Enabling AI for Trade Facilitation in the APEC Region

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EXECUTIVE SUMMARY

In recent years, APEC has been advancing work on digitalization and modernization of trade processes, for example, digital bills of lading, digital signatures, and single window. Stakeholders recognize the potential of emerging technologies to massively increase trade efficiency, enhance economic competitiveness, and contribute to prosperity in the region but may lack the expertise or resources for implementation. This report aims to provide policymakers with timely and relevant information on developments surrounding the application of artificial intelligence (AI) for trade facilitation. Many of the AI applications and use cases discussed in this report are prospective, pilot, or only feasible in a handful of APEC economies. Therefore, this report provides a forward-looking roadmap to inform APEC policymakers and trade stakeholders on how to advance digitalization, capacity building, and regulatory work that builds a foundation for effective and trustworthy AI systems in trade facilitation.

Artificial intelligence has significant potential to improve trade facilitation across the Asia-Pacific, but its adoption should remain practical, evidence-based, and grounded in strong governance. Generative AI is expected to play an increasingly important role in customs and border management, particularly when connected to authoritative knowledge bases. Practical applications include officer assistants that search laws, rulings, procedures, and risk indicators; trader assistants that guide document preparation; classification copilots that retrieve tariff notes and prior rulings; and risk-analysis assistants that summarize trader history, case files, and open-source intelligence. Looking further ahead, agentic AI may enable suites of AI agents to coordinate routine trade workflows across traders, customs brokers, logistics providers, customs authorities, and other border agencies.

A central conclusion of this report is that AI should not be legally autonomous. In the trade facilitation context, greater autonomy must be earned progressively through validation, limited scope, auditability, and operational evidence. While low-risk administrative tasks may be automated earlier, legally determinative decisions should remain subject to human accountability through a “human-in-the-loop” approach. For most APEC economies, the immediate priority is developing a disciplined adoption pathway built on reliable data, analytics, decision-support, assisted automation, controlled agents, and only then higher levels of autonomy where legally and operationally justified.

Reliable, high-quality data will be the primary determinant of successful AI deployment in trade facilitation, more so than the sophistication of AI models themselves. Data collection should be designed around real trade processes, while data management systems should incorporate privacy-by-design principles, including role-based access controls, encryption, data minimization, and clear access restrictions. Future digitalization efforts should prioritize interoperable, machine-readable trade data structures that enable seamless information exchange across customs authorities, licensing agencies, tax authorities, ports, transport systems, border inspection bodies, and single-window platforms. Building trust between industry stakeholders and customs agencies utilizing government-administrated databases is a critical enabler of fostering AI systems trained on robust and high-quality data. APEC is well positioned to support the adoption of common international frameworks that can guide domestic data governance and promote interoperability across the region.

At the same time, significant barriers remain in the region's readiness for AI adoption. Workforce capacity represents one of the greatest challenges. 71% of the region’s employers report difficulty filling open positions, with AI-related skills among the hardest to recruit. AI expertise is concentrated in a small number of economies and sectors, particularly trade finance, while sectors such as warehousing, storage, and wholesale import and export lag behind. As AI becomes more deeply integrated into trade facilitation, approximately 60 percent of the workforce will require upskilling or reskilling. To address these shortages,

governments, industry, and academia should collaborate on workforce development through university-led, industry-tailored AI education programs for working professionals, complemented by AI and ICT training within customs administrations.

Digital infrastructure presents a second major constraint. Although internet access continues to improve, regional broadband connectivity remains uneven, and many economies continue to rely primarily on mobile networks that do not provide the performance required for advanced AI applications. Computing capacity is similarly constrained by access to chips, servers, cloud infrastructure, data centers, energy resources, and other critical inputs. Institutional capability also varies widely. While economies such as the United States, Korea, and Singapore have deeply integrated digital technologies into economic activity, many other APEC economies remain at much earlier stages of digital maturity. Policy responses should therefore reflect each economy's level of digital readiness.

Overall, AI adoption in APEC trade facilitation is advancing, but unevenly. The strongest near-term opportunities lie in risk targeting, anomaly detection, document processing, HS classification assistance, inspection image analytics, and AI-assisted advisory tools. These applications can reduce processing times, improve compliance, and support more targeted border controls. However, successful implementation will depend not only on technological advances but also on improvements in data quality, institutional capacity, cross-agency coordination, legal validity, explainability, auditability, confidentiality, and accountability.

APEC has an important role to play in supporting practical, interoperable, and responsible AI adoption. By facilitating the sharing of use cases and best practices, developing common assurance principles, strengthening data governance and digital infrastructure, supporting capacity building, and encouraging public-private collaboration, APEC can help economies realize the benefits of AI-enabled trade facilitation while maintaining trust, transparency, and human accountability. This report will culminate in a roadmap of priorities for APEC policymakers and stakeholders to position APEC as a global leader in advancing AI for trade.

1.0

Current Status of Applications of AI for Trade Facilitation in the APEC Region

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1.1 Introduction: AI Adoption in Trade Facilitation

APEC's 21 member economies span an extremely wide range of digital and institutional capacities, from highly digitised customs administrations to economies still consolidating basic National Single Window (NSW) and paperless trade infrastructure. Understanding the state of AI deployment in this region therefore requires holding two realities simultaneously: a small cohort of advanced economies operating AI systems at scale, and a larger group for whom the foundational prerequisites of any AI application are still being put in place.

AI is not new to trade facilitation. Long before the recent emergence of generative AI, customs administrations and trade-related service providers were already deploying classical AI – principally, machine learning and natural language processing. For most of the past decade, "AI in trade facilitation" has effectively meant this layer: supervised ML models trained on historical declaration and inspection data, applied to risk targeting, fraud-pattern detection, and, more recently, image analytics for non-intrusive inspection. These classical AI applications are operationally deployed, iteratively improved, and, in several APEC economies, deeply embedded in core enforcement and workflows.

The recent emergence of generative AI, large language models (LLMs), multimodal frontier models, retrieval-augmented generation (RAG) and agentic AI represents a qualitatively different order of capability. Rather than merely flagging an anomaly or scoring a declaration, generative AI can interpret unstructured material, extract meaning from complex documents, and generate outputs grounded in regulatory text; agentic AI goes further still, capable of coordinating multi-step tasks across systems. The central question for APEC is therefore not whether AI is used in trade facilitation, but whether, and how quickly, economies can advance from classical AI toward these generative and agentic capabilities.

The most recent regional benchmarking, the ESCAP–ADB Asia-Pacific Trade Facilitation Report 2026, found the overall AI implementation rate in trade facilitation to be below 15 per cent among surveyed economies1- ranging from roughly 1 to 40 per cent across subregions. East Asian APEC members reported the highest levels of operational deployment and the most developed governance frameworks, while Pacific and several Southeast Asian economies lagged considerably. Within this uneven picture, the divide tracks closely with the classical/generative distinction noted above: the operational base is concentrated in the ML risk and anomaly layer, while generative and agentic applications remain largely emergent or under piloting even in the more advanced economies.

The World Customs Organisation's Smart Customs Project provides a useful institutional reference. Its detailed 2025 report on AI/ML adoption in customs, accompanied by an AI/ML readiness self-assessment tool, illustrates both the ambition and the gap between piloting and scaled deployment that characterises much of the region. The WCO Smart Customs Survey (July 2024)2 found that only 12 WCO Members had fully adopted AI/ML, while 88 of the 116 responding administrations remained in development or consideration phases - a picture that broadly reflects the APEC distribution. Digital infrastructure and AI-readiness gaps between economies in the region are addressed further in Chapter 4 of the report.

1.2 Current Applications: Mature and Emerging Use Cases

AI applications in trade facilitation are best understood as a progression from classical AI to GenAI and agentic AI use cases. **Classical AI** remains most established in:

- Risk management
- Fraud detection
- Anomaly analysis
- Image analytics

Customs administrations have long used selectivity rules and risk profiles to route consignments into inspection or green channels. Machine learning extends this by learning from historical patterns in declarations and trader behaviour to identify anomalies, analyse fraud patterns and support more precise targeting. Korea Customs Service, for example, has developed a big-data and AI approach that combines structured declaration data with unstructured sources and applies machine learning, NLP, network analysis, and deep learning.

The more significant emerging use cases now lie in **GenAI-assisted interpretation** and workflow support. **HS classification** is a clear example. Traditional AI tools can recommend possible HS codes based on product descriptions, invoices and historical declarations. GenAI can add further value by explaining classification options, retrieving relevant information through retrieval-augmented generation, and providing classification rationale for officer or trader review. The final decision must remain governed by law, interpretative rules, and human review.

Document processing is another fast-developing area. Trade remains document-intensive even when it is formally paperless. AI-powered OCR, NLP, and document-intelligence systems can extract data from invoices, packing lists, bills of lading, certificates, permits, and other supporting documents. GenAI can extend this by:

- Comparing documents
- Explaining inconsistencies
- Identifying missing information
- Drafting requests for clarification

In agentic form, such tools could retrieve documents, extract relevant fields and convert scanned document content into structured machine-readable data.

Non-intrusive inspection **image analytics** also remains important, but it is primarily a classical AI and computer vision use case. Models can analyse x-ray, CT, or scanner images to identify anomalies, concealed goods, irregular densities, or possible misdeclarations. The next stage is to link image analytics with GenAI or multimodal models so that officers receive not only an image alert, but also an explanation that relates the image, declaration data, trader profile, and risk indicators. This would improve usability, but it also requires strong validation, labelled datasets, and careful monitoring of false positives and false negatives.

The most transformative frontier is agentic AI in trade workflows. These systems are not limited to answering questions. Properly bounded, they can retrieve information, call APIs, prepare draft applications, populate declaration fields, generate case summaries, schedule follow-up actions, and escalate unresolved issues. In single window and customs environments, this could support permit applications, document reconciliation, trader notifications, risk-analysis preparation, and post-clearance follow-up. In the private sector, similar agents could support customs brokers, freight forwarders, importers, exporters, and banks in preparing compliant trade documentation before submission.

CASE STUDY

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Trade facilitation challenge(s) addressed: When an AI agent presents documentation at a digital border, counterparties and customs authorities currently have no standardized mechanism to verify (a) which legal entity authorized the agent, (b) what scope of authority the agent possesses, and (c) whether the entity behind the agent is who it claims to be. Without such verification, the efficiency gains from AI-driven trade automation are undermined by increased fraud risk, compliance uncertainty, and liability ambiguity — precisely the frictions that trade facilitation aims to reduce.

The challenge is compounded by the cross-border nature of AI agent deployment. An agent configured in one APEC economy may execute transactions in another, raising jurisdictional questions about accountability and regulatory compliance that existing trade facilitation frameworks (built for human actors and document-based processes) were not designed to address.

How the AI system works in practice: The proposed system extends GLEIF's existing Legal Entity Identifier (LEI) and verifiable LEI (vLEI) infrastructure to create a "Know Your Agent" (KYA) verification chain for AI agents conducting commercial activities across borders. The mechanism works as follows:

- **Entity identification:** The deploying organization holds an LEI — a unique 20-character alphanumeric code (ISO 17442) that connects to validated reference data
- **Authority delegation:** Using the vLEI credentialing system, the organization issues a verifiable credential to its AI agent
- **Cryptographic trust chain:** The credential is cryptographically bound through GLEIF's trust chain
- **Transaction attestation:** Each agent-executed transaction is signed with the vLEI credential

Measurable outcomes (projected): Reduction in verification latency, fraud reduction, and cross-border interoperability

Non-quantifiable benefits and challenges: Increased regulatory confidence in permitting AI-automated trade processes; reduced compliance burden for SMEs deploying AI agents (single credential vs. multiple economy-specific registrations); potential resistance from economies with existing digital identity frameworks that may view LEI extension as duplicative.

A practical distinction is therefore between AI that supports analysis and AI that supports action. Classical AI is strongest where the task is to score, classify, detect, or predict. GenAI is strongest where the task is to interpret, explain, summarise, compare, or draft. Agentic AI becomes relevant where the task requires a sequence of steps across systems. For trade facilitation, the near-term priority is to deploy these tools as governed decision-support and workflow-assistance systems, with clear human approval, audit trails,

source grounding, and accountability for legally consequential decisions. A practical way to distinguish the current use cases is shown below.

Application area	Status in APEC trade facilitation	Typical AI role	Main governance issue
Risk targeting, fraud detection, anomaly analysis	More mature in advanced customs administrations	Risk scoring, prioritisation, alert generation	Bias, explainability, model validation, audit trails
HS classification assistance	Emerging but increasingly practical	Suggested HS codes, supporting logic, document/product interpretation	Legal accountability, national tariff specificity, human review
Document extraction and verification	Emerging and scalable	OCR, field extraction, authenticity checks, cross-document validation	Data quality, evidentiary value, confidentiality
NII image analytics	Emerging, advanced in selected economies	Image anomaly detection and inspection support	False positives/negatives, labelled datasets, officer validation
GenAI assistants and agents	Early-stage and experimental	Natural-language advisory, drafting, search, workflow orchestration	Hallucination, confidentiality, accountability, controlled deployment

1.3 Private-Sector Applications Supporting Trade Facilitation

In several respects, private-sector adoption of AI for trade-facilitation-adjacent functions is ahead of government adoption, consistent with the commercial incentives involved. Trade-compliance software vendors have moved quickly to embed AI into classification, denied-party screening, country-of-origin determination and document-extraction modules, marketed on the basis of reduced manual workload, faster clearance, and for classification specifically, reduced exposure to penalties and retrospective duty assessments from misclassification. A newer variant is AI-driven tariff audit tooling, which scans an importer's historical declarations against current rulings and tariff schedules to identify both compliance risk and retroactive refund opportunities using AI for duty recovery as much as forward-looking compliance management.

For traders relying on preferential treatment under the region's extensive web of bilateral and plurilateral FTAs, AI-assisted tools are also beginning to appear for rules-of-origin work matching bills of materials against origin criteria, flagging products close to tariff-shift or regional-value-content thresholds, and generating supporting documentation. These tools remain considerably less mature than HS classification tools, reflecting the qualitative complexity of origin determinations and the fragmented, agreement-specific nature of origin rules across the region's overlapping FTAs.

Several issues arising from this trajectory are directly relevant to trade facilitation policy. These are:

1. Legal liability and audit trails
2. Data confidentiality
3. Access gaps
4. Interoperability between systems

Legal liability does not shift with the tool: regardless of whether an HS code or origin determination is AI-generated, responsibility for the accuracy of a customs declaration remains with the importer, exporter, or licensed agent of record. This creates demand for audit trails and citations of authority behind AI-generated suggestions - a feature increasingly built into commercial tools, though not yet standard across the industry. Data confidentiality is a further concern where proprietary product specifications, bills of materials or supply-chain data are processed by third-party or cloud-hosted AI models, particularly for traders operating across jurisdictions with differing data-sovereignty frameworks.

An **access gap** is also emerging - large multinationals and their brokers are adopting AI compliance tools fastest, while SMEs are less likely to have the transaction volumes, in-house expertise or budgets to benefit, potentially widening the compliance performance gap that trade facilitation reforms aim to close. Finally, **interoperability** between private-sector AI outputs and government systems remains largely absent. AI-assisted classifications and extracted document data generated on commercial platforms are not yet routinely validated against, or fed into, NSW or customs declaration systems. Efficiency gains on the private side therefore do not automatically translate into gains at the border.

1.4 Enablers, Constraints, and Outlook

The enabling conditions for AI in trade facilitation are increasingly clear. The first is **reliable digital trade data.** AI cannot compensate for weak underlying data. In many economies, the main constraint is not the absence of algorithms but:

- Fragmented data
- Inconsistent product descriptions
- Limited access to inspection and audit outcomes
- Weak data governance
- Poor interoperability between customs, other government agencies, port systems, logistics platforms, and single window environments

AI-ready data requires more than data availability; it requires data quality, standardisation, metadata, lineage, access controls, and mechanisms to connect model outputs with operational outcomes. Reliable digital trade data to enable AI for trade facilitation is addressed in Chapter 2 of the report.

The second enabler is **institutional capacity.** Effective AI adoption requires customs domain experts, data scientists, data engineers, legal officers, risk managers, cybersecurity specialists, procurement officials, and operational users to work together. Korea's experience illustrates that the organisational model matters: a dedicated big data and AI function, training programmes, business-led use cases, and an AI platform are not peripheral issues; they are central to sustainable adoption. The ESCAP–ADB survey similarly identifies lack of AI/ML expertise and high infrastructure costs as leading barriers to scaling AI in trade facilitation. Institutional capacity and workforce readiness are addressed in Chapter 3 of the report.

The third enabler is **governance**. Customs decisions have legal consequences: duties are assessed, goods may be detained, licences may be required, penalties may be imposed, and traders may challenge decisions. AI used in customs and trade facilitation must therefore meet higher standards than ordinary commercial productivity tools. Systems should be validated before deployment, monitored after deployment, and subject to audit. They should support explainable and contestable decision-making, especially where outputs affect inspection selection, release, classification, valuation, origin, penalties, or trader treatment. Human-in-the-loop controls remain essential, not as a symbolic safeguard, but as the mechanism through which legal authority, professional judgment, and accountability are preserved. Governance and good regulatory practices to enable AI for trade facilitation are addressed in Chapter 5 of the report.

1.5 Conclusion

Generative and agentic AI will play a growing role in customs and trade facilitation, particularly where grounded in authoritative knowledge bases through retrieval-augmented generation — from officer and trader assistants to classification copilots and, over time, agents that coordinate routine trade workflows across traders, brokers, logistics operators, and government agencies. The key policy point, however, is that "agentic" should not mean legally autonomous: greater autonomy must be earned progressively through validation, limited scope, auditability, and operational evidence, with legally determinative decisions remaining subject to human accountability. For most APEC economies, the near-term priority is a disciplined ladder of adoption — reliable data, analytics, decision-support, assisted automation, and controlled agents — rather than a leap to autonomous AI. Adoption across the region is progressing but uneven, with the strongest near-term opportunities in risk targeting, document processing, HS classification assistance, image analytics, and AI-assisted advisory tools. The binding constraints are as much institutional as technical, spanning data quality, capacity, cross-agency coordination, legal validity, and explainability. APEC's role should therefore be to support practical, interoperable, and responsible adoption — sharing use cases, developing common assurance principles, strengthening data and digital infrastructure, and encouraging public-private alignment. AI will be most valuable when embedded in trusted digital trade systems, improving decision quality while keeping humans accountable for legally consequential outcomes.

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EXTENDED CASE STUDY: AI IN MARITIME TRADE FACILITATION

A Look at Korea's Smart Ports and Supply Chain Risk Management

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A supply chain is fundamentally about flow. Raw materials, intermediate goods, and finished products move from producers to consumers through a series of interconnected processes. Along this journey, various risks and uncertainties may arise. These are commonly referred to as supply chain risks. When such risks materialize and cause delays or interruptions in the movement of goods, they become supply chain disruptions. Efficient supply chain flows are essential for trade facilitation. If goods cannot move smoothly across the supply chain, trade cannot function efficiently. This is particularly important in maritime trade, which accounts for the majority of global merchandise trade. Maritime transport also accounts for the largest share of overall supply chain lead time. Therefore, improving the efficiency and reliability of ports and maritime logistics is critical for advancing trade facilitation across APEC economies. In this context, an important question emerges: How can artificial intelligence (AI) help improve these flows?

