	Shipping company	Customs	Notification of vessel to enter the port city, manifest, container list	E/D	E: Attachments through Malaysia NSW (eManifest) D: Submit as e-form through Malaysia NSW (eManifest)
13			Customs	Shipping company	Ship arrival report number	D	Notification through Malaysia NSW
14		Request for vessel berthing	Shipping company	Port operator	Ship schedule, ship particulars, ship profile, application for vessel to enter the port area/arrival notice, inward container list, cargo manifest, pilot requirement form	E/D	E: Attachments through port's system (different port will have different systems depending on the port operator) D: Submit as e-form through port's system or Malaysia Maritime Single Window (MMSW)
15			Port operator	Shipping company	Acknowledgement receipt, berthing slot allocation, other relevant notifications	D	Electronic notification through port's system or MMSW
16			Shipping company	Port operator	Notification of vessel to enter the port city, manifest, container list	E/D	E: Attachment through port's system or MMSW D: Submit as e-form through port's system or MMSW
17			Port operator	Shipping company	Acknowledgement receipt	D	Electronic notification through MMSW
18		Application for relevant import	Forwarder	PIAs	Permit application form & supporting documents	P/E	E: Through Malaysia NSW (ePermit)

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
19		permit	PIAs	Forwarder	Import permit	P/E	E: Email
20	Destination port	Ship arrival	Shipping company	Forwarder	Notice of arrival	E/D	E: Email E/D: Available through shipping company's system
21		Import declaration (K1 form) and duties payment	Forwarder	Customs	Import declaration form (K1 form)	D	Submit as e-form through Malaysia NSW (eDeclare)
					HBoL, CI, PL, import license, CoO	E	Attachments through Malaysia NSW
22			Customs	Forwarder	Declaration and payment numbers	D	Electronic notification through Malaysia NSW
23			Forwarder	Customs	-	P/E	P: Payment at Customs Department E: Payment via Malaysia NSW (ePayment)
24			Customs	Forwarder	Payment receipt	E/D	E/D: Provided through Malaysia NSW
25		Unloading of goods from ship to yard	Shipping company	Port operator	Notification of goods transfer and loading containers	P/D	D: Electronic notification through port's system or MMSW
26			Port operator	Shipping company	Discharged report (Tally sheet), report of port use and services	P/E	E: Attachments through port's system or MMSW
27			Shipping company	Forwarder	Notice of readiness	P/E/D	E: Email E/D: Available through shipping company's system
28		Arranging for customs inspection and payment to Malaysia Port Authority /port operator	Forwarder	Shipping company	MBoL in exchange for shipping company's delivery order (SDO)	P/E	E: Exchange for SDO through shipping company's system
29			Shipping company	Forwarder	SDO, request for opening goods containers, request for release of goods containers from customs custody	P/E/D	E/D: Provided through shipping company's system

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
30			Forwarder	Port operator	SDO and related documents for payment to Malaysia Port Authority /port operator	P/D	P: Payment at port operator E: Payment via port's system
31			Port operator	Forwarder	Payment receipt, wharf receipt, delivery container slip after receiving payment	P/E/D	E/D: Provided through port's system or MMSW
32			Forwarder	Haulier	Key details for transportation arrangement, delivery container slip	E	Email
33			Forwarder	Port operator	Gate pass application form and relevant documents	P/E	E: Port's system
34			Port operator	Forwarder	Gate pass	P/E	E: Port's system
35			Forwarder	Haulier	Gate pass	P/E	E: Port's system
36			Forwarder	Port operator	Relevant documents for signing in preparation of customs inspection	P	
37	Destination port – Customs	Customs inspection and release of goods	Forwarder	Customs	Submission of relevant documents for release of goods incld. duties payment receipt, SDO, etc.	P	
38			Customs	Port operator	Status of goods	E/D	E: Email D: Through port's system or Malaysia NSW
39			Port operator	Haulier	Equipment Interchange Receipt	P	
40	Buyer's door	Receipt of goods by buyer	Haulier	Buyer	Delivery receipt	P	
41			Forwarder	Buyer	Freight invoice	E/D	E: Email D: Forwarder's system

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official)
Source: Developed by Authors using public information and interviews.

Table A8. Step-by-Step Process of Malaysia's Export Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP system with e-tendering function
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4		Arranging with forwarder	Seller	Forwarder	Key details for quotation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
5			Forwarder	Buyer	Quotation document	E/D	
6			Buyer	Forwarder	Booking Request	E/D	E: Email D: Forwarder's system
7		Confirmation with forwarder	Forwarder	Seller	Booking confirmation	E/D	
8		Arranging with shipping company & haulier	Forwarder	Shipping company	Shipping Instructions (SI)	E/D	E: Email D: Shipping company's system
9			Shipping company	Forwarder	Booking confirmation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
10			Forwarder	Haulier	SI, shipping company's booking confirmation (with empty container pick-up details)	E	E: Email
11		Application for export license	Forwarder	PIAs	Permit application form & supporting documents	P/E	E: Through Malaysia NSW (ePermit)
12			PIAs	Forwarder	Export permit	P/E	E: Email
13		Export declaration (K2 form) and duties payment	Forwarder	Customs	Export declaration (K2 form)	D	D: Submit as e-form through Malaysia NSW (eDeclare)
					Supporting documents i.e. export license, CI, PL, etc.	E	Attachments through e-Customs system Malaysia NSW

