World Customs Organization

SMART CUSTOMS PROJECT

Case Study on the adoption of Artifical Intelligence (AI) and Machine Learning (ML) in China Customs

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CHINA CUSTOMS

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World Customs Organization

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Acronyms

AI	Artificial Intelligence
CT	Computed Tomography
DR	Digital Radiograph
GACC	General Administration of China Customs
GPU	Graphics Processing Unit
IPR	Intellectual Property Rights
IoT	Internet of Things
IT	Information Technology
ML	Machine Learning
OCR	Optical Character Recognition

I. Background

In December 2023, the World Customs Organization (WCO) and the General Administration of Customs of the People's Republic of China (GACC) signed a Cooperation Agreement, marking the launch of the Smart Customs Project funded by China Customs. The WCO **Smart Customs Project** aims to identify Members' current status as regards technology adoption and needs. The project focuses on the following domains:

• updating the WCO/WTO Study Report on Disruptive Technologies (June 2022), which includes further updates and expansions of existing chapters, as well as the addition of new chapters dedicated to specific technologies identified during the project;

• developing detailed information about the business processes, policy arrangements, legal requirements, minimum technical specifications (for implementation/integration), costs and trends associated with identified specific technologies;

• publishing a research paper on the challenges faced by Customs in adopting and leveraging innovative technologies;

• launching a Community Portal to share and push knowledge on technologies and innovative solutions applied to Customs; and

• conducting an analysis of Members' needs, in order to be able to provide them with appropriate technical assistance and capacity building in this field in the future.

The Smart Customs Project will provide information on the use of selected disruptive technologies in Customs, including artificial intelligence (AI) and machine learning (ML), blockchain, cloud computing, data analytics, the Internet of Things (IoT), drones, biometrics, and virtual, augmented and mixed reality, etc.

Key aspects of technology implementation, such as business processes, legal requirements, policy arrangements, technical specifications, costs and trends, will be addressed and included in the Study Report for selected disruptive technologies.

AI/ML is one of the three key technologies in focus under the WCO Smart Customs Project.

According to the results of the Smart Customs Survey (July 2024), only 12 WCO Members have currently adopted AI/ML, while 88 Members are currently developing it or considering developing it.

In order to bridge the digital gap in AI/ML adoption, the Smart Customs Project organizes national study missions to assess key aspects of AI and ML implementation in Member administrations. These assessments cover critical areas such as strategic vision, current efforts, use cases, business processes, legal requirements, policy arrangements, technical specifications, costs, trends and future plans for leveraging AI/ML technologies.

This Case Study presents the information collected through the national study mission held in China from 28 October 2024 to 1 November 2024.

Supported by the Customs Cooperation Fund of China (CCF China), this mission gathered experts and officials from key departments of the General Administration of Customs of the People's Republic of China (GACC) including Risk Management, Science and Technology, Port Control, and International Cooperation, in the GACC Headquarters, alongside representatives from the National Targeting Bureau offices in Shanghai, Qingdao and Huangpu, and officials from regional and local Customs in Huangpu and Guangzhou.

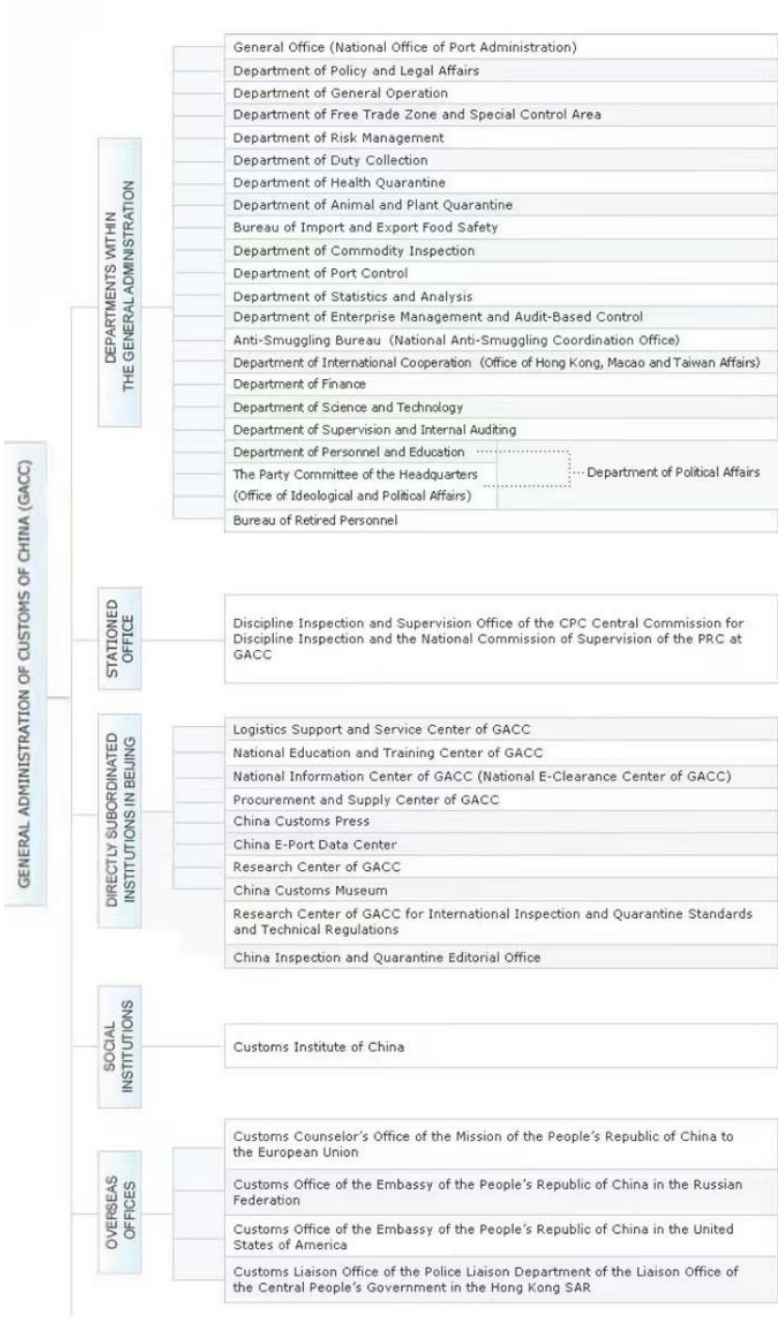
On-site visits in Huangpu and Guangzhou Customs Districts explored key use cases, including the Tianji Knowledge Graph System, the Intelligent Control Model (TianXuan), Smart NII Image Analysis, Intelligent Document Examination, Smart Port Development and AI Applications in the Single Window Environment.

II. Introduction to the General Administration of Customs of the People's Republic of China (GACC)

The General Administration of Customs of the People's Republic of China (GACC), the headquarters of China Customs, serves as a key border agency. Following the government restructuring in 2018, China Customs now has 100,000 staff throughout the country with responsibility for traditional Customs operations as well as border health checks, inspection and quarantine for imported and exported animals, plants and products thereof, imported and exported food safety, and commodity inspection.

The GACC oversees 42 Customs districts which operate through a total of 678 Customs Houses nationwide. The GACC's Guangdong Office oversees regional coordination.

Organization Chart




GENERAL ADMINISTRATION OF CUSTOMS OF CHINA (GACC)
DIRECTLY SUBORDINATED INSTITUTIONS NATIONWIDE
Guangdong Sub-Administration of GACC
Supervising Office of GACC in Tianjin
Supervising Office of GACC in Shanghai
Beijing Customs District
Tianjin Customs District
Shijiazhuang Customs District
Taiyuan Customs District
Hohhot Customs District
Manzhouli Customs District
Dalian Customs District
Shenyang Customs District
Changchun Customs District
Harbin Customs District
Shanghai Customs District
Nanjing Customs District
Hangzhou Customs District
Ningbo Customs District
Hefei Customs District
Fuzhou Customs District
Xiamen Customs District
Nanchang Customs District
Qingdao Customs District
Jinan Customs District
Wuhan Customs District
Zhengzhou Customs District
Changsha Customs District
Guangzhou Customs District
Shenzhen Customs District
Gongbei Customs District
Shantou Customs District
Huangpu Customs District
Jiangmen Customs District
Zhanjiang Customs District
Nanning Customs District
Haikou Customs District
Chongqing Customs District
Chengdu Customs District
Guiyang Customs District
Kunming Customs District
Lasa Customs District
Xi'an Customs District
Lanzhou Customs District
Xining Customs District
Yinchuan Customs District
Urumqi Customs District
EDUCATIONAL INSTITUTIONS
Shanghai Customs College
Chinese Academy of Customs Administration

III. Strategy and Vision

The GACC launched the "Smart Customs" Project and the "Smart Customs for Great China" Campaign in 2023, featuring a series of technology-innovation projects with safety, facilitation and efficiency as core values. These are centred around the "Smart Customs, Smart Borders and Smart Connectivity (3S)" concept and the Smart Customs Cooperation Partnership (SCCP), both proposed by Chinese President Xi Jinping.