In maritime logistics, flow can be broadly divided into two categories. The first is the physical movement of cargo, and the second is the flow of data and information that supports that movement. Supply chain disruptions are often associated with external shocks such as wars, accidents, or natural disasters. However, in many cases, inefficiencies and delays in logistics operations arise not from the physical movement of cargo itself, but from fragmented information, inconsistent data, and ineffective communication among stakeholders. Ports and maritime logistics are highly networked industries involving a wide range of participants, including shipping lines, port authorities, terminal operators, cargo owners, freight forwarders, and customs agencies. As a result, large volumes of data are generated and exchanged throughout the logistics process. This makes ports and maritime logistics a promising area for the application of AI technologies to support decision-making, connect information flows across stakeholders, and improve operational efficiency through advanced data analysis.

Let us begin with ports. Improvements in port productivity contribute directly to trade facilitation by reducing vessel waiting times, shortening cargo handling times, and enhancing information sharing. Figure 1 illustrates the maturity stages of a smart port.

Stage One: Unit Optimization

Most conventional ports can be classified as being at the first stage. At this stage, operations are optimized within individual functional areas, such as transportation or yard operations, by reducing idle time and minimizing resource waste.

Stage Two: Automation

A representative example is Busan New Port Pier 7 (Dongwon Global Terminal Busan, DGT) in the Republic of Korea. At this stage, the terminal is optimized as a unified system. Data generated by automated equipment is transmitted directly to the Terminal Operating System (TOS) in real time. However, some information still remains outside the digital workflow, particularly in areas where data has not yet been converted into digital formats.

Stage Three: Digitalization

Information that could not be shared in the previous stage is converted into machine-readable formats, enabling seamless communication between systems and devices. By using technologies such as drones and various sensors to collect real-time data from across the port, operations can be optimized with much greater precision. To effectively utilize AI technologies, it is essential to first establish an environment in which equipment, facilities, and operational information can be collected and managed in digital formats. From this perspective, the Digitalization stage can be regarded as the foundation for the full-scale adoption and application of AI technologies. In this regard, the Busan Port Authority (BPA) announced the "Busan Port AX (AI Transformation) Initiative" in February 2026. The initiative aims to improve port productivity by 30 percent by 2030 through an investment of KRW 892.1 billion and includes four strategic priorities and twelve key projects. Among them, "AI-based Terminal Operation Enhancement Technologies," including AI agents and digital twins, can be considered representative examples of the Digitalization stage.

Stage Four: Smart

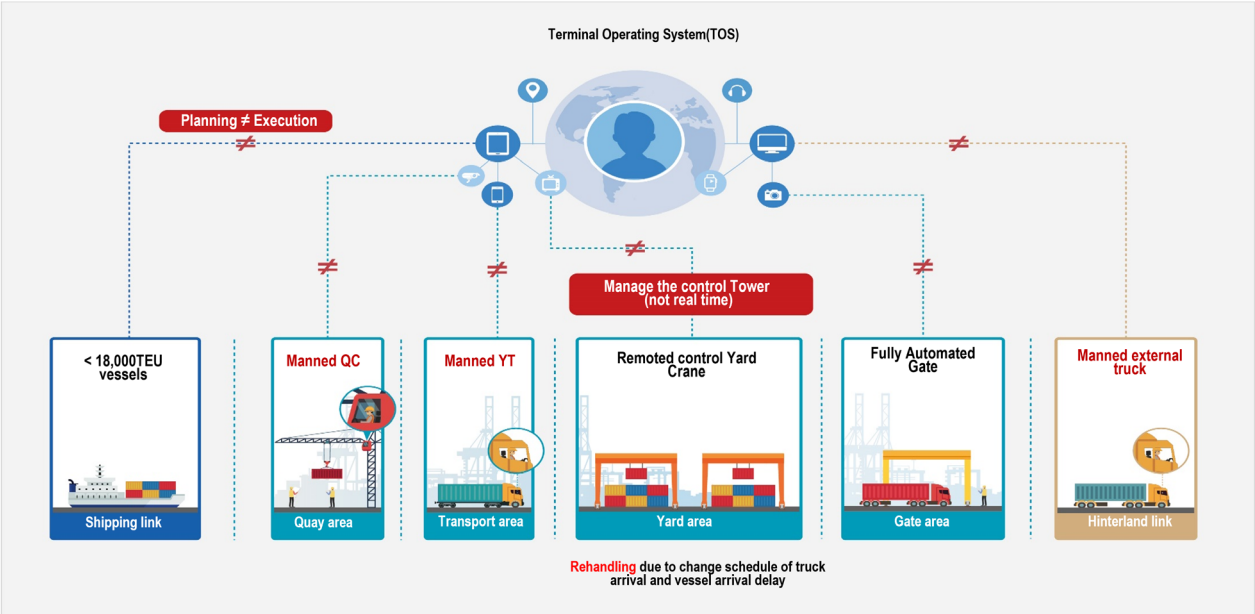
While Digitalization focuses on creating the data foundation for AI, the Smart stage expands the scope of integration and decision-making beyond the terminal to connect the port with both maritime and inland logistics systems. This stage consists of four key components: real-time data storage, simulation data storage, data analysis and implementation, and an advanced Terminal Operating System (TOS). Unlike traditional TOS, which primarily focuses on planning functions, an advanced TOS supports both strategic planning and real-time operational decision-making.

Korea as a Case Study

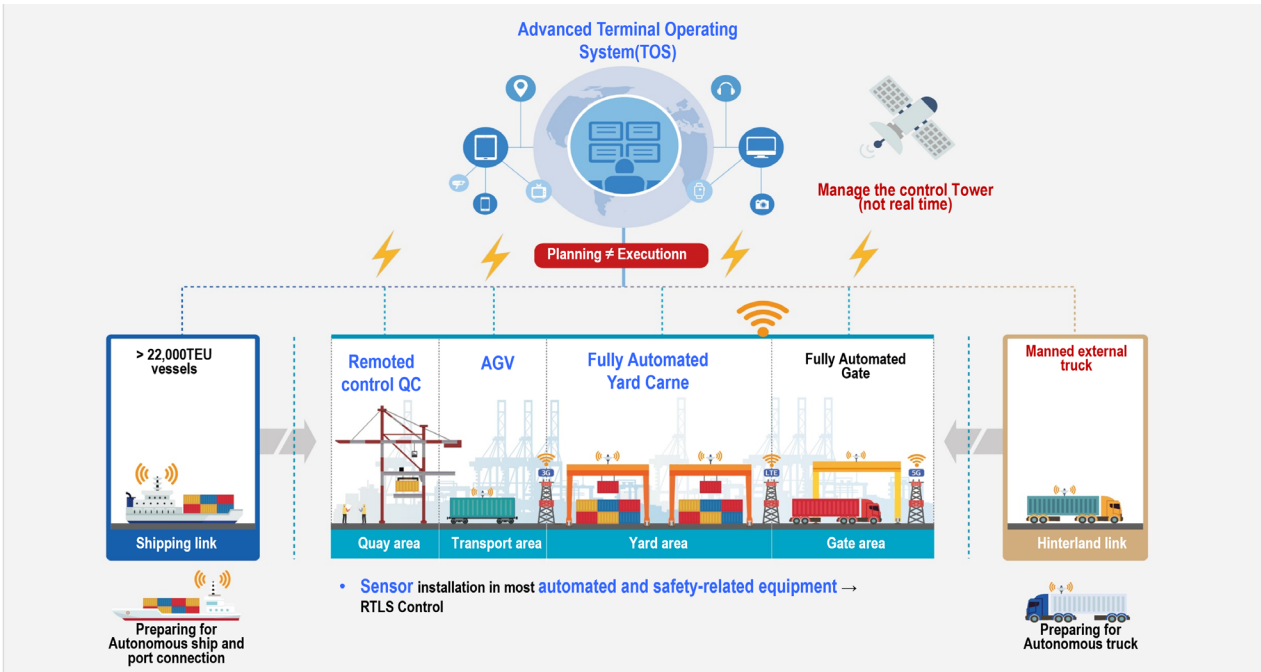
To realize this stage, Korea is pursuing R&D initiatives aimed at developing advanced TOS technologies. In addition, several projects under the Busan Port AX (AI Transformation) Initiative aim to build an intelligent maritime logistics system that extends beyond terminal operations and connects inland and maritime logistics networks. One representative example is AllCon-e, an integrated mobile platform for truck drivers at Busan Port. The platform supports more efficient truck reservations and enhanced safety, while utilizing AI technologies to optimize inland transportation operations. Another example is Port-i, a maritime logistics monitoring system that supports berth allocation optimization and real-time anomaly detection, thereby improving the efficiency of vessel movements and port operations. In addition, the Korea Port Call Optimization (K-PCO) system aims to optimize vessel arrival, berthing, and departure schedules by integrating data from vessels, terminals, and port operators. These examples demonstrate how AI can support decision-making by integrating data and connecting various stakeholders involved in port and logistics operations. In this regard, they can be considered representative examples of the Smart stage.

Figure1. Maturity Stages of Smart Ports

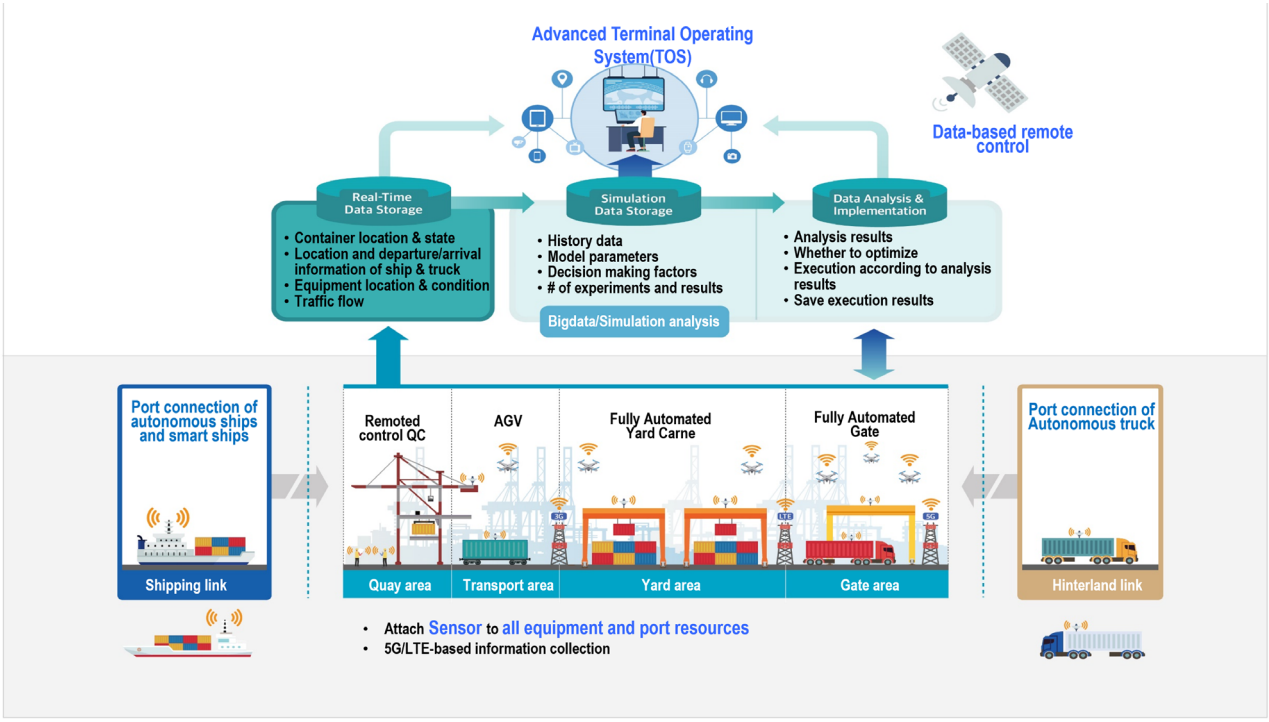
Unit Optimization



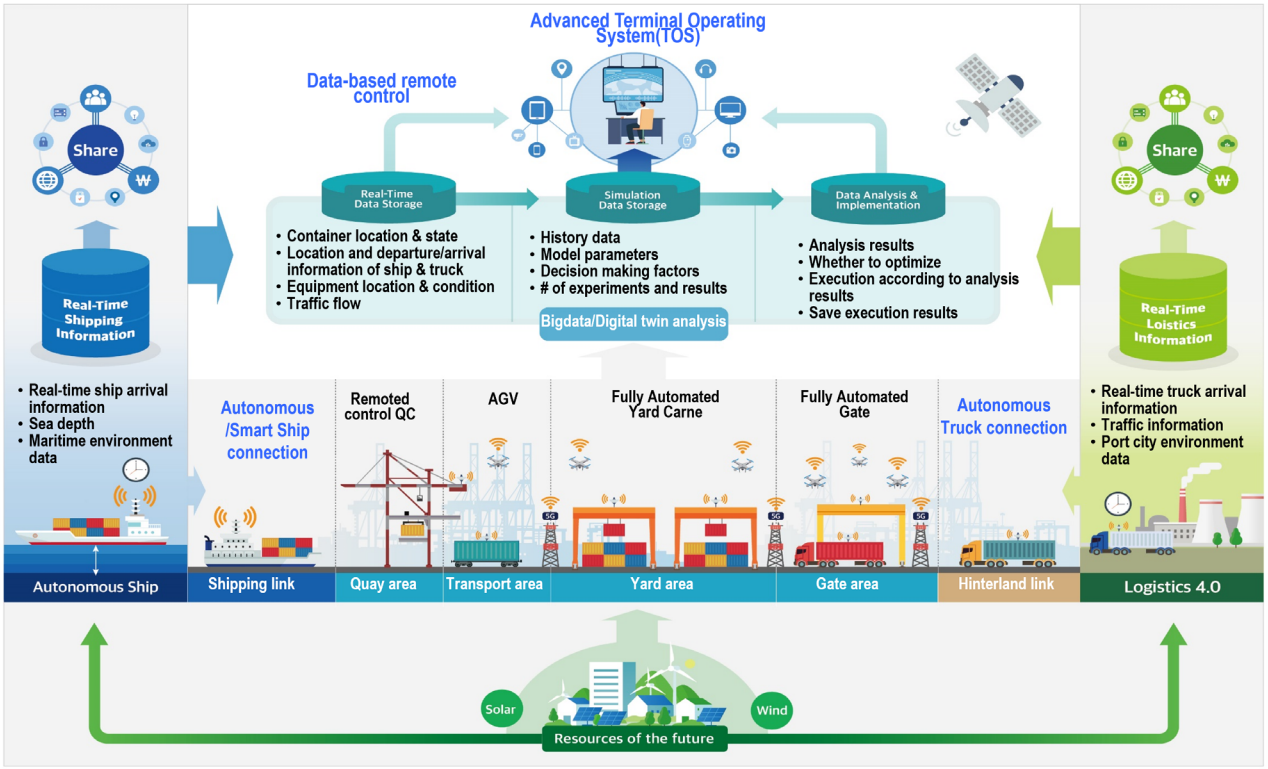
Automation



Digitalization



Smart



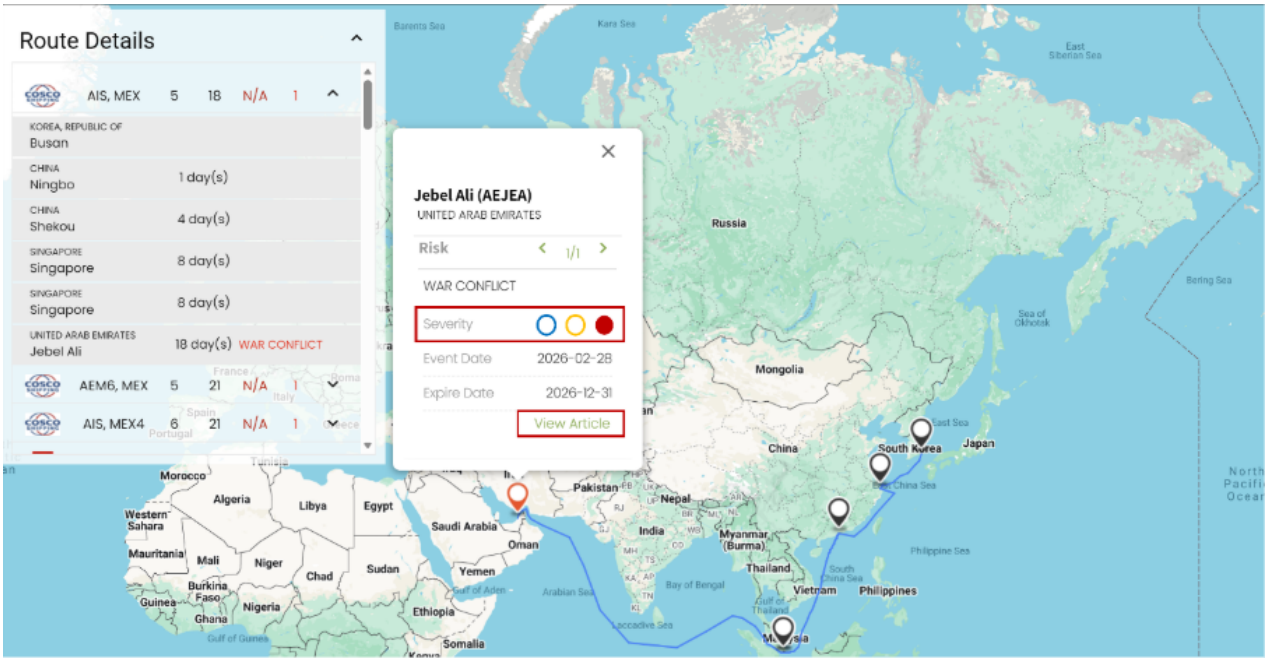
Source: Eon-kyung Lee, Jisung Jo, and et al.(2023), Smart port development strategy study

Maritime transport accounts for the largest share of overall supply chain lead time. As a result, the ability to identify and respond to delays or disruptions during maritime transportation at an early stage has become a critical component of supply chain resilience. Traditionally, individual shipping companies have provided monitoring services to their customers using technologies such as AIS data, blockchain, Internet of Things (IoT) sensors, and AI. These services enable real-time tracking of cargo locations and transportation status throughout the shipping process.

However, since the COVID-19 pandemic, supply chain disruptions have become more frequent and widespread, leading to growing interest in supply chain management at the national level. As economies seek to secure stable supplies of critical goods, attention has increasingly shifted toward monitoring entire maritime transportation networks and identifying potential risks before they materialize. In response to this trend, the Korea Maritime Institute (KMI), a government-funded research institute, is conducting a research project entitled "Development of a Korean Maritime Logistics Supply Chain Early Warning Index and Monitoring Platform" (2026). The project aims to develop an AI-based Early Warning Index (EWI) that quantitatively assesses supply chain risk levels in maritime logistics. It also seeks to establish a monitoring platform capable of tracking global supply chain risks and vessel-commodity network information across maritime transportation networks in real time.

Furthermore, KMI plans to advance the system by developing AI agents that can support government decision-making in responding to supply chain crises beginning in 2027. Moving beyond simple monitoring, the system is expected to evolve into an intelligent supply chain management framework capable of analyzing risk factors, forecasting potential impacts, and recommending response scenarios to support policy decisions.