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
							(eDeclare)
14			Customs	Forwarder	Declaration and payment numbers	D	Through e-Customs system Malaysia NSW (eDeclare)
15			Forwarder	Customs	-	P/E	P: Payment at Customs Department/banks E: Payment via Malaysia NSW (ePayment)
16			Customs	Forwarder	Payment receipt	E/D	E/D: Provided through Malaysia NSW
17		Picking up of empty container, loading of goods & sending to port	Forwarder	Port operator	Gate pass application form and relevant documents	P/E	E: Port's system
18			Port operator	Forwarder	Gate pass	P/E	E: Port's system
19			Forwarder	Haulier	Gate pass	P/E/D	
20			Forwarder	Customs	Cargo control report	D	e-Customs system (Malaysia NSW)
21	Origin port	Unloading of goods to yard	Forwarder	Port operator	Request for permission for the container to the Port Area, application for services	P/D	D: Port's system (different port will have different systems depending on the port operator)
22			Port operator	Haulier	EIR	P	
23	Origin port – Customs	Customs inspection and release of goods	Forwarder	Customs	Submission of relevant documents for release of goods including CI, PL. cargo control report	P	
24			Customs	Port operator	Cargo status	E/D	E: Email D: Through port's system
25		Loading of goods to ship	Shipping company	Forwarder	Notice of readiness	E/D	E: Email E/D: Available through shipping company's system

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
26			Shipping company	Port operator	Container loading list	E/D	E/D: Port's system or MMSW
27			Shipping company	Forwarder	MBoL	P/D	D: eMBoL through shipping company's system
28			Forwarder	Seller	HBoL	P/D	D: eHBoL, through forwarder's system
29	In transit	Ship departure	Forwarder	Customs	Manifest	E/D	E/D: Port's system or MMSW
30			Forwarder	Seller	Freight invoice	E/D	E: Email D: Forwarder's system
31		Applying for relevant PCoO	Seller	Malaysia International Trade and Industry (MITI)	PCoO application form	D	Submit as e-form through Malaysia NSW (ePCoO)
					Relevant supporting document i.e. CI, PL, HBoL	E	Attachments through Malaysia NSW (ePCoO)
32			MITI	Seller	PCoC	P/D	D: Only applicable to ATIGA Form E
33		Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	P (HBoL) /E/D	E: Email D: API integration between seller's & buyer's ERP systems (CI, PL, DO, PCoO), forwarder's system that issues eHBoL

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official)
Source: Developed by Authors using public information and interviews.

Table A9. Step-by-Step Process of Thailand's Import Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Foreign seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP system with e-tendering function
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4	Origin port (after loading on ship) / In transit	Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	P (HBoL) /E/D	E: Email D: API integration between seller's & buyer's ERP systems (CI, PL, DO, PCoO), forwarder's system that issues eHBoL
5	In transit	Arranging with forwarder	Buyer	Forwarder	Key details for quotation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
6			Forwarder	Buyer	Quotation document	E/D	
7			Buyer	Forwarder	Booking Request	E/D	E: Email D: Forwarder's system
8		Confirmation with forwarder	Forwarder	Buyer	Booking confirmation	E/D	
9			Buyer	Forwarder	Documents from buyer (e.g. CI, PL)	E	Email/Attachments through forwarder's system
					HBoL	P/D	D: Forwarder's system that issues eHBoL
					Seller's forwarder details	E/D	E: Email D: Forwarder's system
10		Requesting for MBoL from	Forwarder	Forwarder	Booking confirmation and relevant supporting documents	E	Email

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
		seller's forwarder					
11		Sending of MBoL	Forwarder	Forwarder	MBoL	P/D	D: eMBoL through shipping company's system
12		Pre-arrival notice	Shipping company	Customs	Notification of vessel to enter the port city, manifest, container list	E/D	E: Attachments through e-Customs system D: Submit as e-form through e-Customs system
13			Customs	Shipping company	Ship arrival report number	D	Notification through e-Customs system
14		Request for vessel berthing	Shipping company	Port Authority of Thailand (PAT)/Port operator	Ship schedule, ship particulars, ship profile, application for vessel to enter the port area/arrival notice, inward container list, cargo manifest, pilot requirement form	P/E/D	E: Attachments through port's system (different port will have different systems depending on the port operator) D: Submit as e-form through port's system
15			PAT/port operator	Shipping company	Acknowledgement receipt, berthing slot allocation, other relevant notifications	D	Electronic notification through port's system
16			Shipping company	Marine Transport Bureau	Notification of vessel to enter the port city, manifest, container list	E/D	E: Attachment through Marine Transport Bureau's system D: Submit as e-form through Marine Transport Bureau's system
17			Marine Transport Bureau	Shipping company	Acknowledgement receipt	D	Electronic notification through Marine Transport Bureau's system
18		Application for	Forwarder	PIAs	Permit application form &	P/E	E: Through the Permits from

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
		relevant import license			supporting documents		Related Agencies' websites (can be accessed by through Thai NSW/e-Customs)
19			Permits from Related Agencies	PIAs	Import permit	P/E	E: Email
20	Destination port	Ship arrival	Shipping company	Forwarder	Notice of arrival	E/D	E: Email E/D: Available through shipping company's system
21		Import declaration and duties payment	Forwarder	Customs	Import declaration form	D	Submit as e-form through e-Customs system
					MBoL, CI, PL, import license, CoO	E	Attachments through e-Customs system
22			Customs	Forwarder	Declaration and payment numbers	D	Electronic notification through e-Customs system
23			Forwarder	Customs	-	P/E	P: Payment at Customs Department E: Payment via e-Payment system
24			Customs	Forwarder	Payment receipt	E/D	E/D: Provided through e-Customs system
25		Unloading of goods from ship to yard	Shipping company	PAT/Port operator	Notification of goods transfer and loading containers	D	Electronic notification through port's system
26			PAT/Port operator	Shipping company	Discharged report (Tally sheet), report of port use and services	P/E	E: Attachments through port's system
27			Shipping company	Forwarder	Notice of readiness	E/D	E: Email E/D: Available through shipping company's system
28		Arranging for	Forwarder	Shipping	MBoL in exchange for shipping	P/E	E: Exchange for SDO through