III.1 The « 3S » Concept

On 9 February 2021, the Chinese President Xi Jinping proposed the concept of "Smart Customs, Smart Borders and Smart Connectivity (3S)". This concept combines collaborative governance theory with the application of modern technologies, envisaging the development of solutions for enhancing Customs institutional innovation and governance capabilities and deepening international Customs cooperation, in order to promote trade security and facilitation.
The core value of the "3S" is the "Smart" concept, which highlights two aspects: the application of new technologies and equipment, and the extensive use of innovative thinking.

Smart Customs encourages technological innovation and optimization of means of control to modernize Customs management system and capabilities. Smart Customs features smart infrastructure, smart Customs control and smart internal management.

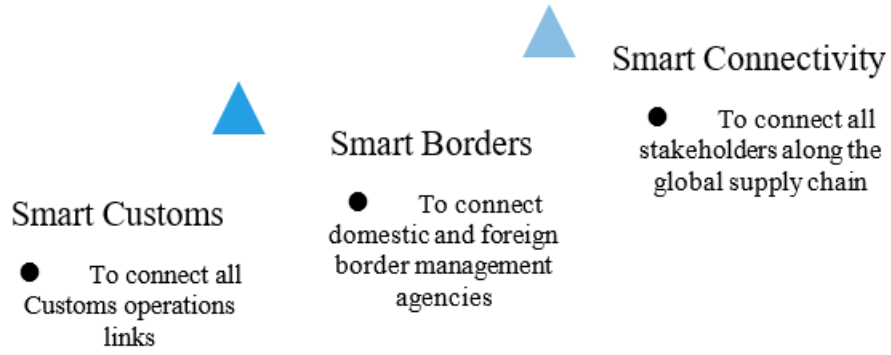
"Smart Customs" is considered to be the basis of "Smart Borders" and "Smart Connectivity".

The Smart Customs concept advocates both technological advancement and innovation. It explores the use of AI, blockchain, the Internet of Things (IoT), big data, biometric recognition, drones, virtual reality, 3D printing and other disruptive technologies to achieve electronic and automated Customs control, further improves the precision and effectiveness of Customs clearance, alleviates the shortage of human resources, improves decision-making and operation mechanisms, shares the dividends of innovation and prevents corruption risks.

The concept also aims to ensure adaptability to new situations in order to maintain the security and stability of the supply chain, considering the emerging changes to Customs operations and work modalities brought by new technologies and new business forms. It promotes the simplification of Customs procedures, adopts the concept of risk management, integrates and optimizes Customs clearance processes, creates a more efficient and modern Customs environment, and promotes the healthy development of international trade.

Smart Borders encourages all Customs and border agencies to share information and strengthen joint operations and risk control to achieve coordinated border management.

Smart Connectivity encourages interconnection, compatibility of systems and standards, and stakeholder cooperation along the global supply chain to ensure trade security and facilitation. It is the ultimate goal of international Customs cooperation that promotes the intelligent governance of the global supply chain.



III.2 The Smart Customs Cooperation Partnership (SCCP)

On 24 August 2023, Chinese President Xi Jinping announced the implementation of a Smart Customs Cooperation Partnership (SCCP) approach at the "BRICS Plus" Leaders' Dialogue, aiming to promote the development of Smart Customs through technology and innovation, in order to improve trade facilitation and responses to global challenges.
SCCP operationalizes the "3S" concept, aiming to build partnerships with other Customs administrations, other government agencies, relevant international organizations, private sector and academia, to jointly promote the modernization of Customs operations and capabilities.

The following actions are envisaged in this framework:

- applying intelligent technology and innovative thinking to promote the development of Smart Customs;
- promoting information sharing and mutual recognition of controls at the international level;
- leveraging on stakeholder cooperation to promote global supply chain interconnectivity;
- providing capacity building assistance; and
- reducing Customs clearance time and costs to promote economic and trade development.

In application of the SCCP initiative, initiatives are under discussion with other WCO Members such as the South African Revenue Service (SARS) and the Superintendencia Nacional de Administación Tributaria of Peru (SUNAT).

III.3 The implementation Scheme (1 + N + X)

The implementation of the Smart Customs strategy relies on two overarching objectives:
- **the first is related to the Customs operation system:** to optimize business operation procedures and standards, build policy requirement parameters and knowledge banks, realize the interconnection of all types of data and strengthen coordinated governance;

- **the second is related to the scientific and technological support system:** to enhance the application of science and technology through a support platform, big data platform, business collaboration platform and infrastructure platform to realize intelligent analysis and automatic control.

The implementation scheme can be summarized as **"1+N+X"**, in which "1" is the overall construction scheme, "N" refers to the implementation in 22 operational fields such as risk prevention and control, port

control, commodity inspection and other business operations; and "X" refers to the application schemes in 132 specific business scenarios, such as the port inspection.

The implementation scheme is supported by a selection of strategic projects.

IV. Data Management

Nine key projects selected by GACC for 2024 include optimizing business processes, building a big data lake, parameters base, knowledge base and intelligent model base, providing a one-stop service for cross border trade, and building a coordinated and unified operation and monitoring platform nationwide. In this framework, three areas of implementation are presented as follows:

A. Data infrastructure. The GACC has optimized data governance models and internal and external data sharing methods and built a standardized big data lake Focusing on the management of organizational data and third-party data, the GACC has integrated over 261 billion records into the data lake and developed a data analysis platform to provide users with basic tools such as a full-scale data, tables and subject database.

B. Digital construction. The GACC has digitally converted laws, regulations and policy control measures into computer language to realize parameter identification and enable automatic computerized control. More than 4,600 policy documents have been sorted in various business fields, over 3,700 parameters have been extracted, and the parameter operation platform has been built.

C. Data application. An intelligent model database has been established with the advanced Catboost AI algorithm, and a model cluster has also been formed. In addition, specific intelligent models have been developed to target frauds involving solid waste, food security, animal and plant safety, and other enforcement areas. To date, 24 models have been developed and 20 models are under construction.

V. Leadership and Governance

In terms of organizational structure, GACC's **Risk Management Department** is responsible for developing intelligent models and databases. This includes collecting requirements for model development, overall planning for data sharing and governance, as well as overseeing model construction and application across the nationwide Customs operations. The selection of AI modules for development depends on the expected performance, the maturity level and the difficulty of data collection and data governance, as well as the consideration of strategic priorities.

Other key organizational branches at the central level are the **Department of Science and Technology**, ensuring the development and maintenance of the technical infrastructure and obsolescence plans, the **Department of General Operations**, for oversight and strategic alignment, **the Department of Statistics and Analysis**, responsible for data security and management policy, as well as the **Department of International Cooperation** and the **Department of Personnel and Education**, in charge of personnel mobilization and requalification.

The Smart Customs strategy encourages engagement of **local offices** and field operations including risk management, duty collection, health quarantine and animal and plant quarantine, etc. An example of this multi-level approach, the "Model Operational Management Centre", is established in Huangpu Customs to undertake demand coordination, project management, performance evaluation and other tasks related to the application of intelligent models.

A lifecycle management approach for the development and application of Customs intelligent models is detailed in the GACC's "Measures for the Management of Intelligent Models for Big Data in Customs" and

the “Measures for the Management of Customs Data”. They establish a lifecycle management standard for Customs intelligent models and clarify model management, including demand collection and assessment, project initiation and bidding, model research, development and deployment, pilot promotion and application, model iteration and optimization, and model operation, maintenance, and removal.

Breaking through the traditional management mode, an agile project management approach has been adopted to minimize the time required for deployment.

VI. Policy Arrangements

In 2021, the GACC formulated the **“14th Five-Year Plan for Big Data Application in Customs”**, marking the gradual institutionalization and standardization of big data application management.