Figure2. Example interface of the maritime logistics supply chain early warning system



Source: Jisung Jo et al.(2026), Development of a Korean Maritime Logistics Supply Chain Early Warning Index and Monitoring Platform

By around 2030, AI technologies are expected to become widely commercialized across the port, shipping, and logistics sectors. However, alongside the development and expansion of AI applications, there are also important challenges that must be addressed. Among them, one of the most critical issues relates to the collection, sharing, and management of data, which serves as the foundation of AI.

International trade involves a wide range of stakeholders, including shipping lines, ports, terminal operators, cargo owners, freight forwarders, logistics companies, and government agencies. Each of these stakeholders generates and manages data for different purposes and under different responsibilities. As a result, effective use of AI requires data to be connected and shared across organizations. At the same time, however, requirements related to cybersecurity, commercial confidentiality, and personal data protection must also be carefully addressed. For this reason, many APEC economies are exploring ways to establish data governance frameworks that can support the effective use of AI. The Republic of Korea also recognizes the development of institutional and technical foundations for the secure integration and utilization of maritime, port, and logistics data from both the public and private sectors as a key priority.

Ultimately, the success of AI-driven trade facilitation depends not only on the technology itself, but also on how effectively data can be shared and utilized. Given that international trade and maritime logistics are inherently cross-border activities, data governance at the individual economy level has its limitations. Moving forward, APEC economies should work together to establish regional data governance frameworks that promote interoperability, data standardization, and information protection. Such efforts will be essential for realizing the full potential of AI-driven trade facilitation.

2.0

Data Design and Integrity

JACKSON WOOD
Descartes

2.1 Introduction: Data's Role in Accelerating Benefits of AI

Artificial intelligence has the potential to materially improve trade facilitation outcomes in APEC economies. Properly implemented, AI can help customs authorities improve risk targeting, accelerate document review, strengthen revenue collection, identify anomalies in declarations, and reduce administrative friction at the border. These capabilities are increasingly attractive to governments seeking to lower trade costs, improve regulatory efficiency, and strengthen participation in regional and global trade networks. The potential benefits AI can bring to trade facilitation align with the Putrajaya Vision 2040 and Aotearoa Plan of Action, which emphasize the importance of a free, open, transparent, and predictable trade and investment environment supported by digital transformation, innovation, and the flow of data.[1],[2] It is also consistent with the 2025 APEC Ministers Responsible for Trade Joint Statement, which identified AI for trade facilitation as one of three thematic priorities and emphasized "the importance of adopting AI-enabled procedures that contribute to trade facilitation, particularly with enhancing customs procedures."[3]

Data as the Foundation of AI, Not Model Sophistication

AI is no longer confined to the digital economy but is now an integral factor in the future development of APEC's trade facilitation environment. Yet the success of AI in trade facilitation depends far less on the sophistication of the AI models themselves than on the quality, integrity, governance, and interoperability of the underlying data environment. If trade data is fragmented, inconsistent, poorly governed, insecure, or untrusted, AI systems will simply reproduce those weaknesses at greater scale and speed. In a trade environment, that creates more than technical inefficiency. It can disrupt operations, weaken confidence in public institutions, create compliance and legal risk, and ultimately undermine the broader objectives of trade facilitation itself.

For developing economies in particular, AI should not be viewed as a shortcut around foundational modernization challenges. Rather, it should be understood as an accelerator that depends on strong data design, operational trust, disciplined governance, and secure information management. The quality of those foundations will determine whether AI improves trade facilitation outcomes or merely introduces new forms of operational friction and uncertainty.

2.2 Designing Data Around Real Trade Processes

Trade data systems are often structured around administrative silos rather than the actual movement of goods, documents, approvals, and decisions across the border environment. Customs declarations, licensing records, inspection outcomes, shipment histories, valuation decisions, and port events are frequently stored separately, governed inconsistently, or defined differently across institutions. This fragmentation creates immediate limitations for AI-enabled systems because the technology cannot effectively interpret operational context when data remains disconnected.

Effective trade-data design therefore begins with operational reality rather than technical convenience. Systems should reflect how goods move through ports, border crossings, licensing processes, inspections, and post-entry review. AI-supported risk targeting, for example, requires access to transaction histories, routing information, party relationships, licensing status, and prior compliance activity in a form that reflects how customs officers and border agencies actually make decisions in practice.

This also requires clear and consistent definitions for core trade entities such as importer, exporter, consignee, tariff classification, origin, carrier, and shipment. If different systems define those entities differently, AI systems inherit confusion rather than improving efficiency. A shipment identified one way in a customs declaration and another way in a licensing system can easily create inconsistencies that undermine risk scoring or automated validation. Existing standards provide a useful foundation. The World Customs Organization Data Model,[4] for example, provides harmonized data definitions and electronic messages for customs and other cross-border regulatory agencies, while the Harmonized System provides a common basis for product nomenclature. These standards help establish common language, but they do not fully resolve all practical trade-data challenges. Economies may implement them unevenly, extend them differently in domestic systems, or continue to rely on local identifiers, free-text product descriptions, and legacy naming conventions that limit machine readability. APEC can build on these standards by encouraging convergence around shared entity identifiers, structured product attributes, interoperable data schemas, and common minimum definitions for AI-relevant trade datasets.

Privacy considerations must also be embedded into this process from the outset. Trade systems routinely contain commercially sensitive information, including supplier relationships, pricing structures, shipment details, financing arrangements, and customer information. Governments should therefore incorporate privacy-by-design principles into trade-data architecture through role-based access controls, encryption standards, data minimization practices, and clear restrictions governing who can access sensitive information and for what purpose. In many developing economies, confidence in digital systems remains uneven. Strong privacy protections are therefore essential not only for security, but also for building institutional trust and encouraging participation in digital trade processes.

A useful example is the APEC Privacy Framework[5] and the Cross-Border Privacy Rules system,[6] which use an accountability-based approach to support privacy-respecting personal information flows across economies. While originally designed for personal information rather than customs data specifically, the model is relevant to AI-enabled trade facilitation because it demonstrates how privacy safeguards can be built into cross-border data governance from the outset. Similar principles can be applied to trade systems by requiring defined purposes for data use, clear accountability for data controllers and processors, proportional collection of information, and enforceable controls for access, retention, and onward transfer.

2.3 The Importance of Standardization

Trade facilitation depends on information exchange across customs authorities, ports, freight forwarders, customs brokers, terminal operators, carriers, banks, and other government agencies. AI systems cannot operate reliably if those participants use inconsistent naming conventions, conflicting identifiers, incompatible formats, or unstructured records. One agency may record company names differently from another. Product descriptions may appear as vague free text rather than standardized commodity references. Dates, locations, and shipment identifiers may vary across systems in ways that create ambiguity for both humans and machines.

Several international standards already provide useful foundations for addressing this challenge. These include the World Customs Organization Data Model, UN/EDIFACT messaging standards, ISO country and currency codes, and the Harmonized System nomenclature. Likewise, UN/CEFACT standards have helped establish frameworks for electronic trade documentation and interoperability. These frameworks represent important efforts to create more consistent approaches to international trade-data exchange.

CASE STUDY

Edward Ko, *Mely.AI Solutions Inc.*

Mely.AI Solutions Inc.

Trade facilitation challenge(s) addressed: Trade and logistics operations still rely on fragmented and manual digital workflows. This creates delays, data entry errors, compliance risks, poor visibility, and inefficient coordination across supply chain actors. The main challenge addressed in this case study is the conversion of fragmented and unstructured trade documentation into structured, searchable, and actionable data that can accelerate customs clearance, cargo planning, compliance validation, and operational decision making.

How the AI system works in practice: The AI system receives trade and logistics documents in different formats, such as PDFs, scanned files, emails, EDI files, and inconsistent document templates.

- **Computer Vision and OCR:** read the document content
- **NLP and machine learning models:** identify, extract, classify, and structure the required data
- **Domain specific models:** validate the information against customs, operational, and client requirements
- **Large Language Models:** support exception handling, summarization, decision support, and operational recommendations
- **Agentic AI framework:** reasons the results and take simple action automatically when no exceptions detected

Human operators review low confidence results or exceptions, provide feedback, and the system improves over time through a human in the loop workflow.

Measurable outcomes: The solution reduces manual data entry, accelerates document processing, improves data quality, and lowers rework. In specific use cases, document redaction processing time was reduced from hours to minutes, dangerous goods data became searchable in seconds, and customs broker workflows achieved faster clearance times with lower operational cost and less manual rework.

Non-quantifiable benefits and challenges: Benefits include improved employee productivity, stronger operational visibility, better customer satisfaction, higher stakeholder trust, improved compliance confidence, better safety readiness, stronger decision making, and more transparent supply chain coordination. Challenges include change management, onboarding complexity, fragmented legacy systems, variable data quality, inconsistent operating procedures, the need for user training, and maintaining human trust in AI outputs. AI model bias and incorrect recommendations are mitigated through confidence scores, human review, explainability, auditability, and escalation workflows.

Even so, global trade-data standardization remains incomplete and fragmented. Many economies continue to operate overlapping legacy systems, inconsistent identifiers, and partially digitized workflows. Future modernization efforts should therefore prioritize interoperable, machine-readable trade-data structures capable of supporting AI-enabled workflows across institutions and borders.

Over time, governments and international organizations should work toward greater adoption of standardized entity identifiers, interoperable single-window architectures, structured transaction schemas, and secure API-based exchange frameworks. Future standards should also prioritize explainability and auditability so that AI-supported decisions can be traced and reviewed where necessary. Through its voluntary, non-binding, and consensus-based model of cooperation, APEC provides an ideal platform to advance the development of these international standards.

At the same time, interoperability should not come at the expense of confidentiality. Greater connectivity between systems inevitably increases the exposure surface for commercially sensitive information. Governments must therefore balance interoperability objectives with clear governance rules covering data sharing, cross-border information transfers, third-party access, retention policies, and cybersecurity protections. Without those safeguards, efforts to modernize trade-data exchange could weaken trust even while improving operational efficiency. Further priorities on the development of governance rules that support data privacy in the implementation of AI for trade facilitation are explored in Chapter 5: Good Regulatory Practices.

2.4 Data Quality as an Operational Discipline

Data quality must be treated as an ongoing operational discipline rather than a one-time modernization exercise. In trade facilitation environments, failures in data quality produce immediate consequences. Inaccurate or incomplete data can lead to poor risk scoring, inconsistent treatment of shipments, faulty revenue estimates, duplicate records, and unnecessary border delays.

AI systems cannot compensate for poor-quality data. If inaccurate or incomplete records are used to support tariff classification, valuation, inspection selection, or fraud detection, the result will simply be poor-quality automation delivered at greater speed. This creates particular risks in customs environments where regulatory decisions can carry legal, financial, and operational consequences.

A common cautionary example can be seen when large logistics or marketplace operators attempt to automate customs workflows before the underlying product and shipment data has been cleaned. If vague item descriptions, inconsistent supplier names, missing manufacturer information, or outdated classification tables are fed into an automated screening or declaration process, the system may accelerate the wrong decision rather than improve the right one. The practical result can include avoidable shipment holds, incorrect duty calculations, duplicate exception queues, and costly manual rework. For policymakers, the lesson is not that automation should be avoided. It is that AI deployment should be preceded by data validation, exception handling, human review thresholds, and feedback loops that allow poor-quality records to be corrected before they are reused at scale.

For that reason, governments should embed validation and quality controls directly into operational workflows. Validation rules at the point of entry, duplicate-record detection, exception management processes, traceable corrections, and periodic quality reviews are all essential components of a sustainable trade-data environment. Data-quality controls should be treated as operational capabilities rather than purely technical exercises.

Importantly, economies do not need to solve every data-quality problem simultaneously. A phased approach focused on high-value datasets associated with targeted AI use cases is often more realistic and operationally sustainable. Governments may initially prioritize declaration data, licensing information, shipment histories, or trader profiles before expanding to broader ecosystem integration.

Singapore's use of an AI-enabled HS/CA Product Code Checker7 provides a useful example of a more phased approach. Rather than attempting to automate all customs decision-making at once, the tool focuses on a specific, high-volume pain point: helping businesses identify Harmonized System and competent authority product codes from product descriptions. This type of bounded use case is especially relevant for developing economies because it allows governments to test AI against a defined dataset, measure user value, refine search accuracy, and retain official channels for rulings or escalation where the result is uncertain. Pilots of this kind can help economies build confidence, improve data discipline, and develop internal AI expertise before expanding to more consequential use cases such as risk targeting, inspection selection, or enforcement referrals.

Data-quality initiatives must also incorporate strong protections around sensitive information management. High-quality trade data is commercially valuable and, in some cases, strategically sensitive. Governments should therefore establish clear rules governing encryption, retention, deletion, access monitoring, and audit logging to ensure that improvements in data quality do not inadvertently create new security or confidentiality risks.

2.5 Integrity, Traceability, and Auditability

Trade data supports revenue collection, regulatory enforcement, legal decisions, and commercial rights. Confidence in the authenticity and integrity of that data is therefore essential. As AI becomes more deeply integrated into customs and border operations, governments and traders alike will need confidence that records have not been improperly altered, that decisions can be reconstructed, and that the basis for AI-supported outcomes can be understood and reviewed when necessary.

This does not necessarily require full technical transparency into every AI model. It does, however, require strong surrounding controls, including audit trails, provenance tracking, access management, version control, secure storage, and decision logging. If an AI-supported system recommends a shipment inspection, hold, escalation, or enforcement referral, officials and affected businesses need confidence not only in the recommendation itself, but also in the integrity of the underlying data and governance process.

These controls are particularly important in economies where trust in digital systems may still be evolving. Strong traceability and governance frameworks help ensure modernization strengthens institutional legitimacy rather than creating new forms of opacity. They also help governments defend enforcement decisions and respond more effectively to disputes or appeals.

2.6 Interoperability Across Institutions

Trade facilitation is inherently cross-institutional. Customs authorities operate alongside licensing agencies, tax authorities, ports, transport systems, border inspection bodies, and single-window platforms. If data remains trapped inside disconnected systems, AI will inevitably operate against fragmented views of trade activity.

Interoperability allows governments to reduce repetitive submissions, improve consistency across agencies, and create more context-rich environments for AI-supported decision-making. A customs risk engine that cannot access licensing status, shipment history, or related tax information will produce weaker outcomes than one operating against a more complete operational picture.

This does not require constructing a perfectly unified system immediately. It does require deliberate architecture for secure data exchange, shared identifiers, and common governance standards capable of supporting future integration efforts. Governments should focus on practical interoperability that supports operational coordination rather than pursuing overly ambitious technology transformation programs disconnected from institutional realities.

At the same time, interoperability must be balanced with strong privacy protections. Connected systems should not create uncontrolled visibility into commercially sensitive data. Governments should establish clear rules governing data-sharing permissions, role-based access, jurisdictional controls, secure API authentication, and third-party access rights.

2.7 Governance and Accountability

Successful AI deployment depends as much on institutional discipline as technological capability. Governments need clear answers regarding who owns trade data, who is responsible for quality, who can modify records, how disputes are corrected, how AI-supported decisions are reviewed, and what controls exist over sensitive-information access.

Without clear governance, data quality deteriorates, accountability becomes diffuse, and confidence in digital systems weakens over time. Human oversight remains particularly important where AI influences decisions with commercial or legal consequences, including inspections, shipment holds, penalties, or enforcement referrals. AI should strengthen official decision-making rather than obscure responsibility for it.

The U.S. Customs and Border Protection Directive No. 1450-030 on AI Operations and Governance8 provides a useful governance reference point. It establishes an internal framework for the strategic use of AI within CBP and assigns responsibilities across offices and oversight functions. Several features are especially relevant for APEC economies considering AI-enabled trade facilitation: maintenance of an AI use-case inventory, privacy threshold analysis, defined governance and approval pathways, and clear personnel responsibilities for implementation and oversight. These controls help ensure that AI systems are not deployed as isolated technical tools, but as governed public-sector capabilities subject to accountability, privacy review, and operational supervision.

Governance frameworks should therefore establish clear rules defining acceptable AI usage, escalation procedures, access monitoring, vendor management, confidentiality obligations, protections against unauthorized access to sensitive datasets, and procedures for reviewing AI-supported outcomes. This becomes especially important where economies rely on external technology providers or cloud infrastructure partners to support modernization initiatives. Where AI affects inspection, release, penalty, or enforcement decisions, governance frameworks should also require explainable decision records, documented human review, periodic performance testing, and channels for traders to challenge or correct inaccurate data used in AI-supported decisions.

2.8 Conclusion

The successful use of AI in trade facilitation will not be determined primarily by which AI model is selected or which technology appears most advanced. It will be determined by whether economies build the data foundations necessary to make AI systems reliable, explainable, scalable, secure, and trusted.

That means designing data around real trade processes, standardizing language and structure, managing data quality as an ongoing discipline, protecting integrity and traceability, enabling interoperability across institutions, embedding privacy protections, and establishing clear governance and accountability frameworks.

AI can absolutely help APEC economies improve trade facilitation outcomes. But it cannot compensate for weak data foundations. The opportunity lies in building trusted trade-data ecosystems that allow automation and intelligence to support better decisions, faster border processes, stronger compliance outcomes, and deeper participation in global commerce. In that sense, data design, governance, integrity, and privacy are not secondary technical concerns. They are the core enablers of successful AI-enabled trade facilitation.

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3.0

Human Resource Development and Workforce Considerations

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The authors are grateful for the research assistance of Charles Wong in analyzing the LinkedIn talent data of AI-skilled professionals.

3.1 Introduction: The Dual Reality of AI in Trade

This chapter examines the current state of AI adoption in trade facilitation and related industries, assesses workforce preparedness across the region, and explores the challenges and opportunities this transition presents. Drawing on examples from different economies, the chapter offers a framework for building AI competence within the trade workforce while fostering the stakeholder trust and accountability necessary for a successful and inclusive transition.

3.2 The State of Play: Opportunities and Challenges

Accelerating AI Adoption in Trade and Customs

The APEC region is rapidly transitioning from basic automation to the adoption of generative AI and agentic AI (autonomous systems) to eliminate operational inefficiencies. A key example can be seen in regional banking, where AI is utilized to automate transaction profiles, reducing front-office processing time by up to 50%.[1] In the trade facilitation context, economies are leveraging AI to modernize trade infrastructure, making customs and logistics operations more agile, efficient, and resilient.

The practical benefits of this transition are already evident across various economies. Customs authorities are beginning to integrate AI into their core operations to enhance threat prediction,[2] improve anomaly detection in cargo screening,[3] and automate complex, data-intensive administrative workflows such as commodity coding and unit value anomaly detection,[4] and cargo manifest data matching and consolidation[5] —paving the way for a more streamlined and secure global trading environment.

Bridging the Trade Finance Gap for SMEs

Beyond customs and administrative efficiency, AI presents a significant opportunity to address financial disparities in global trade ecosystems. A critical theme in recent APAC trade finance research is the massive global trade finance shortfall—estimated at $2.5 trillion by the Asian Development Bank (ADB)—which disproportionately affects Small and Medium Enterprises (SMEs). Banks often reject SME trade loan applications due to strict Anti-Money Laundering (AML) and Know Your Customer (KYC) compliance costs. AI-driven risk management and automated compliance solutions can lower these costs, allowing banks to finance smaller, viable commercial transactions.