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
		customs inspection and payment to PAT/port operator		company	company's delivery order (SDO)		shipping company's system
29			Shipping company	Forwarder	SDO, request for opening goods containers, request for release of goods containers from customs custody	P/E/D	E/D: Provided through shipping company's system
30			Forwarder	PAT/Port operator	SDO and related documents for payment to PAT/port operator	P/D	P: Payment at PAT/port operator E: Payment via e-Payment system
31			PAT/Port operator	Forwarder	Payment receipt, wharf receipt, delivery container slip after receiving payment	E/D	E/D: Provided through port's system
32			Forwarder	Haulier	Key details for transportation arrangement, delivery container slip	E	Email
33			Forwarder	PAT/Port operator	Gate pass application form and relevant documents	E/D	E/D: Port's system
34			PAT/Port operator	Forwarder	Gate pass	E/D	
35			Forwarder	Haulier	Gate pass	E/D	
36			Forwarder	PAT/Port operator	Relevant documents for signing in preparation of customs inspection	P	
37	Destination port – Customs	Customs inspection and release of goods	Forwarder	Customs	Submission of relevant documents for release of goods incld. duties payment receipt, SDO, etc.	P	
38			Customs	PAT/Port operator & forwarder	Status of goods	E/D	E: Email D: Through port's system
39			PAT/Port operator	Haulier	Equipment Interchange Receipt	P	

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
40	Buyer's door	Receipt of goods by buyer	Haulier	Buyer	Delivery receipt	P	
41			Forwarder	Buyer	Freight invoice	E/D	E: Email D: Forwarder's system

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official)
Source: Developed by Authors using public information and interviews.

Table A.10. Step-by-Step Process of Thailand's Export Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Seller's door	Requesting for quotation	Buyer	Seller	-	E/D	E: Email D: Buyer's ERP system with e-tendering function
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4		Arranging with forwarder	Seller	Forwarder	Key details for quotation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
5			Forwarder	Buyer	Quotation document	E/D	
6			Buyer	Forwarder	Booking Request	E/D	E: Email D: Forwarder's system
7		Confirmation with forwarder	Forwarder	Seller	Booking confirmation	E/D	
8		Arranging with shipping company & haulier	Forwarder	Shipping company	Shipping Instructions (SI)	E/D	E: Email D: Shipping company's system
9			Shipping company	Forwarder	Booking confirmation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
10			Forwarder	Haulier	SI, shipping company's booking confirmation (with empty container pick-up details)	E	E: Email
11		Application for export license	Forwarder	PIAs	Permit application form & supporting documents	P/E	E: Through the relevant PIAs'' websites (can be accessed through Thai NSW)
12			PIAs	Forwarder	Export license	P/E	E: Email
13		Export declaration and duties payment	Forwarder	Customs	Export declaration,	D	D: Submit as e-form through e-Customs system
					Supporting documents i.e. export	E	Attachments through e-

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
					license, CI, PL, etc.		Customs system
14			Customs	Forwarder	Declaration and payment numbers	D	Through e-Customs system
15			Forwarder	Customs	-	P/E	P: Payment at Customs Department/banks E: Payment via e-Payment system
16			Customs	Forwarder	Payment receipt	E/D	E/D: Provided through e-Customs system
17		Picking up of empty container, loading of goods & sending to port	Forwarder	PAT/Port operator	Gate pass application form and relevant documents	E/D	E/D: Port's system
18			PAT/Port operator	Forwarder	Gate pass	E/D	
19			Forwarder	Haulier	Gate pass	E/D	
20			Forwarder	Customs	Cargo control report	D	e-Customs system
21	Origin port	Unloading of goods to yard	Forwarder	PAT/Port operator	Request for permission for the container to the Port Area, application for services	D	Port's system (different port will have different systems depending on the port operator)
22			PAT/Port operator	Haulier	EIR	P	
23	Origin port – Customs	Customs inspection and release of goods	Forwarder	Customs	Submission of relevant documents for release of goods incld. CI, PL. cargo control report	P	
24			Customs	PAT/Port operator & forwarder	Cargo status	E/D	E: Email D: Through port's system
25		Loading of goods to ship	Shipping company	Forwarder	Notice of readiness	E/D	E: Email E/D: Available through shipping company's system
26			Shipping	PAT/Port	Container loading list	E/D	E/D: Port's system

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
			company	operator			
27			Shipping company	Forwarder	MBoL	P/D	D: eMBoL through shipping company's system
28			Forwarder	Seller	HBoL	P/D	D: eHBoL, through forwarder's system
29	In transit	Ship departure	Forwarder	Customs	Manifest	E/D	E/D: Port's system
30			Forwarder	Seller	Freight invoice	E/D	E: Email D: Forwarder's system
31		Applying for relevant PCoO	Seller	Permits from Related Agencies	PCoO application form	D	Submit as e-form through DFT SMART-I System
					Relevant supporting document i.e. CI, PL, HBoL	E	Attachments through DFT SMART-I System
32			Department of Foreign Trade (DFT)	Seller	PCoO	P/D	D: Only applicable to ATIGA Form E
33		Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	P (HBoL) /E/D	E: Email D: API integration between seller's & buyer's ERP systems (CI, PL, DO, PCoO), forwarder's system that issues eHBoL

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official)
Source: Developed by Authors using public information and interviews.