In 2023, the GACC designed the **“Overall Plan for Smart Customs”** and the **“Construction Plan for Intelligent Models”,** and clarified the development goals, main tasks and key projects for AI in the GACC.

In this framework, the GACC has aggregated data from internal Customs sources, exchanges with other ministries and commissions, international exchanges and external purchases, and established a Customs big data lake after data cleaning. Currently, the GACC big data lake contains more than 15,000 data tables and over 261.4 billion data records, providing rich data resources for Customs AI applications. The GACC has also unified intelligent model algorithm interfaces and built a model research and development environment.

Another key pillar of the AI policy is **team building and talent cultivation**. A dedicated team for model construction has been established at the central level to carry out the work full-time.

VII. Legal Framework

At the national level, China has promulgated laws and regulations such as the Data Security Law of the People’s Republic of China, the Cybersecurity Law of the People’s Republic of China, the Personal Information Protection Law of the People’s Republic of China, and the Measures for Security Assessment of Cross-border Data Transfer to strengthen the overall management of data security.

At the Customs level, the GACC has promulgated the “Standards and Specifications for the Classification and Grading of Customs Data” and the “Administrative Measures for Customs Data Security (for Trial Implementation)” to improve system for Customs data security. The “Administrative Measures for the Use of Customs Big Data”, the “Administrative Measures for the Sharing of Customs Big Data Resources”, the “Administrative Measures for the Application of the Customs Big Data General Analysis Platform” and the “Administrative Measures for the Customs Application Model of Big Data (for Trial Implementation)” have been promulgated to promote the management of big data applications. The “Measures for the Management of Customs Data Resource Sharing” have also been promulgated to facilitate data sharing and coordination. The “Implementation Plan for the Construction of Smart Customs Business Data” has been issued to strengthen data quality management and data infrastructure.

In terms of IPR, all content developed through AI by Customs is owned by the GACC.

VIII. Use cases

62 intelligent models are currently either operational, under construction or at the research and exploration stage in the GACC: 22 models are at the pilot stage, 20 models are under construction, 18 models are at the research and exploration stage and 2 models have been fully deployed;

- the Intelligent Control Model (TianXuan),
- the Intelligent Image Review Model.

These intelligent models cover four management areas: external law enforcement and control, enterprise-related services, internal administrative management and compliance audit.

Law enforcement and control models are mainly developed for Customs in areas such as port control, revenue collection, anti-smuggling and risk prevention and control. For example, the "Intelligent Image Review Model" uses image classification and recognition algorithms based on deep neural networks to automatically and efficiently identify cargo images generated by large container/vehicle inspection equipment (H986) and CT equipment and implements precise inspections in the event of anomalies to reduce Customs clearance time and improve supervision efficiency.

Enterprise-related service models are primarily used to facilitate trade and enhance the sense of gain for enterprises in import and export. For example, the "Smart Benefit-Access Service Model" uses intelligent means to proactively inform importers and exporters of preferential policies, reduce reporting and filling requirements, and conduct intelligent audits, thereby improving the coverage of, and easy access to, preferential policies, and reducing the risks and costs of imports and exports for enterprises.

Administrative management models are built to enhance the level of internal administrative management within the organization, such as assisting offices, finance, human resources and other departments in improving management efficiency. For example, the "Smart Office Model" uses AI to achieve the automatic collection and distribution of office information, and to assist in the drafting of official documents, rapid proofreading and intelligent error correction.

Compliance audit models are established by Customs for audit and supervision to ensure internal management compliance within the organization, being instrumental in improving internal governance. For example, the "Smart Supervision Model" uses natural language processing algorithms to automatically identify and convert unstructured documents from historical compliance audits into structured supervision points, improving audit and supervision efficiency.

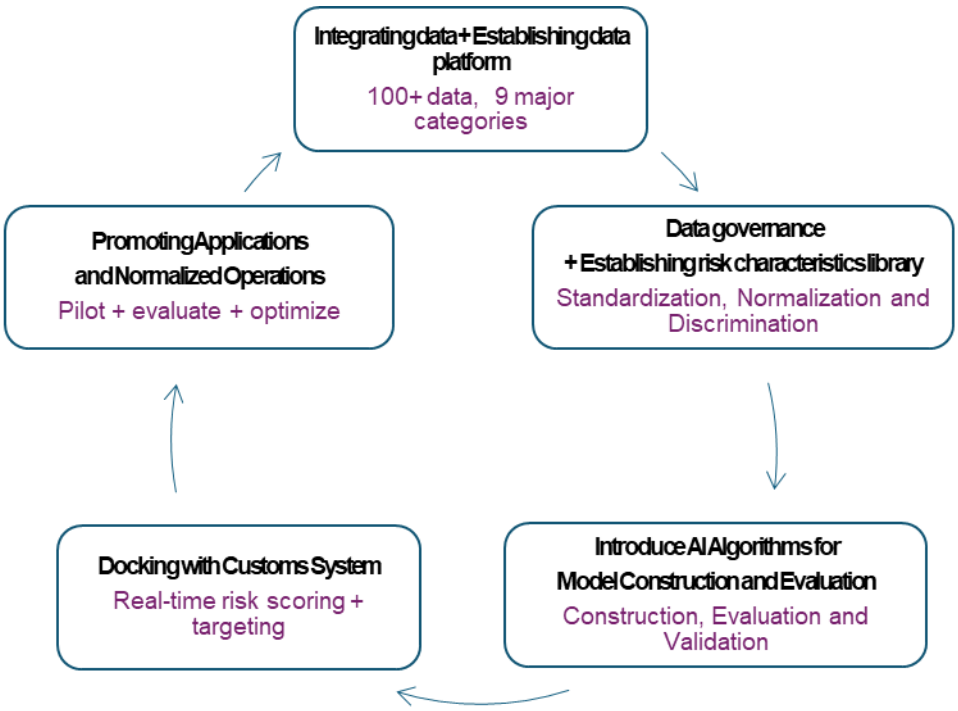
VIII.1 TianXuan (Merak) in the Risk Prevention and Control Bureau

In November 2023, TianXuan 1.0 was implemented in 260 ports across China. Working as an AI targeting expert, TianXuan is a set of programs based on big data technology and AI algorithms. It takes the historical Customs declaration data as a training sample. It can intelligently score the Customs declaration risk in real time, and automatic targeting then quantifies the risk rating and issues instructions on inspection and treatment. The learning "brain" (i.e. the neural network) continually learns the correlations between the inspection results and the risk factors, including the original declaration data or the risk characteristics which are summarized by human experts.

The calculating "brain" evaluates the risk based on the current declaration data input and the targeting strategy learned from the learning "brain". It quantifies the risk rating and assigns different risk feature labels accordingly.

TianXuan models are scalable. In 2017, the first generation of TianXuan had only 13 risk indicators. After more than six years of continuous iteration, the number of current risk indicators has reached 105, including tax assurance, drugs and precursor chemicals, safety and other restrictions, intellectual property rights and risk indicators previously used during and after sea and air transportation. A Standard Operating Procedure (SOP) has been established for the full life cycle management of the model, ensuring its replicability.

Structure of TianXuan



These models are all built on the basis of specific scenario requirements, with the expectation of an increased demand for intelligent models, as the implementation of the Smart Customs Strategy progresses.

VIII.2 Smart Image Analysis

The GACC deploys Non-Intrusive Inspection (NII) equipment such as large-scale container/vehicle scanners, X-ray scanners and CT units. In order to further tap the potential capacity of NII equipment and ensure the effectiveness and efficiency of this equipment, the GACC has been actively exploring the application of AI technology to realize the automatic identification and comparison of NII images since 2014, starting from the application for the identification of imported solid waste.
In 2017, the GACC and Tsinghua University conducted joint research to apply AI and big data technology to systematically comb massive NII historical images (up to millions of images) for training purposes, and successfully released the first version of the algorithm. Later on, the GACC carried out pilot projects in some Customs districts and rolled the application out step by step in all Customs districts nationwide.

After nearly seven years of practice and development, the GACC has promoted the AI-supported image analysis application in all eligible large-scale container/vehicle scanners and CT units across the country and embedded the technology into the Customs operation process and operating system. Different algorithms are developed for different types of equipment.

So far, the operation mode featuring "primary analysis by machine and supplementary analysis by expert" has been explored and applied in some Customs districts on a pilot basis, aiming to realize the goal of "replacing people through machines" in the future.