The Critical AI Skills Gap and Workforce Transformation

However, realizing the transformative potential of AI across the trade sector depends on overcoming a critical challenge common to many industries: an acute and growing shortage of AI-skilled workers and digital infrastructure. The World Economic Forum (WEF) identifies skill gaps as the biggest barrier to business transformation between 2025 and 2030, a hurdle cited by over 60% of employers.[6] This challenge

is intense across the Asia Pacific and the Middle East region, where 71% of employers report difficulty filling open roles—closely mirroring the global average of 72%—with AI skills being the hardest to find.[7]

For SMEs, this barrier is immediate. They often lack the digital infrastructure and the specialized talent (e.g., big data, AI and cybersecurity experts) required to integrate into these new AI-driven supply chain platforms. Without accessible tools and digital literacy, smaller firms in emerging APEC economies risk being cut out of global supply chains altogether.

Fundamentally, this talent shortage stems from a broader global workforce transformation, where AI is generating new, specialized demands rather than simply eliminating work. The WEF projects a net gain of 78 million jobs globally by 2030 (170 million created versus 92 million displaced),[8] a massive transition that will demand reskilling or upskilling nearly 60% of the workforce.[9] This dynamic is already evident in recent C-suite barometers in the Asia-Pacific: rather than displacing workers, AI is actually driving headcount growth and reshaping workforce composition.[10] Over 40% of APAC business leaders report that AI has created new roles within their organizations, significantly outpacing the percentage of those who say it has replaced jobs.[11] The trade finance sector offers a prime example of how this evolution plays out in practice. As AI is heavily utilized for document-intensive, manual processes including verifying bills of lading, commercial invoices, and letters of credit using Optical Character Recognition (OCR) and Natural Language Processing (NLP), the required skill set for human workers is shifting. Professionals are moving away from routine administrative tasks to higher-value strategic roles, such as advisory, complex risk assessment, and relationship management.

Disparities in Workforce AI Preparedness across APEC Economies

Given that such a transition requires significant investment in education and infrastructure, AI readiness has become **geographically polarized.** Research output and specialist talent remain concentrated in a small number of countries. According to Stanford HAI's AI Index, within APEC, the United States and China lead global output; and advanced economies like Japan, Korea, Singapore, Australia, and Canada boast strong AI talent pipelines and industry investment.[12] The International Monetary Fund's (IMF) *AI Preparedness Index* reveals a highly uneven landscape across Asia Pacific—exceeding 70% in advanced economies such as Singapore, Korea, Japan, and the United States, but falling below 30% in lower-income economies like Papua New Guinea. This "great divergence" poses a barrier to region-wide AI integration in cross-border trade and commerce.[13], [14]

The Hong Kong University of Science and Technology's ongoing study on AI talent distribution across regions and sectors reveals a similar disparity. As Table 1 illustrates, the proportion of professionals with AI skills in trade- and logistics-related industries ranges widely across APEC economies.

Table 1: Distribution of professionals with AI skills in trade- and logistics-related industries across APEC economies

Below table shows the number of AI-skilled professionals per 1000 workers in each industry sector based on LinkedIn profiles in each economy:

No. of AI-skilled Professionals per 1000 Workers across the APEC Economies	International Trade and Development (Financial Services)	Freight and Package Transportation	Rail & Truck Transportation	Warehousing and Storage	Wholesale Import and Export
Range across APEC Economies	0 - 29.73	0 – 24.87	0.37 – 11.97	0 – 8.60	0.44 – 5.65
Mean of APEC Economies	10.36	5.87	5.62	2.89	2.71

No. of AI-skilled Professionals per 1000 Workers across the APEC Economies	International Trade and Development (Financial Services)	Freight and Package Transportation	Rail & Truck Transportation	Warehousing and Storage	Wholesale Import and Export
Median of APEC Economies	9.35	3.76	4.85	2.05	2.39
Top Five Economies	Singapore, New Zealand, United States, Canada, Japan	Singapore; Canada; Hong Kong, China; New Zealand; Japan	Singapore; Japan; Chinese Taipei; Hong Kong, China; Mexico	Singapore; Japan; Vietnam; Papua New Guinea; Hong Kong, China	Canada, Chile, New Zealand, Australia, Brunei Darussalam

*Note: The dataset is based on **LinkedIn member profiles,** which primarily represents professionals active on global professional networking platforms. (Source: LinkedIn Talent Insights)*

While the ratios of AI-skilled workers remain generally low across trade and logistics sectors (mostly below 2% of the overall sector workers), several economies stand out with notably higher AI talent ratios: Singapore; Japan; Canada; New Zealand; Hong Kong, China; and the United States. This suggests a more mature, system-wide integration of AI into trade and supply chain operations across these economies. In contrast, some economies currently show lower overall AI talent density in these sectors, mostly falling below 5 AI-skilled workers per 1,000 workers—indicating that while automation is spreading, AI has not yet broadly penetrated their traditional trade and logistics workforces.

Furthermore, the data reflects a significant **sectoral concentration** of AI-skilled workers. More than half of APEC economies concentrate AI workers in International Trade and Development—a financial services function. Sectors like *Freight and Package Transportation* have relatively strong AI talent distributions. In contrast, sectors such as Warehousing and Storage and Wholesale Import and Export show the lowest AI talent densities overall, with most economies reporting fewer than 3 AI-skilled workers per 1,000. This indicates that storage and wholesale operations remain highly manual or less attractive to AI professionals.

The pronounced difference in AI talent density across economies and sectors is closely tied to how their workforce structures are evolving. More digitized, data-intensive industries, such as financial services, are actively redesigning their workforce architectures—reskilling staff, automating processes, and building cross-functional teams. This redesign accelerates the demand for and retention of AI talent, creating a virtuous cycle: more strategic roles attract top AI professionals, who in turn drive further transformation. Without such workforce redesign, even well-capitalized hubs may fail to retain AI talent, as skilled professionals find few opportunities to apply their expertise beyond isolated tasks.

Overall, AI expertise remains highly centralized in established global trade hubs and digitally mature economies, whereas foundational and traditional supply chain activities such as trucking, warehousing, and wholesale import/export are experiencing a substantial shortage of AI talent. This uneven distribution presents a potential bottleneck for end-to-end supply chain optimization. The data suggests that cultivating AI proficiency within the foundational, day-to-day logistics workforce remains a critical challenge for APEC economies.

3.3 A Framework for Action: Fostering an AI-Competent Trade Workforce

Bridging the AI skills gap in trade-related industries requires a multi-faceted strategy built on tripartite collaboration between governments, industries, and academic institutions. High-level frameworks like the APEC Internet and Digital Economy Roadmap (AIDER) and the APEC Framework on Human Resources Development in the Digital Age provide a policy foundation for these efforts. Several APEC economies offer scalable models for translating this into action, directly applicable to the trade sector.

Building Foundational and Sector-Specific Skills

Region-wide upskilling programs are essential. **South Korea** has launched university-led, industry-tailored AI courses for working adults in finance and manufacturing, a model readily adaptable to trade professions.15 Critically, the Korea Customs Service has established its own internal ICT Expert Training Program, which includes training in Python and machine learning, directly building AI capacity for trade facilitation from within.[16]

Hong Kong, China combines a sector-focused training approach for industry professionals and a comprehensive AI-inclusive upskilling strategy for the broader workforce. For example, the Hong Kong Monetary Authority (HKMA) launched the Enhanced Competency Framework (ECF) on Fintech for Banking Practitioners—a certification program developed jointly with the Hong Kong Institute of Bankers and local universities that established transparent competency standards for building a robust tech talent pipeline. Originally designed for the financial services industry, this model is readily adaptable to trade-related sectors such as customs and logistics.[17] To further broaden workforce agility, the government is upgrading its Employees Retraining Board into "Upskill Hong Kong", offering comprehensive skill-based and AI application training from foundational to advanced levels for the workforce.[18]

Looking across the broader APEC region, **Thailand** has implemented the National AI Strategy and Action Plan (2022-2027) with an aim to cultivate AI ethics awareness for 600,000 citizens and train 30,000 AI talents within 6 years.[19] To close professional skill gaps, the government has heavily leveraged public-private partnerships with both local and global tech leaders, including Google and Microsoft. This includes the recent noteworthy "AI for All Thais" initiative—that embeds AI education directly into Thailand's university system for the first time—and various collaborations providing Thai-language AI and digital literacy courses for workers and educators.[20], [21]

Similar government-led targeted workforce AI and digital literacy initiatives are taking shape across the region. These include **China's** large-scale vocational training and education efforts through its AI + Education Action Plan,[22], [23] which support the broader industrial transformation envisioned by the "AI Plus" (AI+) initiative within its 15th Five-Year Plan (2026-2030);[24] **Singapore**'s government-subsidized SkillsFuture for Digital Workplace 2.0 program, which equips citizens and enterprises with essential tech and data skills;25 and **the Philippines**' "Leadership in the Digital Era" and "AI in the Workplace" courses, which actively upskill its public sector.[26]

Drawing from these regional examples, economies can accelerate their AI readiness by forging strategic partnerships, such as partnering national universities with industry associations to co-design micro-credential courses tailored for working professionals in specific sectors. Simultaneously, they can actively solicit public-private partnerships with global technology providers to scale high-quality training resources without bearing the full infrastructure costs.

To build a robust talent pipeline that meets evolving industry demands, economies should convene joint task forces—comprising government regulators, academic institutions, and industry leaders—to define standardized AI competency benchmarks for key sectors, while upgrading legacy retraining programs to focus on scalable digital skills that ensure long-term employability for professionals and the broader public. Within the specific context of trade facilitation, customs and other border regulatory agencies can establish dedicated in-house tech academies to upskill existing personnel. This ensures that digital transformation is driven by internal experts and closely aligned with institutional requirements.

Creating a Holistic Ecosystem for Trade Transformation

A comprehensive approach for workforce empowerment moves beyond training to create a sustainable support system for organizations and actors across the trade ecosystem. **Hong Kong, China** exemplifies this approach through a multi-pronged strategy that spans policy steering via a dedicated Committee on AI+ and Industry Development Strategy, [27] practical enterprise AI support through the "HKPC Picasso" platform,[28] targeted SME upskilling via the Transformation Sandbox (T-box) program,[29] and streamlined sharing of cargo and trade data with banks through the "Project Cargox" initiative.[30]

Demonstrating a similar holistic approach, **Malaysia** empowers local exporters and MSMEs with its AI-driven "MADANI Digital Trade" platform, which serves as a unified one-stop hub for market intelligence, business matching, and trade facilitation, effectively reducing cross-border trade costs and unlocking access to global markets.[31], [32] Similarly, **Indonesia** prioritizes comprehensive ecosystem development—spanning essential data infrastructure, ethics, and collaborative innovation—through its overarching National Strategy for Artificial Intelligence (Stranas KA 2020-2045).[33]

Referencing these regional models, other economies can establish cross-agency steering committees to drive overarching national strategies that systematically address foundational issues and reflect industry needs. On a practical level, economies can also develop centralized "sandbox" platforms and secure public-private data-sharing infrastructures to lower technical barriers, empowering MSMEs to successfully navigate their digital transformation.

3.4 Ensuring a Responsible Transition: Trust, Governance, and Accountability

While industry leaders work to safely integrate AI into trade operations, they must navigate significant hurdles—such as data privacy, regulatory uncertainty, and algorithmic transparency—which are often cited as the top barriers to scaling AI. Overcoming these challenges relies heavily on building stakeholder trust through transparent governance and maintaining human accountability. To achieve this, organizations must establish robust governance frameworks and, most importantly, develop a trade workforce capable of upholding responsible practices and making informed decisions while working alongside complex AI systems. As a result, there is a growing demand across the sector not just for technical AI engineers, but for **AI governance and ethical AI professionals.**

CASE STUDY

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Turing Space

Trade facilitation challenge(s) addressed: A container shipment from one APEC economy to another generates between thirty and forty distinct documents across export, transport, and import. Industry estimates of trade-document fraud losses run into the tens of billions USD annually. Commercial gen-AI tools collapsed the cost of producing forgeries. Post-2022, anyone can render a credible Certificate of Origin from a prompt. A human inspector under time pressure cannot reliably distinguish a real Certificate of Origin from a generative-AI render.

How the AI system works in practice: The user uploads a document, and the platform validates the format, assigns a case ID, and routes to the appropriate document-class pipeline. The tool returns one of three verdicts:

- **VERIFIED** requires ≥90 percent confidence, visual integrity, institution verified, signatories authenticated, and live portal lookup completed.
- **REJECTED** triggers on vendor markers, a phantom institution, or a known template fingerprint match.
- **SUSPECT** means the algorithm found something it cannot resolve cleanly and the document needs a human reviewer.

Measurable outcomes:

- **Time saved:** A single-document forensic verdict comes back in under thirty seconds. Manual verification of the same document ranges from a few minutes to weeks.
- **Detection accuracy:** A 200-document stratified dataset across four difficulty tiers. Published case studies in the Wall of Forgeries include rejection verdicts at 99.4 percent confidence.
- **Costs:** Pricing sits an order of magnitude below the loaded cost of manual review at any organization Turing Space has measured against.
- **Coverage:** 23,029 institutions indexed, 206 countries reached, 43 attack vectors catalogued.

Non-quantifiable benefits and challenges: The deeper value is confidence at the point of decision. There is an audit trail that survives a year-end review, and there is a deterrent effect from the public Wall of Forgeries. Model bias toward dominant document classes in the training data is real. Turing Space mitigates this with conservative thresholding, returning SUSPECT when in doubt, and by actively expanding the institutional registry into underrepresented economies. Adoption friction in conservative regulatory environments is real too, where customs administrations want formal accreditation before treating an AI-generated report as supporting evidence.

Establishing Transparent AI Governance Frameworks

Economies are establishing robust frameworks that can guide trade-related AI deployment. For instance, Singapore's Monetary Authority introduced sector-specific governance through its FEAT principles (Fairness, Ethics, Accountability, Transparency).[34] Likewise, the Hong Kong SAR Government established the "Ethical AI Framework" to guide risk management in AI projects,[35] and issued the "Policy Statement on Responsible Application of Artificial Intelligence in the Financial Market", promoting a balanced approach to AI development in finance.[36] More recently, it released the "Hong Kong Generative Artificial Intelligence Technical and Application Guideline" in April 2025 to provide a governance framework with local characteristics that suits the Hong Kong, China context for all stakeholders in the AI ecosystem.[37] These frameworks lay the vital groundwork for responsible AI adoption. Good regulatory practices around AI governance will be explored further in Chapter 5 of the report.

Developing Interdisciplinary Trade professionals with Expertise in Both Regulation and AI

Translating these principles into practice requires a highly skilled workforce that simultaneously possesses trade domain expertise, AI proficiency, and a deep understanding of legal and regulatory compliance. As the regulatory landscape grows increasingly complex—with varying AI governance and national standards across APEC economies—maintaining compliance has become a top concern for all stakeholders across the global supply chain. Navigating disparate data protection, consumer privacy, and intellectual property regimes across multiple jurisdictions creates significant legal and regulatory complexity, making specialized advisory expertise essential.

To address this, workforce upskilling must focus on equipping legal advisors, customs brokers, and logistics intermediaries with specialized training on AI-specific issues and regulations. Building this expertise ensures that organizations can maintain compliance, operational integrity, and consumer trust while safely leveraging AI technologies in cross-border supply chain operations.

Fostering Accountability and Data Ethics and Mandating "Human-in-the-Loop" Workflows

Trade professionals must be equipped not only with the technical skills to operate AI-driven systems, but also with the critical principles to evaluate their outputs responsibly. This requires comprehensive training that emphasizes data privacy and handling, bias mitigation, and decision-making. Alongside upskilling, institutional governance and formal "Human-in-the-Loop" guidelines are critical for maintaining safety, fairness, and accountability. Aligning with global benchmarks like the EU AI Act, organizations including the World Customs Organization strongly emphasize that AI must augment, rather than replace, expert human judgment, ensuring that human operators remain ultimately accountable for high-impact decisions in an increasingly automated trade environment.[38]

This principle is reflected in the U.S. Customs and Border Protection (CBP) ruling of January 16, 2026 (CEE. HQ H350722), which defined regulatory boundaries on the preconditions for conducting customs business on behalf of others and demarcated the limits of utilizing AI or automated tools in this process. Under current regulations, only licensed customs brokers are permitted to conduct customs business on behalf of others, and they must have a role in specifying the information generated by an AI tool's decision matrix for entries filed with CBP. This ensures that while AI can act as a powerful preparatory tool, a licensed individual customs broker must remain actively involved in defining entry decisions and making the final determination for filings. By legally anchoring these strict requirements for licensed broker participation, this ruling underscores that advanced automated systems cannot substitute for the formal licensing, professional judgment, and legal accountability of qualified customs professionals.

Realizing the transformative potential of AI in trade facilitation across the APEC region requires more than just adopting new technology. It demands a genuine commitment to human capital and ethical oversight. By actively bridging the critical skills gap and fostering an AI-augmented trade ecosystem through tripartite collaboration—among governments, industries, and academia—while also embedding clear ethical frameworks and human oversight into development strategies, economies can harness AI's capabilities safely. Ultimately, this holistic approach is essential for unlocking inclusive economic growth and empowering the region's trade workforce to confidently move into higher-value, strategic roles.

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4.0

Digital Infrastructure and Development Gaps

DARYL TEO
Access Partnership

4.1 Introduction: Closing APEC's Gaps

AI is transforming international trade at every stage of the transaction, from the movement of goods and the flow of information to the settlement of payments. As described in Chapter 1 of the Report, various stakeholders are exploring AI use across the Buy-Ship-Pay value chain: brokers automating Harmonized System (HS) code classification, customs administrations deploying AI-based risk scoring, and banks accelerating trade finance verification. The commercial evidence for these gains is accumulating. Industries with higher AI exposure record export levels approximately 31 percent higher than those without, and nearly 90 percent of firms already using AI for trade-related activities report tangible benefits, including cost reductions of up to 50 percent in compliance and communications functions.[1]

Yet these gains are neither universal nor guaranteed. The gap between those capturing AI's trade benefits and those that are not reflects underlying deficits in the digital infrastructure and development foundations that make AI deployment possible, of which there are three. Connectivity — reliable broadband at sufficient speed and affordability — provides the baseline infrastructure on which AI tools operate. Compute — access to chips, servers, data centers, and cloud capacity that underpin model training and inference — determines what AI applications are feasible and for whom. Capability — the accumulated organizational experience within government agencies and firms that enables them to absorb, integrate, and govern AI tools effectively — determines whether connectivity and compute translate into genuine gains. This chapter examines each foundation in turn, assesses where the APEC region stands, and identifies the policy levers available to close the gaps.

4.2 Connectivity

Good and reliable connectivity is the starting point to enabling AI for trade facilitation. Without reliable and high-quality broadband, customs authorities cannot process high-velocity data streams – from cargo tracking systems to fuel predictive analytics – and traders remain unable to leverage conversational AI systems and resources to navigate tariff and documentation requirements and manage their own AI/ML projects.