Table A.11. Step-by-Step Process of Indonesia's Import Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Foreign seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP system with e-tendering function
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4	Origin port (after loading on ship) / In transit)	Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	P (HBoL) /E/D	E: Email D: API integration between seller's & buyer's ERP systems (CI, PL, DO, PCoO), forwarder's system that issues eHBoL
5	In transit	Arranging with forwarder	Buyer	Forwarder	Key details for quotation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
6			Forwarder	Buyer	Quotation document	E/D	
7			Buyer	Forwarder	Booking Request	E/D	E: Email D: Forwarder's system
8		Confirmation with forwarder	Forwarder	Buyer	Booking confirmation	E/D	
9			Buyer	Forwarder	Documents from buyer (e.g. CI, PL, HBoL)	E	Email/Attachments through forwarder's system
					HBoL	P/D	D: eHBoL through forwarder's system
					Seller's forwarder details	E/D	E: Email D: Forwarder's system
10		Requesting for MBoL from	Forwarder	Forwarder	Booking confirmation and relevant supporting documents	E	Email

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
		seller's forwarder					
11		Sending of MBoL	Forwarder	Forwarder	MBoL	P/D	D: eMBoL through shipping company's system
12		Pre-arrival notice	Shipping company	PT Pelabuhan Indonesia (Pelindo)/Port operator	Notification of vessel to enter the port city, manifest, MBoL, container list, PKKA (Foreign Vessel Operating License)	P/D	P: Submit physical documents through the port's service window D: Submit as e-form through NLE (INAPORTNET) or port's system
13			Pelindo/port operator	Shipping company	Ship arrival report number	D	Notification through NLE (INAPORTNET) or port's system
14		Request for vessel berthing	Shipping company	Pelindo/port operator	Ship schedule, ship particulars, ship profile, application for vessel to enter the port area/arrival notice, inward container list, cargo manifest, pilot requirement form	E/D	E: Attachments through port's system (different port will have different systems depending on the port operator) D: Submit as e-form through NLE (INAPORTNET) or port's system
15			Pelindo/port operator	Shipping company	Acknowledgement receipt, berthing slot allocation, other relevant notifications	D	Electronic notification through NLE (INAPORTNET) or port's system
16			Shipping company	Pelindo/port operator	Notification of vessel to enter the port city, manifest, container list	E/D	E: Attachment through NLE (INAPORTNET) or port's system D: Submit as e-form through NLE (INAPORTNET) or port's system

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
17			Pelindo/port operator	Shipping company	Acknowledgement receipt	D	Electronic notification through NLE (INAPORTNET) or port's system
18		Application for relevant import license (PI or Persetujuan Impor)	Forwarder	PIAs	Permit application form & supporting documents	P/E	E: Through the relevant PIA's websites (some can be accessed by through NLE: SSm Perizinan)
19			PIAs	Forwarder	Import license (PI or *Persetujuan Impor*)	P/E	E: Email
20	Destination port	Ship arrival	Shipping company	Forwarder	Notice of arrival	E/D	E: Email E/D: Available through shipping company's system
21		Import declaration and duties payment	Forwarder	Customs	Import declaration form	D	Submit as e-form through NLE (CEISA)
					MBoL, CI, PL, import license, CoO	E	Attachments through NLE (CEISA)
22			Customs	Forwarder	Declaration and payment numbers	D	Electronic notification through NLE (CEISA)
23			Forwarder	Customs	-	P/E	P: Payment at Customs Department E: Payment via e-Payment system in NLE (CEISA)
24			Customs	Forwarder	Payment receipt	E/D	E/D: Provided through NLE (CEISA)
25		Unloading of goods from ship to yard	Shipping company	Pelindo/Port operator	Notification of goods transfer and loading containers	D	Electronic notification through NLE (INAPORTNET) or port's system
26			Pelindo/Port operator	Shipping company	Discharged report (Tally sheet), report of port use and services	P/E	E: Attachments through NLE (INAPORTNET) or port's system

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
27			Shipping company	Forwarder	Notice of readiness	E/D	E: Email E/D: Available through shipping company's system
28		Arranging for customs inspection and payment to Pelindo/port operator	Forwarder	Shipping company	MBoL in exchange for shipping company's delivery order (SDO)	P/E	E: Exchange for SDO through shipping company's system
29			Shipping company	Forwarder	SDO, request for opening goods containers, request for release of goods containers from customs custody	P/E/D	E/D: Provided through shipping company's system
30			Forwarder	Pelindo/Port operator	SDO and related documents for payment to Pelindo/port operator	P/D	P: Payment at Pelindo/port operator E: Payment via e-Payment system
31			Pelindo/Port operator	Forwarder	Payment receipt, wharf receipt, delivery container slip after receiving payment	E/D	E/D: Provided through NLE (INAPORTNET) or port's system
32			Forwarder	Haulier	Key details for transportation arrangement, delivery container slip	E	Email
33			Forwarder	Pelindo/Port operator	Gate pass application form and relevant documents	E/D/P	P/E/D: Through NLE (SP2) or port's system
34			Pelindo/Port operator	Forwarder	Gate pass	E/D/P	P/E/D: Through NLE (SP2) or port's system
35			Forwarder	Haulier	Gate pass	E/D/P	E: Email E/D: Available through shipping company's system
36			Forwarder	Pelindo/Port operator	Relevant documents for signing in preparation of customs inspection	P	
37	Destination	Customs	Forwarder	Customs	Submission of relevant	P	

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
	port – Customs	inspection and release of goods			documents for release of goods incld. duties payment receipt, SDO, etc.		
38			Customs	Pelindo/Port operator & forwarder	Status of goods	E/D	E: Email D: Through NLE or port's system
39			Pelindo /Port operator	Haulier	Equipment Interchange Receipt	P	
40	Buyer's door	Receipt of goods by buyer	Haulier	Buyer	Delivery receipt	P	
41			Forwarder	Buyer	Freight invoice	E/D	E: Email D: Forwarder's system

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official)
Source: Developed by Authors using public information and interviews.