VIII.2.1 Applications of AI-supported Image Analysis

• AI-supported image analysis for large-scale container/vehicle scanners

The large-scale container/vehicle scanner used by the GACC adopts a side-view. For the images produced by large-scale container/vehicle scanner, the GACC has developed AI-supported image analysis algorithm modules such as declared goods identification, concealment detection, empty container identification and intercepted goods detection. The algorithms have been deployed on a variety of models of large-scale container/vehicle scanners marketed by different vendors, and more than 1,000 effective goods identification algorithms have been developed. Of these, the declared goods identification function combined with the information on the declaration form can recognize the declared goods and automatically detect false declaration and concealment.

The concealment detection function automatically identifies high-risk areas that are clearly distinct from other areas in the image.

The function of empty container/vehicle identification is to determine whether the container/vehicle declared as empty is actually empty and to spot the location of the goods in the non-empty container/vehicle.

The function of intercepted goods detection automatically identifies a variety of key inspection goods, including guns and controlled knives, hidden in bulk goods.

Moreover, the GACC has developed and deployed the abnormality detection function against the vehicle body in some ports in demand, such as land border ports, to realize the automatic identification of suspected non-vehicle body areas in the cab and chassis areas.

• AI-supported image analysis for top-view passenger vehicle scanners

The passenger vehicle scanners used by the GACC adopt the top-view. Considering the different angles between passenger car scanners and side-view large container/vehicle scanners, the GACC has explored and tailor-made AI-supported image analysis modules especially for passenger car scanners, including a foreign items recognition algorithm and a multi-category target detection algorithm, and achieved good results through testing.
The multi-category target detection module adopts the target detection algorithm. The algorithm adopts the refined feature extraction method, which can effectively improve the detection ability of different categories of intercepted articles, leading to the automatic detection and warning of knives, guns, contrabands, wine (flat placed) and other taxable items.

• AI-supported image analysis for CT units

The GACC utilizes three-dimensional scanning images, two-dimensional DR Images and slice images of CT equipment to obtain information such as item density and equivalent atomic number, enabling contraband detection. At the same time, combined with the declaration information of express and postal parcels, the system can identify and examine the name of declared goods. To date, more than 1,000 effective article identification algorithms have been developed., These include the contraband detection function, which can quickly detect drugs, guns and their parts, controlled knives and other contraband, and notebooks, cameras, watches and other high taxable goods, in the two-dimensional/three-dimensional images.

The smart image comparison function is customized and developed for Customs offices examining express and postal parcels with electronic clearance data. With the help of their AI-supported image analysis system, the articles library is established through CT unit images and declaration text information. Information such as the name, quantity and weight of the articles in the declaration form is automatically compared with the scanned images, followed by the assessment of whether the articles reflected in the scanned image are consistent with those in the declaration of the express package.

VIII.2.2 Managing the Application AI-supported image analysis

• Classified algorithm deployment

Algorithm results often do not match on-site operations, especially in case of newly launched algorithms. In order to address this problem, the GACC has explored the combination of "grand unification" and "small scale autonomy" processes in algorithm deployment, to further optimize the application of AI-supported image analysis management. In the "grand unification" process, based on the unified supervision mode, the GACC is planning to conduct overall management and scientific classification of the AI-supported image analysis algorithms. Unified deployment and application will be conducted to those well-developed interception algorithms, for instance, those with an accuracy rate higher than 95%. In the "small autonomy" process, to meet the needs of different actual scenarios in different Customs districts, the GACC has authorized regional Customs to make independent and reasonable adjustments and deployments that meet the unified requirements. **As a result of the customized adjustment of algorithms, so far the overall accuracy rate of AI-supported image analysis for large-scale container/vehicle scanners has increased by about 5 per cent** and the false positive rate has been reduced by 8 per cent. The overall accuracy of AI-supported image analysis for CT equipment has been improved by about 6 per cent and the false positive rate reduced by 5 per cent. The matching level of the algorithms has increased.

• Images Cross-Validation

The scenario GACC faces involves vehicles loaded with transit goods moving from one Customs district to another or entering and exiting through different ports.
These scenarios mean that the larger-scale container/truck scanners in different ports need to scan the same truck/goods, and the images need to be cross-validated to detect risks. The "Images Cross-Validation" function therefore meets the practical needs of GACC control management. Pilot projects have been conducted in major ports, applying the vehicle body image subtraction algorithm, as well as the generative vehicle body concealment detection algorithm, receiving positive feedback.

VIII.2.3 Effectiveness and benefits

For Customs administrations:

• increased Customs control effectiveness: Since the application of AI-supported image analysis, the non-intrusive inspection and detection capability of GACC has been significantly improved, further improving performance of Customs NII equipment and significantly increasing seizures.

• savings in manpower: In the field of large-scale container/vehicle scanning and CT equipment scanning for express parcels, AI-supported image analysis has reached the accuracy level of inspection of Customs officers with 2-3 years of working experience. The manpower required in some of their on-site offices has decreased 57%.

• diversified NII scenarios: Through the continuous development of classified algorithm deployment, images cross-validation and other functions, the flexibility of AI-supported image analysis has increased, thus improving the ability of AI-supported image analysis to cope with different business scenarios and different types of goods.

For enterprises:

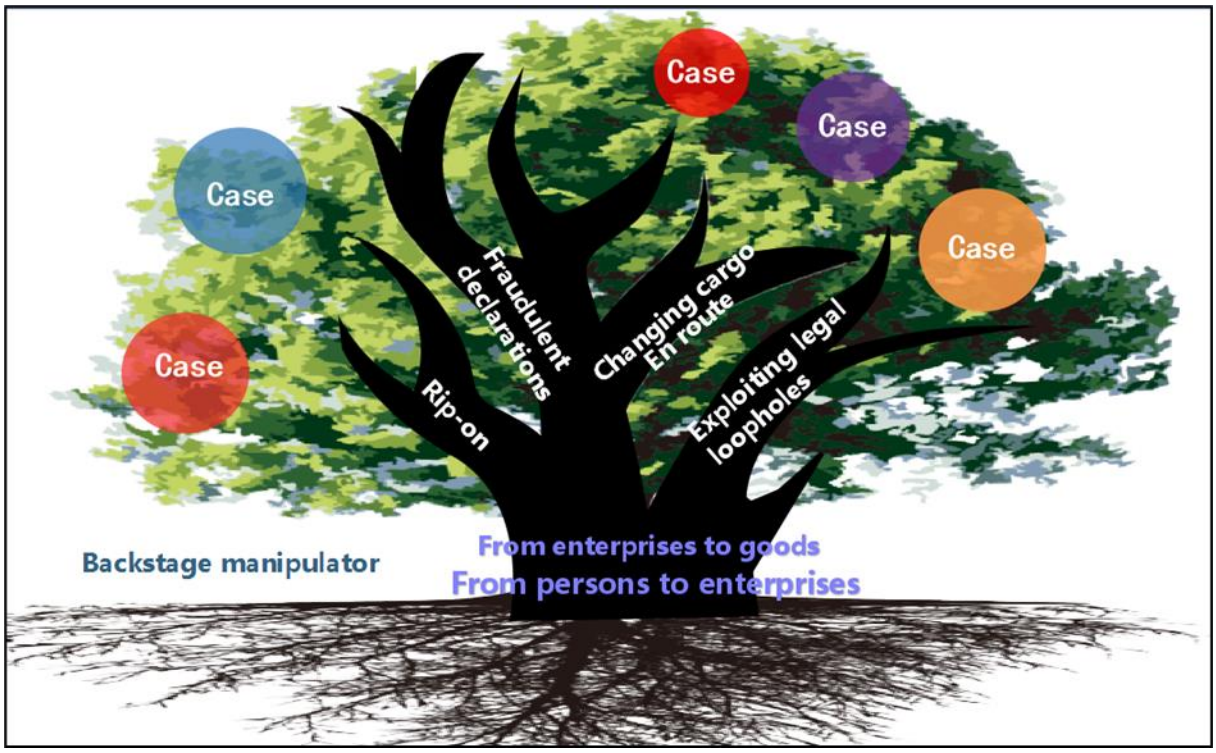
• reducing the inspection time and further improving the **efficiency of Customs clearance**. Compared with manual analysis, AI-supported image analysis has the advantage of being faster and more stable, achieving the goal of further reducing the Customs clearance time, improving the Customs clearance efficiency and promoting trade facilitation.
• ensuring the **consistency of law enforcement standards:** Deploying the same algorithm in different Customs offices will realize the unification of image analysis standards, reduce the discretion of Customs officers and reduce the risk of law enforcement **integrity**.