The headline numbers suggest significant progress, but the picture is more uneven on closer inspection. Internet usage across APEC economies has risen sharply from 44 percent in 2011 to 89 percent in 2024, yet more than 300 million people in the region remain unconnected or poorly connected. [2],[3] Where fixed broadband is available, performance is strong. As of 2023, 11 APEC economies recorded median fixed broadband speeds exceeding 100 Mbps, with a regional median of 133.4 Mbps, speeds broadly conducive to AI workloads. However, the reach of fixed broadband remains constrained at below 50 per 100 people across all APEC economies, meaning those speeds apply to a limited subscriber base. Much of the growth in internet usage has instead been driven by mobile connectivity, where the regional median download speed of 49.4 Mbps trails fixed broadband considerably.[2],[4] The more sophisticated AI applications that matter most for trade facilitation, such as risk scoring and cargo image analysis, require the speeds and bandwidth that fixed broadband provides. Mobile connectivity, as currently constituted, cannot reliably deliver these speeds and bandwidth.[5]

Closing these gaps will require action on several fronts. Enabling private investment remains the highest-priority lever: liberalizing foreign direct investment in telecommunications, streamlining infrastructure permitting, mandating passive infrastructure sharing, and establishing clear spectrum allocation frameworks can collectively lower the cost and accelerate the pace of commercial rollout. Where commercial returns are insufficient to drive coverage, particularly in rural and remote areas where many smaller manufacturers and services firms operate, direct government subsidy through universal service funds and shared access points can extend the reach of internet connectivity. Alongside terrestrial infrastructure, fast-tracking licensing for satellite broadband operators and ground stations can also offer viable near-term complements.[6]

4.3 Compute

Compute, the processing power, hardware, and infrastructure required to run AI models and process data, is the second of the three foundations. Access to chips, servers, data centers, and cloud capacity determines what AI applications are practically available to customs administrations and firms and at what cost.

The available deployment options present trade-offs in cost-efficiency, capability, and sovereignty that administrations and firms must weigh against their specific operational and regulatory contexts.1 These options range from commercial cloud services offered by global providers delivering scalable capacity without upfront hardware investment but introducing data sovereignty considerations and potential dependencies, to on-premises (The expression “on-premises” is used to describe a scenario in which the IT infrastructure required to deliver a service is physically located on-site and typically managed by the same organization. It contrasts with hosted configurations, where the infrastructure is located off-site, provided, and often managed by an external party) or fully offline deployments that provide maximum control over compute capacity and sensitive trade data but require capital investment that may be beyond the reach of lower-income economies.[7] In practice, most customs administrations have gravitated towards the latter. Currently operational in 102 economies, the ASYCUDA system, a customs management platform developed and supported by the United Nations Conference on Trade and Development (UNCTAD), makes extensive use of open-source technology, with many administrations opting for fully on-premises deployment. Nevertheless, the World Customs Organization (WCO) suggests that a hybrid approach is often ideal – starting with on-premises compute resources for security-sensitive workloads while leveraging cloud AI/ML services for scalable processing and deep learning tasks.[8] Across each of these models, the common requirement is ensuring that trade users maintain reliable access to sufficient compute. It is this, rather than any particular deployment choice, that policy should be designed to secure.

Access and deployment of compute domestically are also increasingly constrained by power and natural resources. Global data center electricity consumption reached an estimated 448 terawatt-hours in 2025 and is projected to nearly double to 945 terawatt-hours by 2030, with an associated water footprint of 9.3 trillion liters and a land footprint exceeding 14,500 square kilometers. [9],[10] Grid access is already becoming a binding constraint on new data center capacity in several markets: in Singapore, land and power constraints have reached practical limits; [11] in Japan, grid access is now described as the single biggest constraint on data center growth;[11] and in Thailand, hyperscale investment is outpacing generation, with the country's power reserve margin falling below 30 percent.[12] While not an immediate concern across most of the region, securing reliable domestic power may become an increasingly important factor for reliable access to compute if power demand continues to outstrip supply. In this respect, economies with abundant hydropower, nuclear baseload, or land available for renewable generation, such as Australia, Canada, and Malaysia, may be better positioned to ensure access to compute for its trade users.

Policy responses will need to be calibrated to each economy's level of readiness. For those at earlier stages of digital development, the most practical path is maximizing access to cloud services on a pay-as-you-go basis for cost-efficiency. Economies at an intermediate stage may consider selective domestic investment alongside mechanisms such as data embassies as a way of managing data sovereignty concerns without bearing the full cost of independent infrastructure. These are arrangements that allow governments to store sovereign data in overseas facilities under their own legal jurisdiction. Development finance and regional cost-sharing arrangements can also reduce the capital burden it entails. More advanced economies and those endowed with natural resources are better positioned to invest in high-performance computing resources and facilitate access to compute for AI developers and users.8 The Republic of Korea and several Chinese cities have implemented initiatives providing free or subsidized cloud credits to AI researchers and start-ups, with subsidy levels ranging from US$33,000 to US$280,000 per recipient.[8]

4.4 Capability

Beyond connectivity and compute, trade stakeholders – exporters, customs authorities, financial institutions, and logistics providers – must also have the capability to absorb AI and re-engineer their processes and workflows around it. This institutional readiness is best built over a period of accumulated experience with digitalization integration. For instance, organizations that have already integrated electronic invoicing, customs management systems, or the use of digital trade finance platforms are far better positioned to take up the next wave of AI-enabled tools.

The divergence in such capability across the APEC region is wide. An economy's digital intensity, the share of its intermediate and capital inputs that come from digital sectors, offers one revealing proxy by measuring how deeply technology has already been embedded in economic activity, a leading indicator for AI readiness and adoption. In Singapore, the United States, and Korea, 10–15 percent of production inputs are already digital; in several other APEC economies the figure is closer to 2–5 percent, which indicates that these economies use a lower share of digital inputs for their economic production and thus may also be less ready to use AI.[13]

Global survey data on tax and revenue administrations reinforces this picture. The proportion of agency budgets allocated to ICT spending rises consistently with economy income level, from 5.5 percent in low-income economies to 9.3 percent in high-income ones. The deployment gap is starker still. Only 5 percent of tax administrations in low-income economies have deployed or are nearing deployment of AI, against 69.1 percent in high-income economies.[14] The gap extends to the private sector. Across other groups such as the OECD, the share of large firms using AI is more than three times that of small firms.[15],[16],[17] MSMEs typically lack dedicated IT staff, cannot afford external consultants to manage integration, and have no internal change management capacity to address incompatible legacy systems, making them least able to absorb the cost of a failed implementation.[18] Exacerbating these divides, outflows of digitally skilled workers significantly exceed inflows in several APEC economies, eroding the institutional capacity needed to develop and sustain AI applications over time.

Continuing on to other factors, sophistication in data management is a critical and often underestimated element of AI capability in customs and trade that can be left wanting in various organizations. For generative AI where foundation models are pre-trained on general-purpose content, the ability to ground outputs in domain-specific trade data is what determines practical utility for trade applications. Building repositories of trade compliance information suitable for integration into generative AI services is consequently becoming a priority for forward-looking organizations. This typically relies on a combination of centralized reporting

databases, data warehouses, and data lakes, hosting a combination of structured and unstructured data. Business intelligence platforms are increasingly incorporating generative AI and natural language processing into their standard offerings, reducing the technical expertise required to develop data infrastructure assets and thus broadening access to AI capabilities.[7]

The local language environment also affects the conduciveness of using AI for trade facilitation within each economy. Having sufficient relevant training data is crucial. However, as of April 2024, 56 percent of open-source datasets on Hugging Face, a leading AI model repository, were in English, and nearly 98 percent of scientific papers are estimated to be written in English even by researchers from non-English-speaking economies[15] This imbalance has contributed to AI models being trained largely on datasets originating from high-income economies and China.[5] The practical consequence for the APEC region is systematic underperformance in processing non-English customs documentation, a significant constraint given the linguistic diversity across member economies.

Addressing these gaps calls for interventions at multiple levels. At the firm level, fine-tuning open-source models such as Llama and DeepSeek to local customs, legal, and linguistic contexts offers a faster and more cost-effective path to tools that actually perform on local trade data than building from scratch. At the government level, two priorities stand out. The first is data governance. Establishing open trade data platforms, harmonizing data standards with World Customs Organization formats, and leveraging existing frameworks such as the APEC Cross-Border Privacy Rules System to facilitate the controlled exchange of trade data can collectively improve the quality and coverage of inputs on which AI models depend.[16] Further details and real-world examples on enabling trade data flows are described in Chapter 2 on Data Considerations. The second priority is human capital, best built through tripartite cooperation between government, academia, and industry. Such cooperation should support measures such as building the talent pipeline through embedding AI skills training in formal education, providing MSME training subsidies, as well as retaining talent through competitive compensation, targeted grants, tax incentives, and more streamlined visa pathways for AI specialists.[15],[16] Further details and real-world examples on building human capital for AI readiness are described in Chapter 3 on Human Resource Development and Workforce Considerations.

Regulatory sandboxes also offer a lower-risk path to adoption for economies hesitant to commit to full deployment without first establishing confidence in how tools perform under real operating conditions, by allowing customs authorities and trade finance institutions to test AI applications in controlled environments before wider deployment. Colombia's privacy-by-design sandbox and the UNDP's AI Landscape Assessment diagnostic, while developed outside the APEC context, are useful reference points for designing regulatory testing environments and following a structured approach to assessing readiness before committing to deployment.[6] International partnerships, including bilateral technical cooperation and APEC-level knowledge-sharing initiatives, can diffuse best practices and connect economies to the expertise and tools needed for swifter implementation. APEC itself has been advancing this digitalization foundation through initiatives such as the APEC Centre of Excellence for Paperless Trade (ACCEPT) and the APEC Internet and Digital Economy Roadmap (AIDER),[19] both of which give firms in member economies a base of trade digitalization knowledge and policy coordination on which AI readiness can be built.

4.5 Conclusion

The consequences of uneven progress fall hardest on those with the most to gain. MSMEs and traders in developing economies are simultaneously the most reliant on the efficiency gains AI can deliver, such as reducing compliance burdens, lowering documentation costs, and opening access to markets otherwise too complex to navigate, and at the same time the least positioned to acquire those gains independently.

The ability of economies and firms to capture AI's benefits in trade ultimately depends on their ability to access and use productivity-enhancing AI applications, which requires strong digital foundations — the connectivity infrastructure that makes digital exchange possible, the computing resources that determine what AI applications are feasible, and the institutional capacity to absorb and sustain it. These three foundations are mutually reinforcing: gaps in any one of these constrain progress on the others and limit their impact. The APEC region's current landscape reflects this dynamic. Where all three foundations are strong as in Korea, China, and Singapore, which lead the region in AI readiness and deployment for trade facilitation, AI is already delivering measurable gains in customs processing, risk detection, and compliance efficiency. Where they are weak or unevenly developed, deployment for trade facilitation remains nascent, with the region's least-developed members yet to realize meaningful benefits from applications that have begun to see widespread use elsewhere in the region.[1]

However, these gaps are addressable. Connectivity can be strengthened by facilitating private investment in infrastructure through foreign direct investment liberalization, streamlined permitting, and clearer spectrum allocation, alongside targeted government subsidies and satellite broadband options for underserved areas. Compute access can be secured through cloud and infrastructure strategies calibrated to each economy's stage of development, alongside measures to enhance natural resource and power resilience. Capability can be built by strengthening trade data governance, advancing digital human capital measures, and leveraging regulatory sandboxes and international knowledge-sharing for safe adoption. Chapter 6 sets out a Roadmap detailing priorities for advancing these enablers.

Connectivity, compute, and capability will together determine whether AI becomes a shared opportunity for trade facilitation across APEC, or a new axis of competitive divergence between economies at different stages of digital development, and between the large firms already deploying these tools and the smaller traders that form the backbone of regional commerce. In a trading environment marked by rising costs and growing complexity, closing these digital infrastructure and development gaps is among the most consequential near-term investments the region can make.

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5.0

Good Regulatory Practices

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5.1 Introduction: Why GRPs Matter for AI-enabled Trade Facilitation

Artificial intelligence (AI) can make trade facilitation faster, more risk-based, and more accessible. Computer vision, natural language processing, machine learning, and large language model (LLM) interfaces can support non-intrusive inspection, customs documentation, trader guidance, risk assessment, anomaly detection, tariff classification, and e-commerce-related checks. These benefits will not scale, however, if regulatory requirements are fragmented, opaque, or locked to today's technology.[1,2,3] For APEC economies, good regulatory practices (GRPs) should operate as both safeguards and accelerators. They safeguard public interests by requiring transparent, accountable, and evidence-based use of AI in border processes. They also accelerate adoption by reducing uncertainty for customs agencies, AI providers, logistics operators, brokers, shippers, and micro, small, and medium enterprises (MSMEs). This approach is consistent with APEC's voluntary, non-binding, and consensus-based cooperation model, the Putrajaya Vision 2040 and the Aotearoa Plan of Action, which emphasize an open, transparent and predictable trade and investment environment, digital transformation, data flows and trust in digital transactions. It also aligns with the APEC AI Initiative (2026–2030), which treats AI as a catalyst for growth while recognizing the need to address risks in a rapidly evolving digital landscape.[4,5]

This chapter recommends that economies apply five GRPs when developing and implementing AI-related rules for trade facilitation: stakeholder consultation; regulatory flexibility; consistency and predictability; transparency in regulatory enforcement; and regulatory coherence across borders. These practices are especially important because AI regulation in trade facilitation sits at the intersection of customs, digital economy policy, data governance, cybersecurity, procurement, competition, and administrative law.

5.2 Stakeholder Consultation: Design Rules with the Users of the System

Governments should consult early and continuously with those who will build, operate, comply with, and be affected by AI-enabled trade systems. Consultation should not be limited to a single public comment period after a draft rule is nearly complete. It should include customs and border agencies, trade ministries, data protection and cybersecurity authorities, port operators, brokers, freight forwarders, AI providers, standards bodies, consumer and civil society representatives, and MSMEs.[6]

The purpose of consultation is practical. Regulators need to understand what data is available, where data quality is poor, which compliance steps are most burdensome, and whether an AI tool may shift risk unfairly to smaller traders. AI service providers need predictable policy signals before investing in systems for customs classification, document review, cargo screening, or trader-facing chatbots. MSMEs need rules and guidance that can be understood without large compliance departments.

Australia's AI Ethics Framework illustrates how an economy can use public consultation to turn broad principles into more operational AI governance. The Australian Government sought views on a discussion

paper prepared with CSIRO's Data61, analysed submissions and feedback from business, academia, and community groups, and developed principles intended to guide responsible AI design and use by business and government. Singapore's AI Verify Foundation provides a complementary model: government, industry, and technical actors work together on testing tools and governance practices for trustworthy AI, and the AI Verify toolkit is designed to help organizations generate testing reports and communicate them to stakeholders.[7,8]

For trade facilitation, each economy should institutionalize consultation through a standing domestic "AI for Trade Facilitation Advisory Group,"[9] led by the customs administration[10] and formally linked to the economy's

National Trade Facilitation Committee or an equivalent whole-of-government coordination mechanism.[11] The group should review proposed AI use cases in customs and related border procedures, comment on data governance, model governance, and human oversight requirements,[12] assess impacts on MSMEs[13] and other affected traders, and recommend whether pilots should be scaled, modified, or terminated before adoption as permanent systems.[14] Consultation records should identify the stakeholders consulted, summarize the comments received, and explain which recommendations were accepted, which were not, and why.[15] Where an AI use case requires cross-agency data sharing, single-window integration, or broader legal reform, the matter should be escalated to the higher-level coordination mechanism. These recordkeeping, response-giving, and escalation duties would make consultation a decision-making discipline rather than a procedural formality.[16]

At the APEC level, existing fora should complement these domestic groups by facilitating experience-sharing, capacity building, information exchange, and non-binding policy guidance.[17] This role is more consistent with APEC's cooperative and voluntary mode of work than a model in which APEC bodies review or approve domestic AI deployments on a case-by-case basis.

5.3 Regulatory Flexibility: Regulate Outcomes, Not Technical Pathways

AI changes faster than ordinary legislative cycles, and APEC economies are already using diverse AI governance approaches. Rules that mandate a specific model architecture, software tool, or document workflow may become obsolete before implementation is complete. Economies should therefore prefer technology-neutral, risk-based, and outcome-oriented requirements:

1. Accuracy
2. Robustness
3. Human oversight
4. Cybersecurity
5. Traceability
6. Appealability
7. Auditability[18,19]

Regulatory flexibility can be built through sandboxes, phased implementation, controlled pilots (or safe-harbor pilots), periodic reviews, and sunset clauses. Sandboxes are particularly useful where customs

agencies need to test whether an AI tool performs reliably with real trade data but should not yet be used as the sole basis for a legally consequential decision. Singapore's Generative AI Evaluation Sandbox, launched by IMDA and the AI Verify Foundation, shows how a regulator can bring ecosystem players together around concrete use cases and common evaluation methods for LLMs. A trade-focused version could test LLM-assisted classification explanations, automated responses to trader inquiries, or extraction of information from electronic trade documents, while requiring human review for decisions that affect duties, penalties, seizures, or release of goods.[20]

Sunset and review mechanisms should apply to both rules and systems, consistent with APEC's emphasis on the regulatory lifecycle and capacity to address emerging regulatory challenges. Economies should require periodic review of AI-enabled border tools, especially those used for risk scoring, inspection prioritization, or fraud detection. Reviews should assess model performance, data drift, false-positive and false-negative rates, bias risks, security incidents, trader complaints, and operational benefits. If a system no longer performs adequately or cannot be explained at the level required for administrative accountability, the agency should modify, suspend, or retire it. This prevents obsolete rules and underperforming systems, the so-called "zombie regulation" and "zombie systems," from burdening innovation and trade. [21]

5.4 Consistency and Predictability: Make AI Governance Work Across Agencies

AI for trade facilitation often cuts across multiple agencies. A shipment may involve customs, agriculture, food safety, health, transport, export control, sanctions, and security authorities. If each agency imposes different data formats, model assurance requirements, or compliance interfaces, AI will add complexity rather than reduce it. Economies should adopt a whole-of-government approach that sets common requirements for AI system registration, data governance, risk classification, human oversight, procurement, logging, incident response, and vendor accountability.[22,23,24]

Information sharing agreements are essential. Agencies should define what trade data may be shared, for what purpose, under what safeguards, and with what retention and audit obligations. The United States Air Cargo Advance Screening (ACAS) program offers a useful trade-security example because it uses advance air cargo information to support targeted risk assessment before aircraft departure. The point is not that every economy should copy the U.S. model, but that cross-agency and trader-facing requirements must be standardized, communicated, and operationally feasible.[25]

Predictability also requires a clear allocation of responsibility. Before scaling an AI tool, governments should identify which agency owns the system, which official remains accountable for legally consequential decisions, which vendor obligations apply, and which channels traders may use to correct errors. For higher risk uses, such as cargo risk scoring or inspection prioritization, agencies should retain human review and preserve sufficient records to explain why a shipment was selected, delayed, released, or escalated.

5.5 Transparency in Regulatory Enforcement: Disclose What Matters Without Compromising Security

Transparency should cover both rules and AI use, as transparency is a foundational GRP across the regulatory lifecycle. Traders need to know when AI is used in a process, including:

a. Whether the output is advisory or decisive,
b. What information they must provide, and
c. How they may contest an error.