Table A12. Step-by-Step Process of Indonesia's Export Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP system with e-tendering function
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4		Arranging with forwarder	Seller	Forwarder	Key details for quotation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
5			Forwarder	Buyer	Quotation document	E/D	
6			Buyer	Forwarder	Booking Request	E/D	E: Email D: Forwarder's system
7		Confirmation with forwarder	Forwarder	Seller	Booking confirmation	E/D	
8		Arranging with shipping company & haulier	Forwarder	Shipping company	Shipping Instructions (SI)	E/D	E: Email D: Shipping company's system
9			Shipping company	Forwarder	Booking confirmation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
10			Forwarder	Haulier	SI, shipping company's booking confirmation (with empty container pick-up details)	E	E: Email
11		Application for export license (PE or Persetujuan Ekspor)	Forwarder	PIAs	Permit application form & supporting documents	P/E	E: Through the relevant PIA's websites (some can be accessed by through NLE: SSm Perizinan)
12			PIAs	Forwarder	Export license PE or Persetujuan Ekspor)	P/E/D	E: Email E/D: NLE (SSm Perizinan)

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
13		Export declaration and duties payment	Forwarder	Customs	Export declaration,	D	D: Submit as e-form through NLE (CEISA)
					Supporting documents i.e. export license, CI, PL, etc.	E	Attachments through NLE (CEISA)
14			Customs	Forwarder	Declaration and payment numbers	D	Through NLE (CEISA)
15			Forwarder	Customs	-	P/E	P: Payment at Customs Department/banks E: Payment via e-Payment system
16			Customs	Forwarder	Payment receipt	E/D	E/D: Provided through NLE (CEISA)
17		Picking up of empty container, loading of goods & sending to port	Forwarder	Pelindo/Port operator	Gate pass application form and relevant documents	E/D/P	E/D: Through NLE (SP2) or port's system
18			Pelindo/Port operator	Forwarder	Gate pass	E/D/P	E/D: Through NLE (SP2) or port's system
19			Forwarder	Haulier	Gate pass	E/D/P	E: Email E/D: Available through shipping company's system
20			Forwarder	Customs	Cargo control report	D	NLE (CEISA)
21	Origin port	Unloading of goods to yard	Forwarder	PAT/Port operator	Request for permission for the container to the Port Area, application for services	D	NLE (INAPORTNET) or port's system (different port will have different systems depending on the port operator)
22			Pelindo/Port operator	Haulier	EIR	P	
23	Origin port – Customs	Customs inspection and release of goods	Forwarder	Customs	Submission of relevant documents for release of goods incld. CI, PL. cargo control report	E/P	

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
24			Customs	Pelindo /Port operator & forwarder	Cargo status	E/D	E: Email D: Through NLE (INAPORTNET) or port's system
25		Loading of goods to ship	Shipping company	Forwarder	Notice of readiness	E/D	E: Email E/D: Available through shipping company's system
26			Shipping company	Pelindo /Port operator	Container loading list	E/D	E/D: NLE (INAPORTNET) or port's system
27			Shipping company	Forwarder	MBoL	P/D	D: eMBoL through shipping company's system
28			Forwarder	Seller	HBoL	P/D	D: eHBoL, through forwarder's system
29	In transit	Ship departure	Forwarder	Customs	Manifest	E/D	E/D: NLE (INAPORTNET) or port's system
30			Forwarder	Seller	Freight invoice	E/D	E: Email D: Forwarder's system
31		Applying for relevant PCoO	Seller	Ministry of Trade	PCoO application form	E	Submit as e-form (E-CO) through e-SKA
					Relevant supporting document i.e. CI, PL, HBoL	E	Attachments through e-SKA
32			Ministry of Trade	Sellerr	PCoO	P/D	D: Only applicable to some PCoO which is shared to INSW
33		Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	P (HBoL) /E/D	E: Email D: API integration between seller's & buyer's ERP systems (CI, PL, DO, PCoO), forwarder's system that issues eHBoL

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official)
Source: Developed by Authors using public information and interviews.

Table A13. Step-by-Step Process of Philippine's Import Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Foreign seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP system
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4	Origin port (after loading on ship) / In transit	Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	P (HBoL) /E/D	E: Email D: API integration between seller's & buyer's ERP systems (CI, PL, DO, PCoO), forwarder's system
5		Arranging with forwarder	Buyer	Forwarder	Key details for quotation	E/D	E: Email D: Forwarder's system
6			Forwarder	Buyer	Quotation document	E/D	
7			Buyer	Forwarder	Booking Request	E/D	E: Email D: Forwarder's system
8		Confirmation with forwarder	Forwarder	Buyer	Booking confirmation	E/D	
9					Seller's forwarder details	E/D	E: Email D: Forwarder's system
10		Requesting for MBoL from seller's forwarder	Forwarder	Forwarder	Booking confirmation and relevant supporting documents	E	Email
11		Sending of MBoL	Forwarder	Forwarder	MBoL	D	D: eMBoL through shipping company's

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
							system
12	In transit	Pre-arrival notice	Shipping company	Customs	Notification of vessel to enter the port city, manifest, container list	E/D	E: Attachments via BOC's E2M / TradeNet D: e-form via BOC's E2M / TradeNet
13			Customs	Shipping company	Ship arrival report number	D	D: BOC E2M / TradeNet
14		Request for vessel berthing	Shipping company	Philippine Ports Authority (PPA)/Port operator	Ship particulars, manifest, pilotage request	P/E/D	E/D: Port Community System / PPA portal
15			PPA/port operator	Shipping company	Acknowledgement receipt, berthing slot allocation, other relevant notifications	D	PPA portal / Port system
16			Shipping company	Marine Transport Bureau	Notification of vessel to enter the port city, manifest, container list	E/D	BOC E2M / MARINA system
17			Marine Transport Bureau	Shipping company	Acknowledgement receipt	D	D: MARINA system
18		Application for relevant import permit	Forwarder	Permits from Related Agencies	Permit application form & supporting documents	P/E	Submitted via Philippine TradeNet / PNSW
19			Permits from Related Agencies	Forwarder	Import permit	P/E	E: Email / TradeNet