VIII.3 Intelligent Models Under Development

VIII.3.1 Tianji Knowledge Graph System (Customs National Targeting Bureau (Huangpu)

The GACC has actively explored the digitalization, "intelligentization" and automation of risk management models, with the application of new technologies in data processing, information screening and risk identification.

The TianJi System is an example of risk management automation leveraging on data and the visualization of relationships among enterprises and "backstage manipulators".



The TianJi System has been developed by the GACC's Department of Risk Management. It aims to promote the digital transformation and intelligent upgrading of risk prevention and control. It is an integrated solution with multiple functions including data mining, risk analysis and assessment, and risk prediction, as well as a user interface, providing support for optimizing risk identification and deepening classification management.

Customs officers use the TianJi System to analyse the levels of connection among consignors, consignees and enterprises. It can extract and summarize the internal relationship, identify possible illegal gangs, uncover backstage manipulators, identify high-risk enterprises, assist decision-making and help crack down on illegal acts such as concealment, evasion and fraud.

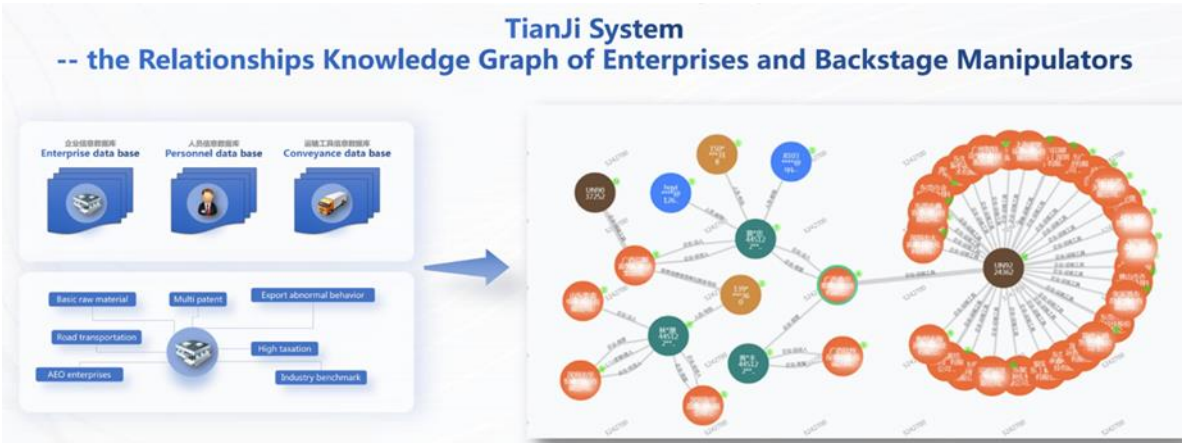
The application of the TianJi System leads to labour savings, as well as an improvement in the efficiency of analysis and the precision of risk prevention and control.

VIII.3.1.1 The Design of the TianJi System

The design of the TianJi System is rooted in the following steps.

• Build data foundations

Customs supervision targets the means of conveyance, personnel, cargo and enterprises. TianJi System integrates all kinds of information and data related to import and export which are independently declared by enterprises to Customs and other regulatory departments. Data cleaning establishes the database of enterprises, personnel and means of conveyance and also builds the data foundations of the system.



• **Data Acquisition**

Data are derived from import and export declarations, generated in the process of Customs enforcement operations such as cargo inspections, laboratory inspections, enterprise audits, anti-smuggling investigations, and obtained from information shared between government departments such as the State Administration of Taxation, the Ministry of Human Resources and Social Security and the State Administration for Market Regulation, and exchanged between Customs at the international level.

The data source channels are gradually expanding, ensuring compliance with data storage and data security requirements.

• **Data Processing**

The collection of unstructured data, including non-formatted text and various document and image formats, is actively explored.

Optical character recognition (OCR) technology is applied to extract information from documents accompanying import and export declarations, transforming the unstructured data, such as enterprise personnel information in image data, into usable structured data.

Large Language Model (LLM) technology is used to standardize data from consignees and consignors, through open source LLM, and similarity matching techniques, to perform data cleaning on consignees and consignors.

• **Data Subject Connection**

Taking enterprises, personnel and the means of conveyance as the main subject, the multi-table data obtained from different channels are connected to establish the main subject database, realizing multi-view and multi-dimensional data queries and analysis.

In the case of enterprises, natural, behavioural and association attributes are identified.

• natural attributes, such as the location of the enterprise, the main business personnel.

• behavioural attributes, such as statistical information including the quantity of import and export goods, the country of origin, and import and export fluctuations.

• association attributes, such as the direct relationship between different enterprises, between enterprises and personnel, and between enterprises and the means of conveyance, the legal representative relationship between enterprises and personnel, and the leasing and use relationship between enterprises and the means of conveyance, etc.

In the case of the means of conveyance, the system applies the national vehicle track data, develops the highway truck track monitoring module, and docks with the marine ship track monitoring module, thus monitoring the entire logistics chain, with the possibility of realizing logistics track monitoring from the port of departure to the port of destination to the wharf data and then to the actual destination, greatly improving the analysis ability.

• Develop the labelling system

In order to compare and detect illegal acts such as concealment, evasion and fraud, a hierarchical labelling system has been constructed with the cooperation of business and technical experts. It uses induction, reasoning and other methods to label specific characteristics of enterprises, personnel and means of conveyance for decision-making. For example, based on anti-smuggling investigations, it sorts the list of historical smuggling cases. The labels include blacklisted enterprises (classification label), level 5 (risk level label), enterprises registered as having been involved in smuggling (layer label), and specific subdivisions of enterprises or personnel with criminal records.

The comprehensive application of blacklist labels, document flow labels, fund flow labels and other types of labels help accurate enterprise profiling and risk assessment. For example, in the event of new import and export activities or the registering of new associated enterprises, activities by high-risk enterprises will trigger alerts, taking them into the risk control channel.

• Identify association relationships

The system introduces association relationships into the Customs risk analysis, through visual representations and the analysis of relationship networks. Building the association relationships knowledge graph, the system fulfils the analysis of enterprises, personnel and means of conveyance.

• firstly, **visualization technology** is used to realize the visual display of association relationships, significantly reducing the complexity of basic data queries, and as a result processing, analysing and revealing relationships intuitively and efficiently.

• secondly, **the intelligent graph algorithm** is used to maximize the effectiveness of expert experience. A practical graph system is established through intelligent graph algorithms such as path calculation by associating abnormal results from data tables, the labelling system and multi-dimensional fraud risk monitoring. The intelligent graph algorithm can further transform expert experience, assist analysts to uncover the relevant targets, and further investigate the import and export relationship.

• thirdly, **relationship analysis** helps with further investigation of high-risk objects. Relationship analysis is introduced to automatically expand the correlation of the analysis objects, calculate the multi-dimensional relationship path and the relationship strength existing among objects, carry out deep exploration and expansion of high-risk objects, uncover new risk characteristics, and broaden risk analysis concepts.

VIII.3.1.2 Functions of the TianJi System

The TianJi System includes three modules: the worktable, analysis centre and track monitoring tool.
The **worktable** provides quick access to resources such as tasks, custom tags and basic query functions.

The analysis centre module provides the relationship network analysis with five main functions.

• **relationship query:** mainly used for basic queries. The relationship query starts with a target, defines the data scope and extension level, searches for associated objects layer upon layer, and displays the relationship of target objects. It can also provide detailed information on the target object, such as the registration date of a target enterprise, its location, line of business, number of import and export declarations, and number of inspections, etc.

• **gang analysis:** analyses the degree of correlation between target objects to realize gang division, provides clustering algorithms such as mobility tightness, position criticality and closed-loop analysis for automatic grouping, and uses the labelling data for further identification, thus further targeting high-risk targets.

• **drift tracking:** quickly monitors the risk drift of high-risk targets. When a case is inspected at a port, the illegal gang identified in that case can be added to the monitoring. If the gang switches to a new enterprise, the drift tracking function can be used to detect and analyse the new associated enterprise and closely monitor the risk of it drifting to other ports to engage in similar illegal acts.

• **intelligent detection:** is more intelligent than drift tracking. It can combine the structural features of the ring pattern, build a targeted model to realize automatic detection, and identify all suspected gangs with similar graphic structures, which can improve the ability of active early warning and prevention of gangs and risk drift.