The U.S. Department of Homeland Security publishes a simplified AI use case inventory for Customs and Border Protection (CBP), including cargo screening, non-intrusive inspection, cargo classification, trade entity risk modelling, and internal administrative and trade-enforcement tools. Similar inventories in APEC economies would help the public and industry understand where AI is used, what the system is intended to do, whether it is in pilot or deployment, and which agency is accountable.[26,27]

Transparency does not require publication of sensitive security rules, model weights, or operational thresholds. It requires meaningful information, namely:

- The legal authority for using AI
- The purpose of the system
- The type of data used
- Whether the output is advisory or decisive
- The role of human review
- Complaint and appeal channels, and
- The categories of evidence an affected trader may request.

For higher-impact use cases, economies should provide plain information on model governance, procurement criteria, and post-deployment evaluations.

Enforcement standards should also be centralized or coordinated. If one agency treats an AI-generated anomaly score as only a screening input while another treats a similar score as presumptive evidence of non-compliance, traders will face inconsistent expectations. Coordinating bodies should issue enforcement guidance on when AI outputs may be used, how officers should document reliance on them, what evidence is needed before penalties are imposed, and how traders can challenge automated or AI-assisted errors.[28,29,30]

5.6 Regulatory Coherence: Align Domestic AI Rules with International Standards and Digital Trade Commitments

Because trade facilitation is cross-border by nature, domestic AI rules should be designed with interoperability in mind, particularly as APEC's AI policy landscape shows diverse regulatory approaches and potential fragmentation. APEC economies should avoid creating isolated AI compliance regimes that require traders or service providers to re-test the same system in every market. A practical long-term goal is to make AI assurance results more reusable across markets, where risk levels, legal systems, and public interests allow it.[31]

International standards and risk-management frameworks can provide a common language. NIST's AI Risk Management Framework organizes AI risk management around govern, map, measure, and manage functions, and ISO/IEC 42001:2023 provides a management-system standard for organizations that provide or use AI-based products or services. These are not substitutes for law, and economies should not treat voluntary standards as binding unless they are incorporated through legislation, procurement rules or contracts. However, they can reduce fragmentation by giving agencies and companies shared concepts for documentation, risk assessment, monitoring, and continuous improvement.[32]

Digital economy agreements can also support coherence. The Digital Economy Partnership Agreement (DEPA), concluded among Singapore, Chile, and New Zealand, illustrates how modular digital trade cooperation can address issues such as digital trade, data, and emerging technologies. For APEC, the relevant lesson is not treaty replication, but modular cooperation on interoperable approaches to electronic trade documents, digital identities, cross-border data flows, source-code protection, AI assurance, and paperless customs processes.[33]

APEC institutions are well placed to coordinate this work. The Sub-Committee on Customs Procedures can focus on customs interoperability, risk management, and border operations. The Digital Economy Steering Group can address data, digital identity, and AI assurance. The Economic Committee can continue developing GRP capacity, including regulatory impact assessment, consultation, and ex post review. The Committee on Trade and Investment can connect these practices to digital trade and supply chain connectivity.[34]

Conclusion and roadmap linkage: translating GRPs into implementation AI will not improve trade facilitation merely because customs agencies buy new tools. It will improve trade facilitation when economies build regulatory systems that make AI trustworthy, interoperable, and accountable. Governments should take five actions. The five GRPs—stakeholder consultation, regulatory flexibility, consistency and predictability, transparency in regulatory enforcement, and regulatory coherence— developed in this chapter provide a practical governance architecture for that effort. These practices should be treated not as abstract principles, but as implementation disciplines for the design, testing, deployment, enforcement, and review of AI-enabled border processes.

Taken together, these GRPs protect public interests while giving government agencies and private-sector actors the confidence to invest in AI-enabled trade facilitation. They can also be translated into APEC workstreams: SCCP-led customs interoperability pilots can operationalize customs-facing elements; DESG-led exchanges can advance AI assurance and data governance; the Economic Committee can strengthen GRP tools such as consultation, regulatory impact assessment, and ex post review; and CTI coordination

can connect these practices to digital trade and supply-chain connectivity. In this way, GRPs become more than procedural safeguards: they provide an implementation pathway for ensuring that AI adoption serves APEC's broader goals of open and predictable trade, inclusive digital transformation, trusted data flows, and resilient regional supply chains.

5.7 Conclusion: Five Actions for Governments

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6.0

Report Summary and Insights

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National Center for APEC

6.1 APEC's Advantage

The application of AI-driven technologies has immense potential to enhance trade facilitation In June of 2026, the UN Economic and Social Commission for Asia and the Pacific (ESCAP), in coordination with the Asian Development Bank, released "Harnessing Artificial Intelligence in Trade Facilitation" a report that found that AI implementation in trade facilitation stands below 15% among economies surveyed. In the context of increased interest and investment in AI worldwide within a still-nascent regulatory environment, this report aims to provide actionable priorities to position APEC as a global leader in advancing AI for trade.

APEC has a robust history of achievement in advancing policies that promote trade facilitation, from the decades-long APEC Supply Chain Connectivity Framework Action Plan (SCFAP) to policy dialogues that advance regional trade agreements (RTAs) and free trade agreements (FTAs). 2025 marked the first time the APEC Ministers Responsible for Trade Statement recognized the potential of AI to reshape the landscape of international trade, especially with regards to enhancing customs procedures. In addition to trade facilitation, APEC has a strong digital agenda that builds toward efficient, sustainable, and interoperable trade systems. An APEC PSU report titled "The Digital Transformation of Trade Facilitation in APEC" from March 2026 highlighted that APEC performs above the global average on the core dimensions of trade facilitation, achieving 87%, with members leading in the implementation of digital trade facilitation measures at 82%. Additionally, 2026 saw the establishment of the APEC Centre of Excellence on Paperless Trade (ACCEPT), which will work to address uneven adoption, fragmented standards, limited real-world cross-border paperless trade pilots, and capacity and readiness gaps.

In addition to a strong trade and digital agenda, APEC provides an effective platform for advancing AI for trade facilitation due to its unique convening power. Every year, APEC brings together policymakers from across ministries in 21 different economies alongside business leaders, academia, and other stakeholders. APEC provides a unique opportunity to foster cooperation between diverse stakeholders involved in every stage of the supply chain. Lastly, APEC supports the adoption of new policies through capacity building workshops and projects that enable the sharing of best practices and policy expertise aimed at closing development gaps between economies in the region.

The rest of this chapter will examine how APEC work across four policy areas is progressing and provide priorities for how APEC officials can best advance future work on AI for trade facilitation. These policy areas are:

- ***Data governance and digital systems*** to foster reliable, interoperable, explainable, scalable, secure, and trusted trade data systems compatible with AI.
- ***Workforce and human resources development*** to foster an AI-competent workforce and close the AI-skills gap.
- ***Digital infrastructure and investment*** to create solutions to finance barriers and enable infrastructure development and access.
- ***Good regulatory practices*** to advance practical approaches and foster high-quality policy on AI for trade facilitation.

These areas align directly with the content and recommendations from Chapter 2-5 of this report.

6.2 A Roadmap for Action

The priorities below are organized around a three-tier framework that reflects how AI for trade facilitation develops in practice: work must first build the foundations, then use those foundations to enable AI implementation, and finally scale successful implementation across the region.

Short-term: Foundational work to prepare organizations, workforces, systems, and physical infrastructure for digitalization and future AI implementation at the most foundational level.

Medium-term: Work that builds on those foundations to enable AI implementation and pilot projects.

Long-term: Work that builds upon existing AI implementation and requires region-wide coordination for scaled outcomes.

Since APEC economies are at different stages of readiness, the priorities within each tier are further distinguished by who is best placed to act: individual economies, public-private partnerships, APEC fora, or region-wide coordination.

Data Governance and Digital Systems

This report highlights the importance of robust digital governance to enable implementation of AI for trade facilitation. Data is the foundation of accurate, trustworthy, and efficient AI models. Present-day digitalization and digital governance efforts should consider the potential needs of AI implementation and be designed around real trade processes, support standardization and interoperability, enable cross-border data flows, emphasize data quality and integrity, and build trust through cybersecurity requirements and legal accountability. Cybersecurity and data protection standards for government operated databases containing sensitive trade information are key enablers to build public-private trust in customs authorities' AI systems.

APEC currently advances digital governance work through several fora, including the Digital Economy Steering Group (DESG), the Telecommunications and Information Working Group (TELWG) and the APEC Centre of Excellence on Paperless Trade (ACCEPT). Policy workstreams and agreements that are central to APEC's work on digital governance include the APEC Internet and Digital Economy Roadmap (AIDER), the APEC AI Initiative, and the APEC Cross-Border Privacy Rules (CBPR).

Priorities for Action

In the short term, APEC fora should advance standard definitions for core trade entities in line with existing international norms through the SCCP to ensure interoperability of systems across borders. At the same time, individual economies should require domestic inter-agency information-sharing agreements to eliminate silos and address foundational issues in their own digital systems before scaling. Establishing regular consultations, developing standards for information-sharing, and advancing work towards interoperable systems are also foundational considerations for agency coordination across borders. Standards for information sharing should align with existing international frameworks, such as the ISO Digital Exchange Standards on AI, the UN/CEFACT Multimodal Transport Reference Data Model, the UNCITRAL MLETR, and eCert for Sanitary and Phytosanitary Measures.

As these foundations take hold, medium-term work should shift toward enabling AI implementation and pilot projects. Within the DESG, APEC fora should develop strategies for creating interoperable data systems that enable cross-border data flows across institutions, emphasizing industry-built systems and public-private

partnership to foster the accurate, high-quality, and robust datasets that AI systems depend on. Public-private partnerships, through regular consultation with industry experts and relevant international bodies convened via the DESG, should embed real-world trade processes and data privacy principles — consistent with the APEC Cross-Border Privacy Rules (CBPR) system — into future work on data access architecture, to secure sensitive trade data and build trust across institutions. These partnerships should also support PECC and ABAC in developing research on cybersecurity confidence threshold frameworks, system reliability, and performance validation to guide risk management for AI adoption in customs agencies.

Over the long term, region-wide coordination should prioritize interoperability and machine-readable trade-data structures across digitalization workstreams, especially within ACCEPT, to align foundational digital systems and enable future implementation of AI in trade facilitation across borders.

Workforce and Human Resources Development

This report identifies large gaps between the hiring demand for AI skills and the supply of AI-competent workforce. These gaps are exacerbated by regional disparities in the concentrations of AI skills and low AI competency in certain trade-related sectors. Furthermore, MSMEs often lack the big data, AI, and cybersecurity experts required to integrate their systems into new AI-driven supply chain platforms. The shortage of AI talent is a higher barrier for MSMEs' AI adoption than large firms, who have greater resources to attract top AI talent and reskill employees.

APEC's Human Resource Development Working Group (HRDWG) released a "HRD Framework in the Digital Age" in 2017 that provided a high-level strategic direction on strengthening regional cooperation in HRD in the face of rapid technological change through joint and regional research activities, policy discussions, and development of joint programs, projects and initiatives.

Priorities for Action

In the short term, APEC fora should build on Priority Area 2 of the APEC Framework on HRD in the Digital Age — which calls for expanding collaboration between government, academia, and industry to develop 21st century competencies — by encouraging the HRDWG to create dedicated platforms and events for tripartite cooperation specifically on workforce AI-skilling programs. APEC fora should also advance standard guidance within the SCCP for the creation of domestic ICT expert training programs for customs authorities across APEC economies.

In the medium term, economies with high concentrations of AI-skilled workers should share best practices and lessons learned from workforce training and collaborate through the HRDWG, in line with the Lima Roadmap, to develop scalable models for upskilling. Individual economies should also use APEC capacity-building programs to encourage member economies to support firms in fine-tuning open-source models to local customs, legal, and linguistic contexts.

Over the long term, region-wide coordination through the HRDWG and the APEC AI Initiative should prioritize workforce programs that foster hybrid AI skills across sectors to avoid the siloed training pathways that have limited past efforts.

Digital Infrastructure and Investment

This report explores how persistent gaps in broadband connectivity and other foundational digital infrastructure present one of the largest barriers to APEC economies realizing the benefits of implementing AI in trade facilitation processes. Given the high level of divergence in AI readiness across the region, building APEC's infrastructure capacity for AI in trade facilitation will require coordinated public-private partnership and policy measures along with targeted, scaled, and transitional projects. Enabling private sector investment remains the highest priority to building the necessary infrastructure.

The APEC Artificial Intelligence Initiative (2026-2030) highlighted "cultivating an investment ecosystem for resilient AI infrastructure" as one of three major strategic goals. The Initiative focuses on "strengthening AI-related capabilities across all sectors" by building "public sector capacity, private sector capacity, workforce capacity, consumer capacity and trust, and regional cooperation on capacity building." The Initiative encourages APEC fora and sub-fora to integrate and advance its priorities across strategies and work plans, share information on efforts with the DESG and TELWG, and to foster cross-fora collaboration and partnerships, including with ABAC and PECC.

Priorities for Action

In the short term, individual economies should adopt enabling measures for private investment in critical digital infrastructure, such as liberalizing foreign direct investment in telecommunications, streamlining infrastructure permitting, and establishing clear spectrum allocation frameworks. Alongside this, public-private partnerships should encourage large companies to provide AI-based tools and platforms targeted at MSMEs, such as retrieval-augmented tools for generating case-by-case information about a shipment's compliance requirements, agentic assistants for document preparation, and trade-route optimization platforms.

In the medium term, individual economies should consider government subsidies to support infrastructure development and investment, particularly in rural and remote communities, to ensure the benefits of AI are accessible to all, including MSMEs. Building on work in the TELWG, APEC economies should advance efforts to remove regulatory barriers facing satellite broadband operators and ground stations, especially in archipelagic and island economies and economies that lack connectivity infrastructure, including by streamlining infrastructure permitting, mandating passive infrastructure sharing, and establishing clear spectrum allocation frameworks.

Over the long term, region-wide coordination should enable the development of computing power by advancing a hybrid approach that balances the trade-off between infrastructure cost and data sovereignty concerns. This approach can evolve as infrastructure matures: in the early stages, economies can rely on cloud services on a pay-as-you-go basis for cost efficiency; at an intermediate stage, they can pursue selective domestic investment alongside data sovereignty infrastructure; and in advanced stages, they can build high-performance computing resources and facilitate access to compute for AI developers and users, both domestically and internationally.

Good Regulatory Practices

This report highlights persistent disparities in the region's readiness for AI adoption, including in institutional capacity. The APEC region can be divided into two broad categories: economies on the cutting edge of AI innovation and implementation and economies that are still developing foundational digital infrastructure. MSMEs and traders in developing economies are simultaneously the most reliant on the efficiency gains AI can deliver and are yet the least positioned to acquire those gains independently.

Governments play an important role in enhancing the capacity of MSMEs to utilize and reap the benefits of AI systems for trade facilitation. Over 60% of businesses in the Asia Pacific are MSMEs, and MSMEs are a main driver of increasing volumes of cross-border small parcel shipping. Enabling MSMEs to access the benefits of AI technologies in trade facilitation is vital not only to ensure equitable economic gains across the region, but also to realize integrated and efficient trade processes at all stages of global supply chains. APEC's work on MSMEs is woven throughout all policy areas and fora.

Priorities for Action

In the short term, APEC fora should create permanent AI-for-trade consultation mechanisms within ACCEPT that include relevant international bodies, MSMEs, and technical experts, not only large firms, and should leverage the ACCEPT Secretariat to publish AI use inventories and enforcement standards so

traders know when AI is used, who is accountable, and how to contest errors. Economies should map domestic AI governance requirements to international standards in line with the APEC AI Initiative, APEC good regulatory practices, and regional digital trade commitments.

In the medium term, public-private partnerships should continue development of trade digitalization sandboxes within the SCCP and ACCEPT for AI tools used in customs classification, document review, risk assessment, cargo screening, and trader guidance. Considering the rapidly developing nature of AI technology, APEC policymakers should strive for policies and frameworks that do not inhibit innovation by using measures such as sunset clauses and flexible enforcement requirements. Additionally, the SCCP and ACCEPT should advance development of accountability provisions for AI used by customs authorities, supported by APEC research on cybersecurity confidence thresholds to guide risk management. This includes guidance on how single window systems and other customs platforms verify AI agent identity, confirm authorization, and allocate liability.

Over the long term, region-wide coordination should advance interoperability through harmonization of AI governance requirements in line with the APEC AI Initiative, APEC good regulatory practices, and regional digital trade commitments, so that AI assurance efforts can be reused across markets.

6.3 Conclusion and Outlook

This report provides an overview of opportunities and barriers to AI implementation in trade facilitation in the APEC region. With its robust background in policy development on trade facilitation and digitalization, as well as capacity building mechanisms and multistakeholder convening power, APEC has an important role to play in supporting practical, interoperable, and responsible AI adoption in trade facilitation.

As AI development and innovation continues to advance, there is much that is unknown about the potential applications and impact of this technology. What is clear is that AI has the potential to transform work at every stage of the supply chain and bring new efficiencies and savings to trade facilitation processes. The continuously developing nature of AI technologies and highly uneven readiness across the region may seem to be a barrier to developing region-wide policy, these facts of the AI landscape make it all the more important that APEC advance coordinated and forward-looking work on AI policy.

The Pacific Economic Cooperation Council encourages APEC officials and industry leaders to consider inclusion of the report priorities in ongoing and future trade facilitation workstreams.

Case Study Annex

Global Legal Entity Identifier Foundation (GLEIF)

1. Basic Information

Organization name: Global Legal Entity Identifier Foundation (GLEIF)

Case study submitter name/contact: Nicolas Miailhe, AI Lead & Board Member, FPTPEC

Organization type: International nonprofit foundation (established by the Financial Stability Board / G20)

Economy / economies where the solution is deployed: Global — LEIs have been issued in more than 250 countries and jurisdictions through GLEIF's network of 39 LEI issuers and associated validation and registration agents, covering all APEC economies including the United States, China, Japan, Korea, Australia, Hong Kong China, Singapore, Chinese Taipei, and Canada. GLEIF has recently established country representation in China.

Year(s) of implementation: LEI system operational since 2014; verifiable LEI (vLEI) credentialing system launched 2022; AI agent identification application proposed for 2026–2028.

Project status: Operational (LEI/vLEI infrastructure) / Conceptual-to-Pilot (AI agent identification extension)

2. Trade Facilitation Challenge Addressed

Description of the trade facilitation challenge(s) addressed:

The rapid proliferation of autonomous AI agents in cross-border commercial activity is creating a novel verification gap in international trade. AI agent frameworks — notably OpenClaw, which has spread virally across the Asia-Pacific region since early 2026 with major adoption in China, and similar platforms — enable software agents to execute multistep commercial tasks autonomously: negotiating procurement terms, submitting customs documentation, executing payments, and managing supply chain logistics on behalf of enterprises.

This creates a pressing trade facilitation challenge: when an AI agent presents documentation at a digital border, counterparties and customs authorities currently have no standardized mechanism to verify (a) which legal entity authorized the agent, (b) what scope of authority the agent possesses, and (c) whether the entity behind the agent is who it claims to be. Without such verification, the efficiency gains from AI-driven trade automation are undermined by increased fraud risk, compliance uncertainty, and liability ambiguity — precisely the frictions that trade facilitation aims to reduce.

The challenge is compounded by the cross-border nature of AI agent deployment. An agent configured in one APEC economy may execute transactions in another, raising jurisdictional questions about accountability and regulatory compliance that existing trade facilitation frameworks (built for human actors and document-based processes) were not designed to address.