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
20	Destination port	Ship arrival	Shipping company	Forwarder	Notice of arrival	E/D	E: Email E/D: Available through shipping company's system
21		Import declaration and duties payment	Forwarder	Customs	Import declaration form	D	Submit as e-form through e-Customs system
					HBoL, CI, PL, import license, CoO	E	Attachments through e-Customs system
22			Customs	Forwarder	Declaration and payment numbers	D	BOC E2M
23			Customs	Forwarder	Payment receipt	E/D	P: Bank counter E: e-Payment via TradeNet
24		Unloading of goods from ship to yard	Shipping company	PPA/Port operator	Container discharge notice	D	Port system
25			PPA/Port operator	Shipping company	Tally sheet, service report	P/E	Port system
26			Shipping company	Forwarder	Cargo ready notice	E/D	E: Email E/D: Available through shipping company's system
27		Arranging for customs inspection and payment to PAT/port operator	Forwarder	Shipping company	MBoL in exchange for shipping company's delivery order (SDO)	P/E	E: Exchange for SDO through shipping company's system
28			Shipping company	Forwarder	SDO, request for opening goods containers, request for release of goods containers from customs custody	P/E/D	Carrier ERP

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
29			Forwarder	PPA /Port operator	SDO and related documents for payment to PPA/port operator	P/D	P: Over the counter E: e-payment system
30			PPA/Port operator	Forwarder	Payment receipt, wharf receipt, delivery container slip after receiving payment	E/D	Port System
31			Forwarder	Haulier	Key details for transportation arrangement, delivery container slip	E	Email
32			Forwarder	PAT/Port operator	Gate pass application form and relevant documents	E/D	E/D: Port's system
33			PAT/Port operator	Forwarder	Gate pass	E/D	E/D: Port's system
34			Forwarder	Haulier	Gate pass	E/D	Email / carrier system
35			Forwarder	PPA/Port operator	Relevant documents for signing in preparation of customs inspection	P	Manual submission
36	Destination port – Customs	Customs inspection and release of goods	Forwarder	Customs	Submission of relevant documents for release of goods incld. duties payment receipt, SDO, etc.	P	Manual submission
37			Customs	PAT/Port operator & forwarder	Status of goods	E/D	BOC E2M / Email
38			PPA/Port operator	Haulier	Equipment Interchange Receipt	P	Manual
39	Buyer's door	Receipt of goods	Haulier	Buyer	Delivery receipt	P	Paper

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
40		by buyer	Forwarder	Buyer	Freight invoice	E/D	E: Email D: Forwarder's system

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official).
Source: Developed by Authors using public information and interviews.

Table A14. Step-by-Step Process of Philippine's Export Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4		Arranging with forwarder	Seller	Forwarder	Key details for quotation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
5			Forwarder	Buyer	Quotation document	E/D	
6			Buyer	Forwarder	Booking Request	E/D	E: Email D: Forwarder's system
7		Confirmation with forwarder	Forwarder	Seller	Booking confirmation	E/D	
8		Arranging with shipping company & haulier	Forwarder	Shipping company	Shipping Instructions (SI)	E/D	E: Email D: Shipping company's system
9			Shipping company	Forwarder	Booking confirmation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
10			Forwarder	Haulier	SI, shipping company's booking confirmation (with empty container pick-up details)	E	E: Email
11		Application for export license	Forwarder	Permits from	Permit application form & supporting documents	P/E	TradeNet / PNSW

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
				Related Agencies			
12			Permits from Related Agencies	Forwarder	Export license	P/E	E: Email
13		Export declaration and duties payment	Forwarder	Customs	Export declaration,	D	D: BOC E2M
					Supporting documents i.e. export license, CI, PL, etc.	E	Attachments through BOC E2M
14			Customs	Forwarder	Declaration and payment numbers	D	BOC E2M
15			Forwarder	Customs	Payment	P/E	P: Payment at Customs Department/banks E: Payment via e-Payment system
16			Customs	Forwarder	Payment receipt	E/D	E/D: TradeNet / E2M
17		Picking up of empty container, loading of goods & sending to port	Forwarder	PAT/Port operator	Gate pass application form and relevant documents	E/D	E/D: Port Community System
18			PPA/Port operator	Forwarder	Gate pass	E/D	PPA /Terminal system
19			Forwarder	Haulier	Gate pass	E/D	Email / Port system
20			Forwarder	Customs	Cargo control report	D	BOC E2M
21	Origin port	Unloading of goods to yard	Forwarder	PPA/Port operator	Request for permission for the container to the Port Area, application for services	D	Port's system (different port will have different systems depending on the port operator)
22			PPA/Port operator	Haulier	EIR	P	Manual
23	Origin port –	Customs inspection and	Forwarder	Customs	Submission of relevant documents for release of	P	Physical inspection