• **automatic alert:** provides alerts to Customs. If a new associated risk target is found, the system will automatically send SMS or email alerts. It may carry out risk assessment and risk treatment in advance, and effectively curb the recurrence of illegal acts.

The **track monitoring tool** provides track query and monitoring services on marine ships and road trucks. Road truck track monitoring depends on quasi-real-time data (with a 2-3 minute delay). 20 functions have been developed, including tracking monitoring, fence monitoring, fence guarding, multi-zone joint control and track matching. The track monitoring tool can be applied to quick viewing of designated vehicles, batch monitoring of target vehicles, early warning of vehicles entering and leaving specific areas, and screening of smuggled vehicles accompanied by accomplices. High-risk transport vehicles can be identified conveniently and efficiently.

VIII.3.1.2 Results of the TianJi System

Some cases that used the TianJi System on inspections and anti-smuggling are presented below.
• in March 2023, a gang was caught smuggling LCDs valued at 4.48 billion Chinese renminbi (RMB), with a false Customs procedure declaration. The case was selected as one of the GACC's top 10 anti-smuggling cases in 2023.

• in December 2023, the System detected 621.8634 kg of cocaine concealed in wood blocks imported from Ecuador.

• in July 2024, the System detected the importation of 4,300 tons of dried betel nut fruits, which are prohibited import articles and classified as a level 1 carcinogen by the World Health Organization's International Agency for Research on Cancer (IARC).

• in July 2024, the System detected 4,960 kg of pangolin scales concealed in mica plate, which was the largest quantity of smuggled pangolin scales detected by the GACC in the past three years.

VIII.3.1.2 Resources of the TianJi System

The TianJi System was developed within around one year by a team of around 20 staff, involving the mobilization of hardware including 12 servers and 2 GPU. The estimated cost of the solution is approximately RMB 5 million, excluding the cost of the Customs Big Data Platform. More than 60% of the work goes on data cleaning.

VIII.3.2 Project TianXuan: Developing a Human in the Loop Approach

Project TianXuan is aimed at developing intelligent targeting modules, based on correlation analysis. The Project includes AI prompts for inspections for evidence-based decision-making.

As an outcome of the Project, the Targeting Centre of Huangpu has submitted a proposal for a policy applying a "Human in the loop approach". This project was initiated in Huangpu Customs in 2017 and rolled out for nationwide implementation in November 2023. The users of this model are analysis experts. it has saved about 30% of human resources.

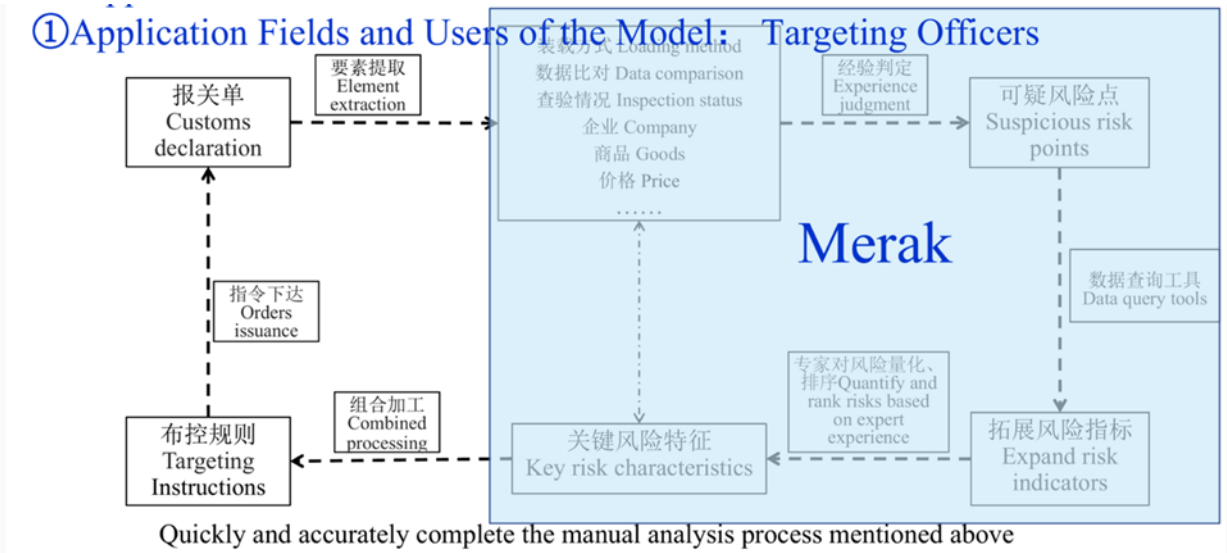
The performance of this model depends on the following factors:

• data accuracy;

• customs officers' skills;

• strong organizational support; and

• the relationship between model decisions and human decisions in the field of deployment.

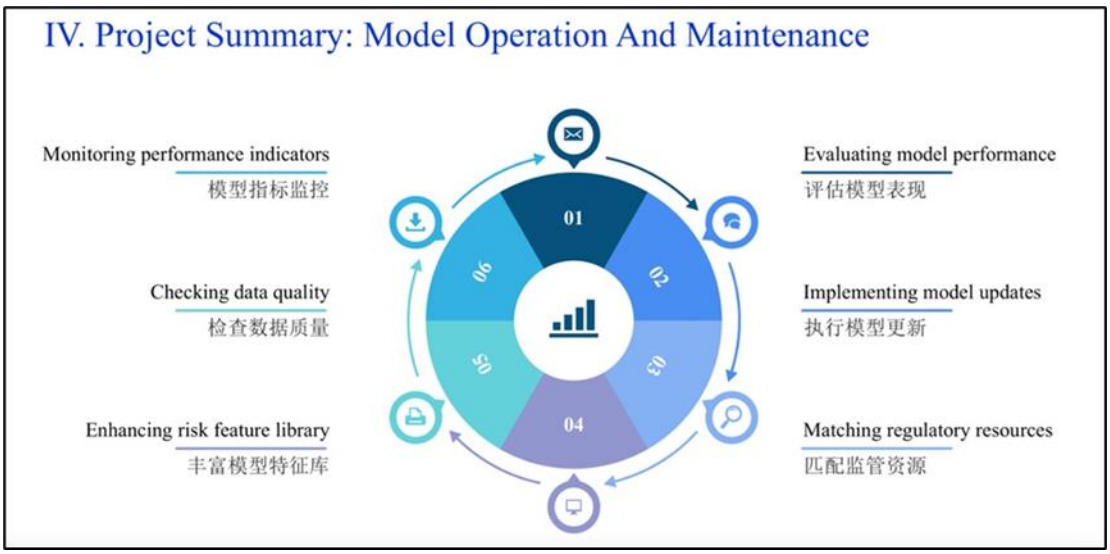


Overall strategic planning of the project:

• “Operation Management Manual”, policy document;

• organizational structure;

• standards and specifications.



Legal frameworks:

• data Security Law of PRC;
• customs Law of the PRC; and
• customs Risk Management Measures of the PRC.

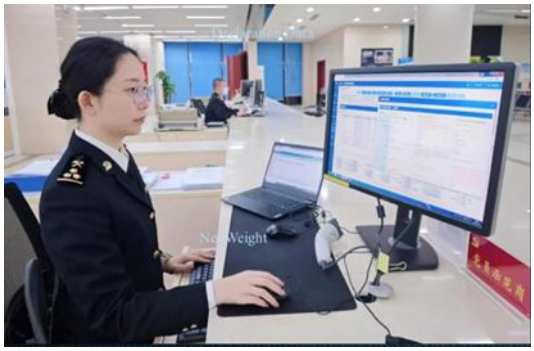
The following are required to ensure data privacy and protection:

- data isolation;
- access control;
- regular audits; and
- training and awareness enhancement.

Project TianXuan involves the following costs:

- time: 6 years;
- labour: 230+ staff;
- financial cost: 1 million RMB (for service procurement of the artificial algorithm only).