Part of the trade process targeted: Pre-arrival (automated document preparation and submission); At-the-border (identity verification of submitting entities); Post-clearance (audit trails and accountability for agent-executed transactions)

3. AI Application Overview

Type(s) of AI used: Large Language Models (LLMs) powering autonomous agent frameworks; cryptographic verification infrastructure (KERI protocol, Authentic Chained Data Containers); verifiable credentials (W3C standard).

Description of how the AI system works in practice:

The proposed system extends GLEIF's existing Legal Entity Identifier (LEI) and verifiable LEI (vLEI) infrastructure to create a "Know Your Agent" (KYA) verification chain for AI agents conducting commercial activities across borders. The mechanism works as follows:

- **Entity identification:** The deploying organization holds an LEI — a unique 20-character alphanumeric code (ISO 17442) that connects to validated reference data including ownership structure, jurisdiction, and legal status.
- **Authority delegation:** Using the vLEI credentialing system, the organization issues a verifiable credential to its AI agent, specifying the agent's authorized scope (e.g., "submit customs declarations for shipments under USD 50,000"), validity period, and the human role that authorized the delegation.
- **Cryptographic trust chain:** The credential is cryptographically bound through GLEIF's trust chain (GLEIF as Root of Trust → Qualified vLEI Issuer → Organization → Agent), using the KERI protocol for secure, decentralized identifier management. This allows any counterparty or customs authority to verify the agent's authorization instantly and automatically.
- **Transaction attestation:** Each agent-executed transaction is signed with the vLEI credential, creating an immutable audit trail linking the action to the authorizing entity and the specific scope of delegated authority.

Data inputs used: LEI reference data (entity identity, ownership, jurisdiction); vLEI role credentials (authorized personnel); agent capability declarations; transaction metadata

Degree of automation: Hybrid — human authorization of agent scope, automated execution and verification of individual transactions

4. Impact and Outcomes

Measurable outcomes (projected):

- **Reduction in verification latency:** Automated vLEI-based agent verification could reduce counterparty due diligence time from days to seconds for AI-initiated transactions.
- **Fraud reduction:** Cryptographic binding of agent actions to verified legal entities directly addresses invoice fraud, impersonation, and unauthorized transactions — risks amplified by autonomous agent deployment.
- **Cross-border interoperability:** As an ISO-based global standard already recognized across APEC economies, the LEI/vLEI system avoids the fragmentation risk of economy-specific agent identification schemes.

Non-quantifiable benefits and challenges: Increased regulatory confidence in permitting AI-automated trade processes; reduced compliance burden for SMEs deploying AI agents (single credential vs. multiple economy-specific registrations); potential resistance from economies with existing digital identity frameworks that may view LEI extension as duplicative.

Primary beneficiaries: Customs authorities seeking to maintain oversight as trade automation accelerates; SMEs deploying AI agents for cross-border trade who need affordable, standardized verification; financial institutions managing counterparty risk in agent-executed transactions; logistics providers integrating AI-driven supply chain management.

5. Regulatory and Policy Environment

Regulations or policies that enabled implementation:

The LEI system was established in 2014 based on recommendations by the G20's Financial Stability Board in 2012 and is mandated for financial transactions across multiple jurisdictions. Within APEC, Korea's Financial Services Commission mandates LEI use for foreign corporate entity investment registration; Japan's Financial Services Agency requires LEIs for OTC derivatives participants. The EU's Digital Identity (EUDI) framework recognizes the vLEI as a valid EUID wallet attribute. These existing mandates provide regulatory scaffolding for extending LEI/vLEI to AI agent identification.

Regulatory barriers or uncertainties encountered: No APEC economy currently has a regulatory framework specifically addressing AI agent identification in trade contexts. The primary uncertainty is whether existing electronic transaction and digital signature frameworks (built for human actors) extend to AI agents acting under delegated authority. Additionally, China's March 2026 restrictions on certain AI agent frameworks in state enterprises signal evolving regulatory approaches that a KYA standard would need to accommodate.

Engagement with regulators or customs authorities: GLEIF maintains active relationships with regulatory bodies across APEC economies, including engagement with the International Chamber of Commerce's Digital Standards Initiative (ICC/DSI) on digital trade documentation standards. The proposed KYA extension would benefit from further engagement with the World Customs Organization (WCO) and APEC's Sub-Committee on Customs Procedures (SCCP) to align with existing trusted trader programs (e.g., Authorized Economic Operator schemes).

6. Ethics, Safety, Privacy, and Cybersecurity

Key risks considered:

- **Privacy:** vLEI credentials are designed for organizational (not personal) identity. However, the delegation chain links agents to authorizing human roles, requiring careful handling under data protection regimes.
- **Cybersecurity:** AI agent frameworks are susceptible to prompt injection attacks that could cause agents to exceed authorized scope. The vLEI's cryptographic binding does not prevent an agent from being manipulated — it ensures the manipulated action is attributable to a verified entity, enabling post-incident accountability.
- **Transparency:** The open architecture of the LEI system (publicly accessible Global LEI Index) supports transparency. Agent credential schemas can be published openly while keeping specific delegation scopes confidential between transacting parties.
- **Bias:** Limited direct bias risk in identity verification; however, credential issuance processes must avoid creating barriers for SMEs in developing APEC economies.

Safeguards or mitigation measures adopted: KERI protocol's decentralized architecture eliminates single points of failure; vLEI ecosystem governance framework (developed using Trust over IP Foundation metamodel) establishes operational integrity standards; Qualified vLEI Issuer qualification ensures validation, operational and technical rigor.

7. Workforce and Skills Impacts

Changes to employee roles or skill requirements: As AI agents assume routine trade documentation and compliance tasks, customs brokers, trade compliance officers, and supply chain managers will shift toward oversight, exception handling, and agent scope management. New roles such as "AI agent compliance officer" may emerge within trading enterprises.

Training or reskilling initiatives implemented: Not yet applicable. Recommendation: APEC economies should consider incorporating AI agent management and verification literacy into existing trade facilitation capacity-building programs, particularly those targeting SMEs.

8. Scalability and Transferability

Scalability within the economy: The LEI system already covers almost 3 million entities globally with established issuance infrastructure in all APEC economies. The vLEI credentialing layer uses open protocols (KERI, ACDC, CESR) that scale horizontally. The primary scaling challenge is not infrastructure but adoption: enterprises must be incentivized to credential their AI agents, which requires either regulatory mandate or commercial necessity (e.g., trading partners refusing to transact with unverified agents).

Key prerequisites for replication in other economies: Existing LEI issuance infrastructure (available for all APEC economies); Qualified vLEI Issuer presence — QVIs are qualified globally, though some economies such as China may prefer locally-based QVIs, a trend supported by GLEIF's recent establishment of country representation there; regulatory recognition of vLEI credentials for trade documentation; customs IT systems capable of verifying vLEI credentials at submission time; and enterprise willingness to adopt agent credentialing as part of standard AI deployment governance.

9. Looking Ahead: From Identity to Behavioral Verification

Agent identification — establishing who authorized an AI agent to act — addresses only the first half of the trust equation. As AI agents scale across trade facilitation workflows, a second question becomes equally critical: can you prove the AI system actually did what it was supposed to do?

Identity, verification and authorization (the "who" question) and behavioral verification (the "what" question) are complementary layers that together form a complete trust chain for AI agent activity in cross-border trade. GLEIF's LEI/vLEI infrastructure resolves the identity, verification and authorization layer. Emerging AI verification technologies — such as those being developed by firms like Lucid Computing, which specialize in independent verification of AI system behavior against declared specifications — address the behavioral layer: confirming that an agent operated within its authorized scope and that its outputs are consistent with its stated capabilities.

The convergence of these two layers has direct implications for trade facilitation at scale. Consider a customs authority processing thousands of AI-agent-submitted declarations daily. Identity verification confirms each agent is authorized by a legitimate, verified entity. Behavioral verification confirms the agent's classification decisions, valuation calculations, and documentation were produced by a system that meets declared performance standards. Together, they provide the assurance framework necessary for customs authorities to confidently increase automation thresholds — moving from pilot-scale AI-assisted clearance to high-volume, AI-agent-driven processing.

For APEC economies seeking to scale AI-enabled trade facilitation while maintaining regulatory confidence, the development of interoperable standards spanning both identity and behavioral verification of AI agents represents a significant opportunity for coordinated action.

10. Key Takeaways for Policymakers

- **Act before fragmentation:** The rapid adoption of AI agent frameworks across the Asia-Pacific — with different regulatory responses already emerging — creates urgency. Establishing a common "Know Your Agent" standard through existing infrastructure (LEI/vLEI) is far more efficient than harmonizing divergent economy-specific schemes after the fact.
- **Build on what exists:** The LEI/vLEI system is an operational, ISO-standardized, G20-established global infrastructure — not a proposal. Extending it to AI agent identification leverages sunk investment and existing regulatory recognition across APEC economies.
- **Verification enables automation:** Policymakers concerned about the pace of AI-driven trade automation should view agent identification as an enabler, not a barrier. Reliable verification of agent authority and provenance is a prerequisite for customs authorities to confidently accept AI-submitted documentation, unlocking efficiency gains.
- **Design for SME inclusion:** Any agent identification standard must remain affordable and accessible. The LEI's annual cost (typically under USD 100) and the vLEI's open protocol architecture provide a model for inclusive credential systems that do not price out smaller traders — particularly compared to the recurring costs of less secure digital certificate churn that many enterprises currently bear.
- **Coordinate across APEC mechanisms:** Agent identification intersects with multiple APEC workstreams — digital trade, customs modernization, SME development, and data governance. APEC's Sub-Committee on Customs Procedures and the APEC Business Advisory Council (ABAC) are natural venues for advancing a coordinated approach.
- **Plan for the full trust chain:** Identity verification alone will not be sufficient as AI agent volumes grow. Policymakers should anticipate the need for complementary behavioral verification standards — ensuring not just that an agent is authorized, but that it operates as declared. Encouraging interoperability between identity infrastructure (such as LEI/vLEI) and emerging AI verification technologies will position APEC economies to scale AI-enabled trade with confidence.

Note: *This is a forward-looking case study. The LEI and vLEI systems are fully operational global infrastructure. The extension to AI agent identification ("Know Your Agent") represents a proposed application that builds on existing capabilities and is informed by the rapid commercial deployment of AI agent frameworks across the Asia-Pacific in 2026. The case study is submitted by the FPTPEC (France Pacific Territories National Committee for Pacific Economic Cooperation) as a contribution to the PECC Signature Project on Enabling AI for Trade Facilitation.*

Mely.AI Solutions Inc.

1. Basic Information

Organization name: Mely.ai Solutions Inc.

Case study submitter name/contact: Edward Ko

Organization type: Privately owned company

Economy / economies where the solution is deployed: Canada (Port of Montreal) Supply Chain, Transportation and Logistics

Year(s) of implementation: We are a 7-year old company

Project status (Pilot / Operational / Scaled): Scaled

2. Trade Facilitation Challenge Addressed

Description of the trade facilitation challenge(s) addressed:

Trade and logistics operations still rely heavily on emails, PDFs, scanned documents, phone calls, fragmented systems, and manual validation workflows. This creates delays, data entry errors, compliance risks, poor visibility, and inefficient coordination across freight forwarders, customs brokers, ports, terminals, carriers, and other supply chain actors. The main challenge addressed is the conversion of fragmented and unstructured trade documentation into structured, searchable, and actionable data that can accelerate customs clearance, cargo planning, compliance validation, and operational decision making.

Part of the trade process targeted (Pre-arrival / At-the-border / Post-clearance): Pre arrival, At the border, and Post clearance.

The solution mainly targets pre arrival preparation and at the border clearance by automating extraction, validation, and preparation of customs and logistics data before submission. It also supports post clearance activities through searchable records, auditability, reporting, productivity measurement, invoice matching, and compliance review.

3. AI Application Overview

Type(s) of AI used (Computer Vision, NLP, ML, LLM, Domain-specific models): Computer Vision, Natural Language Processing, Machine Learning, Large Language Models, Agentic AI framework and domain specific models trained or configured for maritime, customs, logistics, and trade documentation.

Description of how the AI system works in practice:

The AI system receives trade and logistics documents in different formats, such as PDFs, scanned files, emails, EDI files, and inconsistent document templates. Computer Vision and OCR read the document content, while NLP and machine learning models identify, extract, classify, and structure the required data fields. Domain specific models and business rules validate the information against customs, operational, and client requirements. Large Language Models can support exception handling, summarization, decision support, and operational recommendations. Agentic AI framework reasons the results and take simple action automatically when no exceptions detected. Human operators review low confidence results or exceptions, provide feedback, and the system improves over time through a human in the loop workflow.

Data inputs used: Bills of lading, cargo manifests, commercial invoices, packing lists, dangerous cargo declarations, shipping instructions, customs invoices, cover sheets, arrival notices, freight invoices, proof of delivery, purchase orders, goods receipt notes, credit notes, statement of facts, contracts, correspondence, procurement files, incident reports, emails, EDI data, and operational system data.

Degree of automation (Decision support / Automated / Hybrid): Hybrid.

The system automates document reading, extraction, standardization, validation, routing, and integration where confidence is high, while maintaining human review for exceptions, low confidence fields, compliance decisions, and final accountability.

4. Impact and Outcomes

Measurable outcomes (Time savings, Cost reductions, Error reduction/increase):

The solution reduces manual data entry, accelerates document processing, improves data quality, and lowers rework. Measurable outcomes include faster customs clearance preparation, shorter invoice processing cycles, faster manifest processing, faster billing cycles, improved cashflow, reduced manual workload, reduced operational costs, reduced compliance errors, improved accuracy of extracted data, and faster access to searchable trade information. In specific use cases, document redaction processing time was reduced from hours to minutes, dangerous goods data became searchable in seconds, and customs broker workflows achieved faster clearance times with lower operational cost and less manual rework.

Non-quantifiable benefits and challenges (Employee/Customer satisfaction, Ease of adoption/reskilling, AI model biases):

Benefits include improved employee productivity, stronger operational visibility, better customer satisfaction, higher stakeholder trust, improved compliance confidence, better safety readiness, stronger decision making, and more transparent supply chain coordination. Challenges include change management, onboarding complexity, fragmented legacy systems, variable data quality, inconsistent operating procedures, the need for user training, and the need to maintain human trust in AI outputs. AI model bias and incorrect recommendations are mitigated through confidence scores, human review, explainability, auditability, and escalation workflows.

Primary beneficiaries: Customs brokers, freight forwarders, port authorities, terminal operators, ship operators, ground transporters, legal and compliance teams, accounts payable teams, logistics operators, customs authorities, regulators, and importers or exporters that depend on faster, more accurate trade documentation and clearance processes.

5. Regulatory and Policy Environment

Regulations or policies that enabled implementation: The implementation is supported by privacy, cybersecurity, and data governance frameworks, including SOC2 Type 2, Quebec Law 25 and GDPR principles for cross border data flows. The federated data sharing model is also aligned with secure API based data exchange, stakeholder data ownership, and standardized information formats, including the IMO Compendium 47 format for maritime data nomenclature.

Regulatory barriers or uncertainties encountered: Key uncertainties include data sharing rules between private and public actors, cross border privacy obligations, ownership and permitted use of commercial data, cybersecurity expectations, standardization of data formats, and how AI generated recommendations should be treated in regulated customs or compliance workflows. Fragmented legacy systems and inconsistent standards across actors also create barriers to scalable implementation.

Engagement with regulators or customs authorities (If applicable): The solution is designed for use with customs brokers, port authorities, terminal operators, maritime organizations, and customs related

workflows. It supports customs clearance preparation, CBSA field extraction, dangerous goods compliance, public information redaction, and port operations. The broader vision includes collaboration with policymakers, customs authorities, maritime leaders, and public private stakeholders to modernize trade facilitation across Canada and APEC economies.

6. Ethics, Safety, Privacy, and Cybersecurity

Key risks considered (Privacy, Bias, Cybersecurity, Transparency): Privacy risk, cybersecurity risk, unauthorized data access, accidental disclosure of sensitive information, incorrect AI extraction, bias in AI recommendations, lack of transparency, over reliance on automation, data ownership concerns, and compliance risks from inaccurate or incomplete trade documentation.

Safeguards or mitigation measures adopted: Safeguards include human in the loop review, confidence scores for AI outputs, escalation workflows for low confidence or exception cases, auditability of AI recommendations, explainability for operators, secure APIs, authentication tokens, access control at API endpoints, anonymization of data, preservation of data ownership, configurable rules by document type, structured validation protocols, and compliance with relevant privacy and data governance standards such as Law 25 and GDPR.

7. Workforce and Skills Impacts

Changes to employee roles or skill requirements: Employee roles shift from manual data entry and document searching toward validation, exception management, compliance review, system configuration, quality control, and operational decision making. Staff need to understand how to review AI outputs, interpret confidence scores, manage exceptions, provide feedback, and use structured data for better decisions.

Training or reskilling initiatives implemented: Training focuses on onboarding users to AI assisted workflows, teaching operators how to validate extracted data, review exceptions, configure document rules, understand confidence levels, and provide feedback to improve the system. Reskilling is also required to help teams move from repetitive manual work toward supervision, analysis, compliance judgment, and process improvement.

8. Scalability and Transferability

Scalability within the economy: The solution is scalable across the Canadian economy because many trade, logistics, port, customs, finance, and supply chain workflows depend on similar document processing tasks. Once documents are transformed into structured data, the same foundation can support customs clearance, dangerous goods management, invoice processing, manifest processing, berth planning, productivity analysis, and federated data sharing. The vendor agnostic and API based architecture allows adoption across different systems and stakeholders.

Key prerequisites for replication in other economies: Key prerequisites include access to representative trade documents, clear data governance rules, privacy and cybersecurity safeguards, API based integration capability, stakeholder willingness to share selected data, common data standards, structured onboarding, human review workflows, local regulatory alignment, and collaboration between industry and government. Replication also requires trust building, phased implementation, and adaptation to local customs, maritime, and logistics processes.

9. Key Takeaways for Policymakers

Key lessons for policymakers: AI can meaningfully improve trade facilitation by converting fragmented documentation into structured, searchable, and actionable data. Policymakers should support interoperable data standards, secure API based data sharing, privacy preserving data governance, and human centered AI

adoption. Public private collaboration is essential because trade facilitation depends on many actors across ports, terminals, carriers, freight forwarders, customs brokers, and regulators. Policies should encourage phased implementation, shared governance, digital sovereignty, and responsible AI frameworks that preserve accountability while enabling automation, productivity, transparency, and supply chain resilience.

Turing Space

1. Basic Information

Organization name: Turing Europe B.V., the Den Haag headquarters of the Turing Space group, operating the Turing Verify service at verify.turingcerts.com.

Submitter: Yao-Chieh "Jeff" Hu, CEO & Founder

Organization type: VC-backed private company. We build digital trust infrastructure. Two products. Turing Certs issues verifiable credentials on W3C, IETF, and IOTA standards. Turing Verify is our AI forensic engine for documents that come in from somewhere else. EU-hosted, API-first, multi-tenant.

Years of implementation. Turing Space founded 2020. Turing Verify shipped 2025. The trade-document extension launched in 2025 once we had enough Certificate of Origin and Bill of Lading samples in our queue to justify a dedicated pipeline.