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
	Customs	release of goods			goods incld. CI, PL. cargo control report		
24			Customs	PPA/Port operator & forwarder	Cargo status	E/D	E: Email D: BOC E2M
25		Loading of goods to ship	Shipping company	Forwarder	Notice of readiness	E/D	E: Email E/D: Available through shipping company's system
26			Shipping company	PPA/Port operator	Container loading list	E/D	E/D: Port's system
27			Shipping company	Forwarder	MBoL	P/D	D: e-BoL through shipping company's system
28			Forwarder	Seller	HBoL	P/D	D: e-HBoL, through forwarder's system
29	In transit	Ship departure	Forwarder	Customs	Manifest	E/D	E/D: BOC E2M / Port system
30			Forwarder	Seller	Freight invoice	E/D	E: Email D: Forwarder's system
31		Applying for relevant PCoO	Forwarder	Permits from Related Agencies	PCoO application form	D	TradeNet / e-CO
					Relevant supporting document i.e. CI, PL, HBoL	D	TradeNet / e-CO
32			PIAs	Forwarder	PCoC	P/D	TradeNet / e-CO
33		Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	P (HBoL) /E/D	E: Email D: API integration between seller's & buyer's ERP systems (CI, PL, DO, PCoO), forwarder's system that issues eHBoL

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official).
Source: Developed by Authors using public information and interview.

Table A15. Step-by-Step Process of Viet Nam's Import Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Foreign seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP system with e-tendering function
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4	Origin port (after loading on ship) / In transit	Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	P (HBoL) /E/D	E: Email D: API integration between seller's & buyer's ERP systems (CI, PL, DO, PCoO), forwarder's system that issues eHBoL
5		Arranging with forwarder	Buyer	Forwarder	Key details for quotation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
6			Forwarder	Buyer	Quotation document	E/D	
7			Buyer	Forwarder	Booking Request	E/D	E: Email D: Forwarder's system
8		Confirmation with forwarder	Forwarder	Buyer	Booking confirmation	E/D	
			Buyer	Forwarder	Documents from buyer (e.g. CI, PL)	E	Email/Attachments through forwarder's system
9					Seller's forwarder details	E/D	E: Email D: Forwarder's system
10		Requesting for MBoL from	Forwarder	Forwarder	Booking confirmation and relevant supporting documents	E	Email

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
		seller's forwarder					
11		Sending of MBoL	Forwarder	Forwarder	MBoL	M/D	D: eMBoL through shipping company's system
12	In transit	Pre-arrival notice	Shipping company	Customs (GDVC)	Notification of vessel to enter the port city, manifest, container list	E/D	E: Attachments through e-Customs system D: Submit as e-form through e-Customs system (VNACCS)
13			Customs (GDVC)	Shipping company	Ship arrival report number	D	Notification through e-Customs system
14		Request for vessel berthing	Shipping company	Port operator	Ship schedule, ship particulars, ship profile, application for vessel to enter the port area/arrival notice, inward container list, cargo manifest, pilot requirement form	P/E/D	E: Attachments through port's system (different port will have different systems depending on the port operator) D: Submit as e-form through port's system
15			Port operator	Shipping company	Acknowledgement receipt, berthing slot allocation, other relevant notifications	D	Electronic notification through port's system
16			Shipping company	Viet Nam Maritime Administration	Notification of vessel to enter the port city, manifest, container list	E/D	E: Attachment through Viet Nam Maritime Administration D: Submit as e-form through Viet Nam Maritime Administration

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
17			Viet Nam Maritime Administration	Shipping company	Acknowledgement receipt	D	D: Electronic notification through Marine Transport Bureau's system
18		Application for relevant import license	Forwarder	Permits from Related Agencies	Permit application form, and supporting documents	P/E	E: Through the relevant Permits from Related Agencies' websites
19			Permits from Related Agencies	Forwarder	Import license	P/E	E: Email
20	Destination port	Ship arrival	Shipping company	Forwarder	Notice of arrival	E/D	E: Email E/D: Available through shipping company's system
21		Import declaration and duties payment	Forwarder	Customs (GDVC)	Import declaration form	D/P	D: Submit as e-form through e-Customs system
					HBoL, CI, PL, import license, CoO	E/P	E: Attachments through e-Customs system (yellow lane) P: Physical documents validation (red lane)
22			Customs (GDVC)	Forwarder	Declaration and payment numbers	D	Electronic notification through e-Customs system
23			Forwarder	Customs (GDVC)	-	P/E	P: Payment at Customs Department E: Payment via e-Payment system

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
24			Customs (GDVC)	Forwarder	Payment receipt	E/D	E/D: Provided through e-Customs system
25		Unloading of goods from ship to yard	Shipping company	Port operator	Notification of goods transfer and loading containers	D	Electronic notification through port's system
26			Port operator	Shipping company	Discharged report (Tally sheet), report of port use and services	P/E	E: Attachments through port's system
27			Shipping company	Forwarder	Notice of readiness	E/D	E: Email E/D: Available through shipping company's system
28		Arranging for customs inspection and payment to port operator	Forwarder	Shipping company	MBoL in exchange for shipping company's delivery order (SDO)	P/E	E: Exchange for SDO through shipping company's system
29			Shipping company	Forwarder	SDO, request for opening goods containers, request for release of goods containers from customs custody	P/E/D	E/D: Provided through shipping company's system
30			Forwarder	Port operator	SDO and related documents for payment to port operator	P/D	P: Payment at port operator E: Payment via e-Payment system
31			Port operator	Forwarder	Payment receipt, wharf receipt, delivery container slip after receiving payment	E/D	E/D: Provided through port's system
32			Forwarder	Haulier	Key details for transportation arrangement, delivery container slip	E	Email
33			Forwarder	Port operator	Gate pass application form and	E/D	E/D: Port's system

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
					relevant documents		
34			Port operator	Forwarder	Gate pass	E/D	
35			Forwarder	Haulier	Gate pass	E/D	
36			Forwarder	Port operator	Relevant documents for signing in preparation of customs inspection	P	
37	Destination port – Customs	Customs inspection and release of goods	Forwarder	Customs (GDVC)	Submission of relevant documents for release of goods, including duties payment receipt, SDO, etc.	P	
38			Customs (GDVC)	Port operator & forwarder	Status of goods	E/D	E: Email D: Through port's system
39			Port operator	Haulier	Equipment Interchange Receipt	P	
40	Buyer's door	Receipt of goods by buyer	Haulier	Buyer	Delivery receipt	P	
41			Forwarder	Buyer	Freight invoice	E/D	E: Email D: Forwarder's system

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official).
Source: Viet Nam Trade Portal,[59] VNTR,[60] EntendMax,[61] Developed by Authors using public information and interview.