VIII.3.3 Intelligent Document Review Model (Guangzhou Customs)



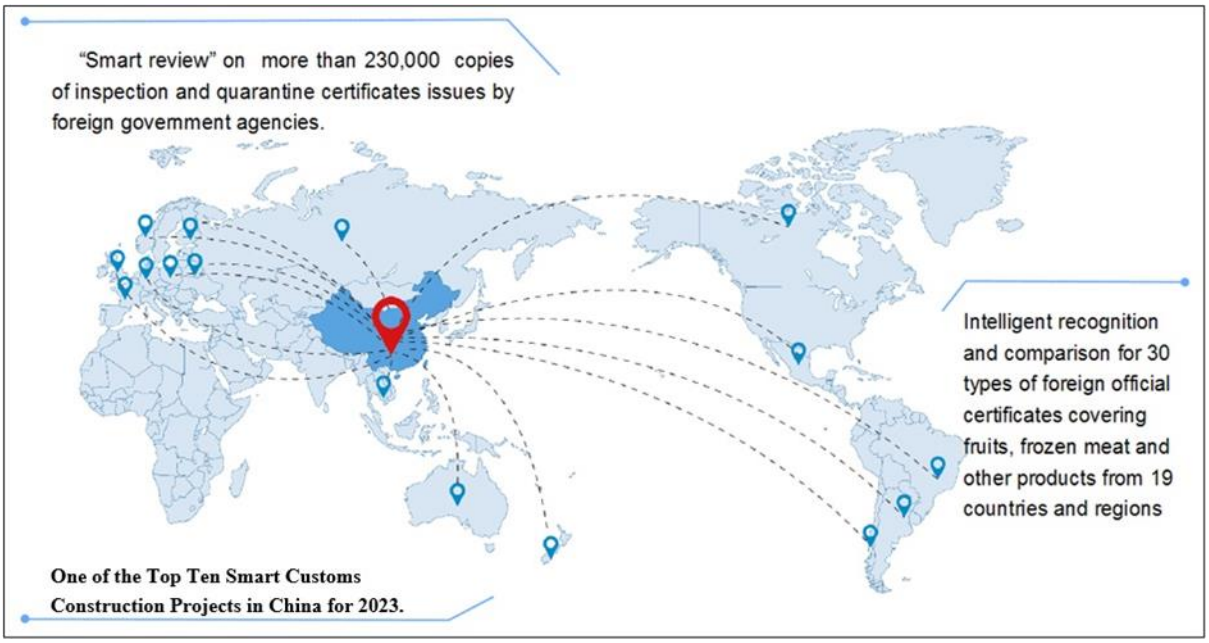
Different goods require different certificates such as phytosanitary certificates for imported fruits and veterinary (health) certificates for imported meat. The large number and variety of documents, as well as the high demand for efficient review, pose a significant challenge to Customs officers.

The "Intelligent Document Review Model" collects and organizes historical certificate image data and uses image classification and recognition algorithms to enable rapid intelligent recognition, training and application of batch documents. It achieves text detection and recognition of key information in documents, with a 95% recognition rate.

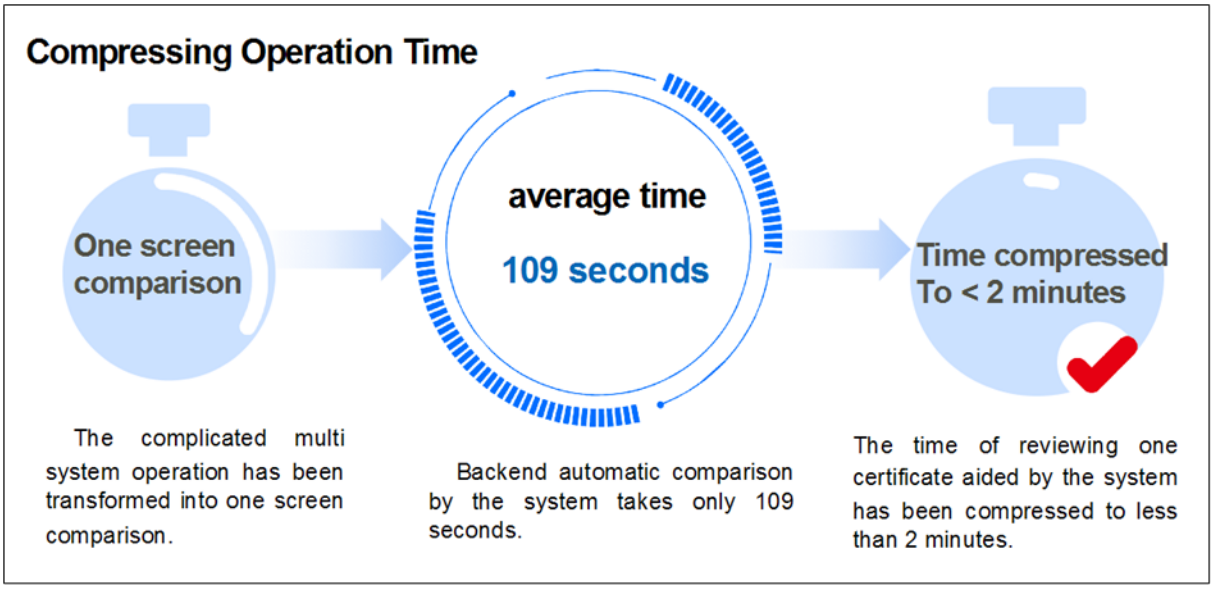
Approximately 30 types of certificates, which represent 60% of the main certificates, are processed through the intelligent module. Synthetic data are used to complete the dataset.

Certificates are obtained from paperless declarations, other countries under bilateral agreements, and the certificates system.

The model was developed over a period of one year by the local office of Nansha Customs and was selected as one of the top ten innovation projects in 2023.



The application of this model has reduced the time required for document review from 20 minutes to two minutes, saving human resources and unifying review standards.



VIII.3.4 Intelligent Wood recognition Model

Wood and its products are among the most common goods subject to Customs supervision. Customs need to screen the risks concerned, such as misdeclaration or concealment of endangered species, tax evasion through over-invoicing or under-invoicing, and plant epidemics.

However, China's wood imports are characterized by large volumes, diverse sources, multiple channels and a wide variety of species, posing challenges for Customs supervision.

These challenges include high technicality and difficulty in wood species identification, lack of on-site professionals, and complexity, long duration and high cost of sampling and testing.

The GACC has therefore compiled a training sample library of common imported and exported wood samples and endangered wood samples. Using a convolutional neural network algorithm based on deep learning, the GACC has developed an intelligent wood recognition model. This model can assist front-line personnel at ports to quickly and intelligently identify wood and wood products through photo uploads.

Currently, the model has been tested and applied at 20 ports under 11 regional Customs offices. In 2024, it identified 168 batches of wood samples nationwide, of which 140 batches were found to be inconsistent with declarations, including 57 batches of endangered wood (101 items). The model has shortened the sampling and testing process from over 10 days to 10 minutes, thereby enhancing effectiveness of supervision and addressing regulatory challenges.

VIII.3.5 Intelligent Recognition Model for Exotic Harmful Organisms at Ports

Exotic harmful organisms pose a threat to biological security. There are various types of exotic harmful organisms, and their identification requires strong technical capacity. However, current detection equipment and technologies deployed at ports are unable to identify certain types of exotic organisms. Inspection officers cannot quickly determine the type of harmful organisms during inspections and can only take samples and send them to professional laboratories for identification.
The GACC has developed an algorithm model for identification of exotic harmful organisms at ports, which automatically collects data on these organisms to enable the rapid and accurate identification of nearly 100 species. This improves port quarantine efficiency, resolves front-line regulatory challenges and alleviates the resource pressure on Customs, ports and enterprises. The model is currently being trialled in the national biosecurity monitoring at Beijing Customs. Since the launch of the trial, it has effectively identified 14 types of exotic invasive harmful organisms more than 30 times.

VIII.3.6 Intelligent Iron Or Screening Model

Iron ore is also a common imported good, which is required to undergo solid waste screening, inspection for foreign inclusions and radioactivity testing. These processes are time-consuming and labour-intensive tasks. The GACC has developed an intelligent iron ore screening model that uses online real-time detection technologies such as near-infrared spectroscopy, X-ray fluorescence spectroscopy and high-speed image acquisition and recognition to obtain data on the composition, near-infrared spectrum and appearance of imported iron ore. This model enables intelligent perception, analysis and disposal of iron ore, reducing the number of inspections by 90% and saving an average of eight hours per ship for iron ore clearance.
Currently, the models are specialized models designed to solve specific tasks and enhance the level of intelligent governance in corresponding fields. In the future, the GACC expects to integrate the variety of specialized models into a cohesive system, ultimately creating a “smart brain” that can help Customs address various issues.