Project status. Operational and at scale for credential and identity documents. Six million plus credentials issued through the broader Turing Space group, with 23,029 institutions indexed for Verify. Pilot for trade-specific document classes through 2026, running with selected freight forwarders, customs brokers, and trade-finance banks.

2. Trade Facilitation Challenge Addressed

A container shipment from one APEC economy to another generates somewhere between thirty and forty distinct documents across export, transport, and import. Commercial Invoice. Packing List. Bill of Lading. Certificate of Origin. Phytosanitary Certificate or some other SPS attestation. Certificate of Free Sale. Inspection Certificate. Letter of Credit. Customs Declaration. Cargo Manifest. Dangerous Goods Declaration. And so on. Every one of those documents underwrites a decision with real money attached.

That makes them targets. A forged Certificate of Origin moves preferential tariff treatment under an FTA to goods that never qualified, an attack we call origin laundering, which simultaneously defrauds the importing economy's customs revenue and corrodes the FTA itself. A forged Phytosanitary Certificate gets pesticide-laden produce or quarantine-restricted plant material across a border. A double-issued or altered Bill of Lading enables double-financing fraud against trade-finance banks. Industry estimates of trade-document fraud losses run into the tens of billions of dollars annually, and most informed observers think the real number is higher than the reported one.

What makes the problem worse is that the people who have to catch this are working under impossible time pressure. A customs officer has minutes per consignment. A trade-finance officer reviewing a Letter of Credit under UCP 600 has to spot any inconsistency between the LC, the Bill of Lading, and the Invoice within five banking days. A phytosanitary inspector at a port of entry rarely has direct access to the issuing NPPO's records. The official tool for cross-border verification is mutual administrative assistance under Article 12 of the WTO Trade Facilitation Agreement, which works fine on a timeline of weeks to months, which is to say not at all.

Then 2022 happened. Commercial generative-AI tools collapsed the cost of producing convincing document forgery. Before 2022, faking a credible Certificate of Origin required either specialized graphic-design skills or access to a stolen template. After 2022, you can render one from a prompt. They aren't anymore. A human inspector under time pressure cannot reliably distinguish a real Certificate of Origin from a generative-AI render. The economics of forgery have shifted, and the side that is shifting faster is the side we don't want to win.

Part of the trade process targeted. Pre-arrival, at-the-border, and post-clearance. In pre-arrival, the engine verifies submitted Certificates of Origin, Phytosanitary Certificates, and Bills of Lading against issuer registries during the advance-cargo-information window, integrated via API into Single Window systems and freight-forwarder workflows. At-the-border, a customs officer presented with a paper or PDF gets a verdict in under thirty seconds. Post-clearance, the same engine runs in bulk against historical consignments under risk-management programs like Authorized Economic Operator and post-clearance audit, surfacing clusters of submissions derived from a shared forged template that no sampling-based audit would have found.

3. AI Application Overview

Types of AI used. Computer vision for pixel-level forensics: compression-artifact analysis at up to 400 percent magnification, seal and watermark fingerprinting, paper-texture consistency, signature integrity, structural geometry. Domain-specific ML models for template fingerprinting across a registry of previously catalogued forgeries: every forgery we confirm contributes its artifact fingerprint to the registry, and every future submission built from the same source template gets flagged in under a second. NLP for content-logic checks: anachronistic dates, impossible address combinations, typography released after the document's claimed issue date, country-of-origin claims that contradict HS-code or producer registry data. An LLM does auxiliary reasoning for cross-document consistency checks between Invoice, Bill of Lading, and Letter of Credit, and writes the human-readable findings into the audit-ready report. EXIF metadata analysis and ICAO 9303 check-digit verification handle the parts of the problem that are purely structural.

How it works in practice. The user uploads a document, either image or PDF, up to 20 MB. The platform validates the format, assigns a case ID, and routes to the appropriate document-class pipeline. Pre-screen catches the easy cases in under 200 milliseconds: vendor markers, phantom institutions, known template fingerprints. If the document survives pre-screen, it goes through the 250-checkpoint forensic engine. Tier 1 is visual and structural integrity. Tier 2 is content logic plus a live institutional lookup against the indexed registry. The output is a two-page A4 annotated PDF with the document image, the flagged anomalies, the detailed findings, a verdict, a confidence score, and a case ID that can be quoted in a compliance file.

We return one of three verdicts and we do not hedge between them. VERIFIED requires ≥90 percent confidence, visual integrity, institution verified, signatories authenticated, live portal lookup completed. REJECTED triggers on vendor markers, a phantom institution, or a known template fingerprint match. SUSPECT means we found something we cannot resolve cleanly and the document needs a human reviewer before anyone acts on it.

Data inputs. The document file. Its embedded metadata. The indexed registry of 23,029 institutions across 206 countries. The attack-vector catalog of 43 documented patterns covering diploma mills, professional credentials, government and civil records, business and financial documents, health credentials, identity and licenses, and structural fraud. The template-fingerprint registry, which grows with every confirmed detection. And where the issuer operates a digital verification endpoint, whether a national customs portal, a Chamber of Commerce, or an NPPO, we call it.

Degree of automation. Hybrid with explicit human-in-the-loop boundaries. VERIFIED and REJECTED above the configured confidence threshold can be processed automatically inside customer workflows. SUSPECT goes to a human. And the entire service is positioned as decision-support, not legal determination. The Terms of Service explicitly disclaim that any verdict constitutes legal advice, professional certification, or a finding of authenticity. Results must not be used as sole evidence in customs adjudication, employment, academic, immigration, or any other consequential proceeding without an independent check through

official channels. This isn't legal hedging. It's how a high-risk decision-support system should be designed in 2026, and the EU AI Act now requires it.

4. Impact and Outcomes

Measurable outcomes. A single-document forensic verdict comes back in under thirty seconds. Manual verification of the same document ranges from a few minutes for an experienced inspector eyeballing a familiar template, to weeks for a mutual-administrative-assistance request to a foreign authority. Our pricing sits an order of magnitude below the loaded cost of manual review at any organization we have measured against.

Detection accuracy. Our internal benchmark uses a 200-document stratified dataset across four difficulty tiers: trivial, easy, medium, and hard. Trivial and easy are nearly solved. Medium and hard are where the template-fingerprint registry earns its keep. Our published case studies in the Wall of Forgeries include rejection verdicts at 99.4 percent confidence, where the forensic evidence stack leaves no ambiguity: EXIF inconsistency plus seal compression artifacts plus a typeface that did not exist at the document's claimed issue date plus a watermark fingerprint shared with eleven prior rejections.

Coverage is the part that is hardest to grow and most valuable when you have it: 23,029 institutions indexed, 206 countries reached, 43 attack vectors catalogued. Trade-document vectors already in production include Fake Certificate of Origin, Fake Business Registration, Tampered Bank Statement, Fake Insurance Certificate, and Tampered Tax Document. The mechanism adds Phytosanitary template fraud, Bill of Lading double-issuance clustering, Letter-of-Credit discrepancy detection, and Customs Declaration HS-code inconsistencies.

Non-quantifiable benefits. The deeper value is confidence at the point of decision. Officers stop second-guessing themselves on documents that pass cleanly and stop rubber-stamping documents that probably should not. There is an audit trail that survives a year-end review: case ID, timestamp, methodology summary, and full findings log. And there is a deterrent effect from the public Wall of Forgeries. Our position on the Wall is that its purpose is not public shaming of claimants. It is a growing ledger of templates that cannot be reused without being caught. Every autopsy frame burns one more template.

Non-quantifiable challenges. Model bias toward dominant document classes in our training data is real. We mitigate it with conservative thresholding, returning SUSPECT when in doubt, and by actively expanding the institutional registry into underrepresented economies. Adoption friction in conservative regulatory environments is real too, where customs administrations want formal accreditation before treating an AI-generated report as supporting evidence. False positives on legitimate but unusual documents surface as SUSPECT, which is the right answer. A valid Certificate of Origin from a small Chamber of Commerce we have not yet indexed would land there.

Primary beneficiaries. Customs administrations, especially those running Single Window systems and risk-management programs. National Plant Protection Organizations and SPS authorities. Trade-finance banks operating under UCP 600. Freight forwarders, customs brokers, and AEO operators who carry the compliance liability for the documents they handle. Chambers of Commerce and other authorized issuers who want a way to publish verifiable proofs of their genuine issuances. Exporters and importers, especially the SMEs that cannot afford in-house trade-compliance forensics. And, at the end of the chain, the consumers and supply-chain participants who quietly pay the cost of trade fraud whenever it is not caught.

5. Regulatory and Policy Environment

Regulations that enable the work. The WTO Trade Facilitation Agreement, particularly Articles 7 and 10, gives risk-management approaches the legal foundation they need. The WCO SAFE Framework of Standards and the Mercator Programme do the same on the customs side, and the Revised Kyoto Convention codifies paperless trade and risk-based controls. RCEP and CPTPP both contain electronic Certificate of Origin provisions, which create the regulatory space we work in. The EU AI Act has been in force since 2025 and aligns cleanly with our human-in-the-loop architecture and our explicit decision-support disclaimers. GDPR is accommodated through EU primary hosting in Amsterdam and data-minimization in our processing

pipeline. The W3C Verifiable Credentials Data Model 2.0, IETF SD-JWT VC, OID4VCI, OID4VP, and IOTA DID provide the substrate for the next generation of trade documents, the ones that will not need forensic verification because they will be cryptographically verifiable from the start.

Regulatory barriers. Evidentiary standing is the live question. It is still unclear in most economies whether a Turing Verify report can be entered as supporting evidence in customs adjudication or trade-finance dispute resolution. We position the verdict as decision-support that triggers human escalation, not as the basis for an enforcement action. The other live constraint is cross-border data flow. Some economies require trade-document data to remain within national borders. We address this with regional data residency and on-premise enterprise deployment for the most sensitive customers.

The third constraint is more structural: most Chambers of Commerce and SPS authorities do not yet publish digital signatures or verifiable credentials on issued certificates. That forces us to rely on visual forensics and institutional registry lookup rather than direct cryptographic verification. The longer-term answer is for these issuers to migrate to W3C VC issuance directly, which our sister product Turing Certs supports. We expect the migration to take a decade, and we expect to be doing visual forensics on legacy paper documents for at least that long.

Regulator engagement. Turing Space operates under recognition partnerships with the Tokyo Metropolitan Government for 2024 to 2026 and the Taiwan Ministry of Digital Affairs. We are an institutional supplier to the European Commission's Erasmus+ programme, WHO PMNCH, UNHCR, and UNESCO. Turing Space founded the Asia Pacific Digital Identity Consortium in October 2024 to bridge Japan, Taiwan Singapore, the Republic of Korea, and other APAC economies, and I serve as European Chamber Of Commerce Taiwan (ECCT) Co-Chair of the Digital Committee and a Youth Advisory Committee Member of the Executive Yuan of Taiwan, and on the APEC IIED programme.

6. Ethics, Safety, Privacy, and Cybersecurity

The risks worth taking seriously are privacy, bias, cybersecurity, transparency, and liability. Trade documents carry commercially sensitive content: parties, quantities, prices, terms. The cross-border data flow on those documents is increasingly regulated. AI models can underperform on document classes or issuing authorities that are underrepresented in training data, which manifests as false positives that fall disproportionately on small or non-Western traders. Forensic verification systems become high-value targets the moment they sit inside critical trade infrastructure. Officers and traders need to understand why a verdict came back the way it did. And the system has to be designed so that an AI verdict is never confused with a legal determination.

Our mitigations are unglamorous and we publish them. EU primary hosting in Amsterdam, with regional data residency options. GDPR compliance with explicit consent flows, data-subject rights endpoints, and a published Data Rights process. EU AI Act alignment with documented model governance, human-in-the-loop on SUSPECT, and an explicit decision-support disclaimer. ISO 27001 controls across the production environment. Data minimization. We keep only the fields required to produce the verdict beyond the configurable retention window. Original images and intermediate AI traces are purged. End-to-end encryption of uploads and reports in transit and at rest. No third-party data sharing; no selling of document data; no using it to train external models. The audit-ready PDF report includes the case ID, the timestamp, a methodology summary, and the full findings log. The Wall of Forgeries publishes only template-level fingerprints, never claimant identities or document imagery, and we redact aggressively by default. And the conservative thresholding is the most important safeguard of all: when the engine is uncertain, it returns SUSPECT, which routes the document to a human reviewer rather than to an enforcement action.

7. Workforce and Skills Impacts

Customs officers and trade-finance reviewers stop doing the cheap, mechanical part of verification and start doing the expensive, judgment-heavy part. The skill emphasis shifts from primary visual forensics to triage, interpretation of AI-generated findings, and final disposition decisions on SUSPECT cases. Compliance and audit teams expand

from sample-based post-clearance review to full-population scanning, which is qualitatively different work. The engine surfaces clusters of submissions derived from a shared forged template that a sampling audit will never see. Issuing-authority staff at Chambers of Commerce and SPS authorities take on credential-issuance responsibilities as their economies migrate to verifiable-credentials issuance, rather than only stamping paper.

What we provide on the reskilling side is documentation rather than a separate training product. The free public Glossary, FAQ, How It Works pages, and the forensic case studies in the Wall of Forgeries Autopsy Frames are accessible to anyone. The API and developer documentation let trade-document workflows integrate the engine without a vendor-services engagement. Enterprise deployments include onboarding and ongoing case-review training. Across the Asia Pacific Digital Identity Consortium, we run cross-jurisdictional capacity building on the standards stack of W3C VC, OID4VCI, OID4VP, SD-JWT VC, and HAIP v1, for member economies' trade and identity practitioners.

8. Scalability and Transferability

The architecture is cloud-native, multi-tenant, API-first. One deployment region currently serves customers in fifteen economies and verifies documents claiming issuance from 206. Adding an issuer to the institutional registry is a content operation, not a model retraining cycle. New attack vectors get added on confirmed novel attacks and propagate to all customers automatically. That is the property that matters most for cross-border scale.

What another economy needs to replicate the deployment. The institutional registry needs to include that economy's primary issuing authorities: Chambers of Commerce, SPS authorities, customs administrations, and ministries of trade. Inclusion happens either through publicly available issuer data or through a memorandum of understanding. The point of verification needs reliable connectivity. The legal framework needs to recognize AI-generated forensic reports as supporting evidence, even if not as primary evidence; the UNCITRAL model laws on electronic transactions and electronic signatures are a useful baseline. The medium-term destination is migration of issuing authorities toward W3C VC issuance, which is what shifts the system from visual forensics to cryptographic verification. And the cross-border dimension matters: the full benefit of forensic verification compounds when economies recognize each other's engines and registries. APEC, the WCO, the WTO, ASEAN, and the Asia Pacific Digital Identity Consortium are the natural venues for that recognition.

The other thing that compounds across borders is the open template registry. Every detected forgery template logged in the Wall of Forgeries is a template that cannot be reused anywhere. A multilateral shared registry under WCO, APEC, or PECC would multiply that positive externality across every participating economy.

9. Key Takeaways for Policymakers

Generative AI has structurally changed the threat surface. Before 2022, document forgery required specialized skills. Now it requires a prompt. Trade documents have high commercial and regulatory value and rely on visual inspection under time pressure, which puts them at the front of the queue. Any customs administration, trade-finance bank, or SPS authority operating in 2026 should assume that any document it sees may be a generative-AI render and should design its verification workflow on that assumption.

AI forensic verification is a baseline expectation now, not a luxury. The cost of automated verification is an order of magnitude below the loaded cost of equivalent manual review at any organization we have measured against. Economies that do not deploy AI forensic verification at the border, at the bank, and across the audit cycle are accepting a structural disadvantage in trade-fraud loss rates relative to the economies that do.

Deploy it as decision-support, not legal determination. The verdict should trigger human escalation, especially on SUSPECT cases. Legal frameworks should recognize AI-generated forensic reports as supporting evidence, with the case ID, timestamp, methodology, and findings log carried into the record, while preserving human officers as the locus of final adjudication. The EU AI Act offers a workable model. Conservative economies that import that model wholesale will not regret it.

Open template registries shift the fraud economy. Every detected forgery template logged publicly is a template that cannot be reused anywhere it is recognized. Multilateral coordination on shared registries within WCO, APEC, ASEAN, or PECC turns a single-jurisdiction defense into a regional one and makes the marginal economics of forgery worse for the forger.

The destination is verifiable issuance, not just verification. Visual forensics will be needed for the legacy paper documents for decades. But the trust that holds up under scrutiny comes from cryptographic issuance under W3C VC, IETF SD-JWT VC, and equivalent standards. Customs administrations and Chambers of Commerce should plan migration paths from paper to verifiable credentials, and trade-facilitation agreements should explicitly recognize verifiable credentials as equivalent to, or preferable over, paper certificates.

Equity in trade-document infrastructure is not optional. SMEs, exporters from least-developed economies, and traders working in underrepresented document classes are doubly exposed: to fraud when forgers impersonate them, and to false positives when the verification engine has not yet indexed their issuers. Free tiers for SME traders, capacity building for under-served economies, and active expansion of institutional registries into under-indexed jurisdictions are the difference between an AI-enabled trade-facilitation ecosystem that levels the playing field and one that reproduces existing inequities at higher resolution.

Appendix A: Trade-Relevant Attack Vectors in the Current Registry

The Turing Verify engine currently catalogs 43 attack vectors. Those most directly relevant to trade facilitation:

AV-22 Fake Business Registration. AV-23 Tampered Bank Statement, relevant to Letter-of-Credit collateral. AV-24 Fake Insurance Certificate, relevant to marine and cargo insurance. AV-25 Fake Certificate of Origin. AV-31 MRZ Check Digit Failure, for travel documents of trade actors. AV-32 National ID Checksum Failure. AV-33 Regional ID Format Mismatch. AV-34 Fake Aviation License, relevant to air-cargo operators. AV-35 Trade License National Claim. AV-36 Tampered Tax Document. AV-37 Anachronistic Elements, where typography or technology in the document did not exist at its claimed issue date. AV-39 Date and Address Impossibilities. AV-40 Visual Micro-Anomalies, the compression-artifact and seal-composition family. AV-41 Verification Trap Indicators. AV-42 Auxiliary Document Fraud, covering apostilles, notarizations, and secondary attestations attached to trade documents. AV-43 Translation and Credential Inflation.

The 2026 pilot adds vectors for Phytosanitary Certificate template fraud, Bill of Lading double-issuance detection, Letter-of-Credit discrepancy clustering, and Customs Declaration HS-code inconsistencies.

Appendix B: References:

Turing Verify product site: https://verify.turingcerts.com. Turing Verify whitepaper covering forensic methodology, benchmarks, and the attack-vector taxonomy: https://verify.turingcerts.com/whitepaper. Wall of Forgeries live template registry: https://verify.turingcerts.com/wall. How It Works: https://verify.turingcerts.com/how-it-works. Live Statistics: https://verify.turingcerts.com/stats. Press Kit: https://verify.turingcerts.com/press. Turing Space corporate site: https://www.turingspace.co. Turing Certs verifiable credential issuance counterpart: https://www.turingcerts.com.

WTO Trade Facilitation Agreement: https://www.wto.org/english/tratop_e/tradfa_e/tradfa_e.htm. World Customs Organization SAFE Framework of Standards: https://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/frameworks-of-standards/safe_package.aspx. W3C Verifiable Credentials Data Model 2.0: https://www.w3.org/TR/vc-data-model-2.0/.

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