[59] Customs Procedure, Vietnam Trade Portal
[60] Vietnam Best Practice in Trade Facilitation, Vietnam National Trade Repository
[61] What Is an Import License? A Complete Guide from A to Z, EntendMax

Table A16. Step-by-Step Process of Viet Nam's Export Process

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
1	Seller's door	Requesting for quotation	Buyer	Seller	Request for quotation document	E/D	E: Email D: Buyer's ERP system with e-tendering function
2		Replying to quotation	Seller	Buyer	Quotation document	E/D	
3		Acceptance of quotation	Buyer	Seller	Purchase order (PO)	E/D	E: Email D: API integration between seller's & buyer's ERP systems
4		Arranging with forwarder	Seller	Forwarder	Key details for quotation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
5			Forwarder	Buyer	Quotation document	E/D	
6			Buyer	Forwarder	Booking Request	E/D	E: Email D: Forwarder's system
7		Confirmation with forwarder	Forwarder	Seller	Booking confirmation	E/D	
8		Arranging with shipping company & haulier	Forwarder	Shipping company	Shipping Instructions (SI)	E/D	E: Email D: Shipping company's system
9			Shipping company	Forwarder	Booking confirmation	E/D	E: Email D: Forwarder's system (instant quotation calculator if available)
10			Forwarder	Haulier	SI, shipping company's booking confirmation (with empty container pick-up details)	E	E: Email
11		Application for export license	Forwarder	Permits from Related Agencies	Permit application form & supporting documents	P/E	E: Through the relevant Permits from related agencies websites (can be accessed by through Viet Nam Trade Portal)

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
12			Permits from Related Agencies	Forwarder	Export license	P/E	E: Email
13		Export declaration and duties payment	Forwarder	Customs (GDVC)	Export declaration,	D/P	D: Submit as e-form through e-Customs system (yellow line) P: Physical documents validation (red line)
					Supporting documents i.e. export license, CI, PL, etc.	E	Attachments through e-Customs system
14			Customs (GDVC)	Forwarder	Declaration and payment numbers	D	Through e-Customs system
15			Forwarder	Customs (GDVC)	-	P/E	P: Payment at Customs Department/banks E: Payment via e-Payment system
16			Customs (GDVC)	Forwarder	Payment receipt	E/D	E/D: Provided through e-Customs system
17		Picking up of empty container, loading of goods & sending to port	Forwarder	Port operator	Gate pass application form and relevant documents	E/D	E/D: Port's system
18			Port operator	Forwarder	Gate pass	E/D	
19			Forwarder	Haulier	Gate pass	E/D	
20			Forwarder	Customs	Cargo control report	D	e-Customs system
21	Origin port	Unloading of goods to yard	Forwarder	Port operator	Request for permission for the container to the Port Area, application for services	D	Port's system (different port will have different systems depending on the port operator)

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
22			Port operator	Haulier	EIR	P	
23	Origin port – Customs	Customs inspection and release of goods	Forwarder	Customs (GDVC)	Submission of relevant documents for release of goods, including CI, PL. cargo control report	P	
24			Customs (GDVC)	Port operator & forwarder	Cargo status	E/D	E: Email D: Through port's system E: Key in ship arrival in port system
25		Loading of goods to ship	Shipping company	Forwarder	Notice of readiness	E/D	E: Email E/D: Available through shipping company's system
26			Shipping company	Port operator	Container loading list	E/D	E/D: Port's system P: Physical documents validation
27			Shipping company	Forwarder	MBoL	P/D	D: eMBoL through shipping company's system
28			Forwarder	Seller	HBoL	P/D	D: eHBoL, through forwarder's system
29	In transit	Ship departure	Forwarder	Customs	Manifest	E/D	E/D: GDVC or VNACC
30			Forwarder	Seller	Freight invoice	E/D	E: Email D: Forwarder's system
31		Applying for relevant PCoO	Forwarder	Permits from Related Agencies	PCoO application form	D/P	D: Submit as e-form through e-customs (VNACCs) P: Physical documents validation
					Relevant supporting document	E	E: Attachments through e-

No	Goods Location	Process	Sender	Receiver	Documents/Data Exchanged	Digitalisation Stage*	Platform Involved in Process
					i.e. CI, PL, HBoL		customs (VNACCs) P: Physical documents validation
32			Permits from Related Agencies	Forwarder	PCoC	P/D	D: Only applicable to ATIGA Form
33		Order confirmation	Seller	Buyer	Commercial invoice (CI), Packing list (PL), Delivery order (DO), Preferential certificate of origin (PCoO), House bill of lading (HBoL)	P (HBoL) /E/D	E: Email D: API integration between seller's & buyer's ERP systems (CI, PL, DO, PCoO), forwarder's system that issues eHBoL

*P: Paper/ E: Electronic/ D: Digital (Classified according to the most commonly received format in which they are recognised as official).
Source: MOIT,[62] Developed by Authors using public information and interviews.

[62] A Guide to Exporting from Vietnam, 2021, Vietnam's Ministry of Industry and Trade (MOIT)