VIII.3.7 E-Port: Application of AI and ML in a Single Window Environment (Guangzhou Data Centre)

Nansha Customs Office in Guangzhou Customs District has worked consistently on a Single Window Project at the local level in a Smart Port ecosystem, addressing the following business processes:

- customs clearance declaration;
- cargo arrival and departure; and
- ship arrival and departure.

A smart logistics platform is linked with the Smart Port application and connected to external systems through three interfaces for Port operations, the Single Window and the Customs system.

Eleven AI applications have been developed in the Smart Port application, helping to cut the clearance time by more than 25%, such as:

- intelligent guided vehicles;
- AI detection of dangerous goods, based on cargo manifest;
- automatic localization of containers;
- container selection for inspection;
- localization and locking of e-seals;
- AI and OCR for intelligent identification and audit application for food labels, conducting food label review, ensuring 24-hour remote supervision and prompting post-clearance control;
- application of AI and ML for more accurate trade predictions, integrating auto-regressive moving average models to remove seasonality, applying a data labelling system which depends on policy factors; and
- customer service large model intelligent robot applications, with different channels of communication.

IX. Technologies and Tools

The AI/ML platform relies on the **Customs Big Data Platform**. The platform is a private cloud with hardware equipment including generic servers, GPU servers and network equipment. The private cloud has been chosen to train data in a secure manner.

The platform applies distributed system services, distributed file systems, virtualization and other technologies, and builds dedicated computing and storage resources. It can provide industry mainstream ML frameworks (TensorFlow, Pytorch, etc.), support natural language processing, image recognition and intelligent Q&A algorithms, and deploy visual modelling, model management, algorithm trading and other service components. In terms of security, the platform has native cloud security measures, including but not limited to the following functions: auditing, vulnerability scanning, host security protection, sensitive data protection, data encryption, cloud firewall, etc., which effectively protect and manage assets on the platform. According to the relevant regulatory requirements, security assessments have regularly been conducted on the cloud platform.

Large Language Model (LLM) is an important AI development trend, which places very high requirements on the network bandwidth, data transmission efficiency and intelligent computing power of the existing platform, and requires continuous improvement based on business needs.

The technologies and tools used by the GACC in the construction of traditional ML models include ML frameworks such as TensorFlow, Scikit learn and Pytorch, which are used to build predictive models; In terms of natural language processing, Jieba segmentation, Word2Vec, BERT and other methods are mainly used to analyse and classify Customs declarations and documents. In terms of computer vision, OCR and other technologies are used for document recognition. Combined with open-source algorithms such as OPENCV and YOLO or self-developed algorithms, continuous iteration and independent innovation are carried out to develop intelligent image review algorithms for machine inspection equipment, achieving non-invasive inspection of containers, luggage and mail parcels.

In addition, exploration and application work, including intelligent question answering scenarios, will be carried out with open-source large models.

The selection of traditional ML algorithms and frameworks mainly considers the maturity of the technology and practical application effects. The use of large-scale modelling technology is considered comprehensively in terms of factors such as cost, business scenarios and technical reserves. Traditional ML models are deployed in the model construction environment of the GACC big data cloud platform, and the results are automatically sent to the operating system. However, the application of large-scale models is still in its infancy.

The Customs Big Data Platform is maintained by the GACC and external suppliers. Maintenance plans and maintenance programs are developed and evaluated through standard processes such as internal check tickets, fault tickets and problem tickets. External suppliers provide support services like spare parts and product services.

The **maintenance** of software tools is carried out in-house, through standard processes such as internal change tickets and service requests, to fulfil business demands such as model development, algorithm updates, etc. Some work is aided by external suppliers, such as the use and adaptation of new frameworks.

The GACC maintenance team establishes a service contract with external service providers. Both parties conduct check-point inspections and risk treatment in accordance with the service contract and carry out exchanges of technical know-how from time to time.

X. Skills and Training

As mentioned above, a key pillar of the AI policy is **team building and talent cultivation**. A dedicated team for model construction has been established at the central level to work on this full time.

A national expert pool for Customs intelligent model has been established, comprising selected experts in four areas of business, data, technology and models from across the different Customs offices to work on model construction on a part-time basis.

Training on data application and model construction has been provided for various business lines and Customs offices; and **cooperation with AI high-tech enterprises and universities** has been strengthened.

While the development of AI modules might require external expertise, internal capacity building is considered paramount to ensure the long-term sustainability and maintenance of the algorithms.

XI. Stakeholder Engagement and Communication

The partnership with academia is formalized through Memoranda of Understanding (MoU) for algorithm development.

Collaboration with high-tech industry is facilitated through competitive bidding processes.

An example of collaboration with external partners is the contractual arrangements with the IT Company CloudWalk Technology, an enterprise incubated by the Chinese Academy of Science, to develop Optical Character Recognition (OCR) multimodal large models to flag inconsistency in documentary formats, through a project worth around RMB 2 million.

CloudWalk Technology is the first AI company in China, involved in the development of AI national standards, mainly on the facial recognition coordinated by Ministry of Security.

- general OCR: General Text Recognition
- universal OCR: Universal Section Identification
- standard Tickets

1.0 - OCR

2.0 - Data fusion + training platform

3.0 - Large model empowerment

XII. Costs

The development cycle of AI modules is heterogeneous, with an average development time of 1.5 years, requiring continuous improvement with feedback from local offices and update loops.

While the costs of AI applications vary, they generally involve expenses related to human resources, as well as the mobilization of hardware and computing power for the deployment of AI modules.

Investments in cloud computing are driven by the need to enhance GPU capacity to meet the big data development plan.

Internal staff are employed in sampling, testing, data labelling and tagging, which constitute the majority of the resource implications, as well as algorithm validation, where the development is outsourced through research projects.

Ongoing infrastructure costs are estimated to be approximately 10-15% of the initial investment.

Overall, while the investment in AI is substantial, the benefits in terms of performance improvement are considered to outweigh the costs.

XIII. Innovation

The Smart Customs strategy encourages technological innovation and optimization of means of control to modernize Customs management systems and capabilities, through smart infrastructure, smart customs control and smart internal management.

The innovation approach combines both central oversight and guidance and the promotion of decentralized innovative thinking.

Innovation is also fostered through an **annual Innovation Award** that selects the 'Top Ten Projects' in the GACC, which are showcased for public awareness and communication in the **Customs Museum**, in which a new section has been dedicated to "Smart Customs".

The **selection criteria** for the top ten innovation projects are as follows:

(a) The project aligns with the requirements for the construction of Smart Customs and the values of "security, facilitation and efficiency", demonstrates strong overall coordination and has a good exemplary effect or significant strategic importance.

(b) The project is advanced and leads in addressing the diverse needs of stakeholders, solving practical problems, leveraging technological advancements, complying with laws and regulations, adopting best practices and meeting international standards.

(c) The project has achieved tangible results in areas such as:

- more precise risk prevention and control,
- deeper integration of Customs processes and quarantine and inspection processes,
- improved Customs services for economic development,
- solid and effective progress in Customs modernization and governance, and
- restructuring and strengthening governance capabilities.

The "Top Ten Projects" are selected through a "nomination plus public voting" method. Each Customs district can nominate Projects to the headquarters; Customs officers and relevant stakeholders nationally vote for their favourite projects. A group of experts gather to evaluate the nominated Projects and make the final decision.

XIV. Future Plans

While a series of achievements has already been made in the implementation of the Smart Customs strategy, it is expected that, by the end of 2025, decisive progress will be made in the Customs operation system and the technological support system.

By the end of 2027, breakthroughs are expected in digital and intelligent operations, with a higher degree of integration between the two systems. Full deployment of the Smart Customs approach is expected by 2035.

A concrete example of a plan for the future is the integration of the variety of specialized models into a cohesive system, ultimately creating a "smart brain" that can help Customs address various issues. Another example is the concept of developing algorithms to assist the analysis of user reviews and actions consequent to AI prompts.

The vision for the future is to continuously promote the integration of the "3S" concept into the bilateral and multilateral cooperation framework, strengthen collaboration with the WCO and other international organizations, and facilitate inter-connectivity in the global supply chain.

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Contact us:

Smartcustoms@wcoomd.org

Visit our website:

wcoomd.org/SmartCustoms.aspx

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World Customs Organization

Rue du Marché 30, B-1210
Brussels, Belgium
xxx.directorate@wcoomd.org

#WCOOMD
wcoomd.org