Research on Improving the Efficiency of Customs Clearance and Cargo Transportation & Storage at Dongguan-Hong Kong International Airport Center

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Abstract. The Dongguan-Hong Kong International Airport Center, the world's first cross-border sea-air intermodal project with direct airside access, has boosted logistics efficiency through its "Dongguan security screening, Hong Kong direct flight" model. However, it faces core challenges including institutional barriers, transportation inefficiencies, and insufficient warehouse intelligence. This study uses case analysis, comparative benchmarking, and policy analysis to propose integrated solutions: a Guangdong-Hong Kong collaborative regulatory mechanism, an end-to-end smart customs clearance system, a "sea-land-low-altitude" multimodal network, and intelligent warehouse modernization. A phased roadmap (2025-2030) is outlined to develop the center into a globally leading cross-border logistics hub[1].

Keywords: Dongguan-Hong Kong International Airport Center; Cross-border sea-air intermodal transportation; Customs clearance efficiency; Smart warehouse

1 Introduction

Cross-border logistics efficiency is a critical determinant of regional economic competitiveness in the context of global supply chain transformation. The Dongguan-Hong Kong International Airport Center, as the world's first cross-border sea-air intermodal project with direct airside access, represents a landmark initiative integrating the logistics resources of mainland China and Hong Kong. Since its official operation in April 2023, the center has demonstrated remarkable growth, yet faces persistent challenges in customs clearance efficiency, multimodal transportation coordination, and intelligent warehouse management. This paper investigates the current operational status, identifies core bottlenecks, and proposes systematic countermeasures encompassing institutional innovation, technological integration, and operational optimization. A phased implementation roadmap (2025–2030) is outlined to guide the center's evolution into a globally competitive cross-border logistics hub supporting high-quality development of the Guangdong-Hong Kong-Macao Greater Bay Area[11].

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2 Current Situation, Benchmark Comparison and Development Trend of Dongguan-Hong Kong Airport

2.1 Current Situation of the Construction of Dongguan-Hong Kong International Airport Center

As the first aviation logistics hub in the Greater Bay Area to implement pre-border security inspection, the Dongguan-Hong Kong International Airport Center has become a key logistics node since its official operation in April 2023. Jointly promoted by the Dongguan Municipal Government, the Hong Kong Airport Authority, and Huangpu Customs, it moves export consolidation, security inspection, and palletizing functions to Dongguan, enabling "Dongguan security inspection and direct flight from Hong Kong". By April 2025 (two-year mark), cumulative import/export value exceeded 24 billion yuan, serving over 1,000 enterprises with 900+ cargo types. Q1 2025 saw cargo weight grow 132.23% and value grow 100.71% year-on-year. Current operations support 4 daily export flights and 2 import flights; end-to-end transit time is compressed to 15 hours, saving ~30% logistics cost versus traditional land transport. The regulatory warehouse has expanded from 20,000 to 70,000 sqm, with the main plot expected to handle 1 million tons/year upon full production.

2.2 Benchmarking Analysis: Comparison of Major Aviation Logistics Hubs in the Greater Bay Area

Compared with peer hubs, the Airport Center shows unique advantages. Shenzhen Qianhai's "Departure Air Freight Service Center" achieved over 90 billion yuan in cargo value in 2024 (>35% of Shenzhen Airport's international cargo), with >60% warehouse automation. Guangzhou Baiyun Airport's "Smart Customs" enables 4-hour clearance but is still constrained by Guangdong-Hong Kong cross-border rule gaps.

Hong Kong International Airport handled 4.9 million tons in 2024 but faces high warehousing and ground transport costs. The Airport Center's key advantage lies in its "Dongguan-Hong Kong collaboration" regulatory innovation, though it must improve intelligentization and multimodal network construction by drawing on Qianhai and Baiyun experiences.

2.3 Development Trend: Opportunities for Aviation Logistics in the Greater Bay Area

The Greater Bay Area aviation logistics market faces major opportunities. Air cargo demand is forecast to grow at 10% annually over the next five years, with high-time-limit logistics rising to 40%. Policy support from the NDRC's Greater Bay Area Plan and Hong Kong's 2024 Policy Address accelerates rule alignment. Emerging technologies—low-altitude economy, blockchain clearance, automated warehousing—are maturing rapidly, with Shenzhen already piloting cross-border drone transport of fresh goods, cutting delivery time by 80% vs. traditional sea transport.

With Hong Kong International Airport's third runway fully operational in 2025 (adding 5 million tons capacity), the Airport Center is expected to reach 1 million tons annually by 2025-2030. Cross-border drone transport could reduce high-value electronic product transit from 15 hours to 3 hours at 40% lower cost, further enhancing the center's strategic position.

3 Existing Problems of Dongguan-Hong Kong International Airport Center

3.1 Institutional Barriers Restrict the Customs Clearance Efficiency

The primary challenge is the institutional gap between two independent customs territories. Hong Kong's "first-line liberalization, second-line control" free port model contrasts with the mainland's stricter "positive list" management, requiring repeated declarations on transfers—adding an average 2.5 hours per shipment and raising enterprise customs costs by ~15%. The average clearance time at the airport center remains 8 hours, compared to 4 hours achievable via single-window integration (as at Shenzhen Bao'an). Mutual recognition of inspections currently covers only 5 goods categories (<20% of cargo volume), far below the Yangtze River Delta's 12-category coverage[12].

On smart customs, although both sides have promoted single-window docking, inconsistent technical standards impede data sharing: Hong Kong Customs uses six systems (ROCARS, ACCS, etc.) while the mainland uses China International Trade Single Window, forcing enterprises to file on multiple platforms. By contrast, Singapore Changi achieves 80% goods exemption via its pre-clearance system. Deeper institutional innovation in data interconnection and rule coordination is urgently needed[7].

3.2 Shortcomings in the Transportation Network and Bottlenecks in Efficiency

The airport center relies primarily on air-sea intermodal transport, but the Humen-Hong Kong route averages only 10% vessel loading rate—far below the 75% breakeven—with actual loading of 112 tons against a designed capacity of 2,000 tons. By contrast, the Shanghai Yangshan Port-Incheon route maintains >80% loading through container standardization and fixed-schedule dispatch.

Sea freight from Dongguan to Hong Kong Airport takes 15 hours including loading/unloading, while cross-border trucks from Shenzhen Yantian Port take only 3 hours (at 40% higher cost), creating a timeliness-cost trade-off that limits high-value cargo choices.

The low-altitude economy remains nascent at the airport center: strict cross-border airspace management requires case-by-case approval for drone transport, lacking normalized operation. Multimodal coordination also lags—multiple cargo handlings reduce transfer efficiency, while Hong Kong Airport's ULD (Unit Load Device) model enables seamless connection.

3.3 Insufficient Level of Warehousing Automation and Informatization

Low warehousing automation is a key bottleneck: 90% of sorting and palletizing is manual, with a 3% error rate vs. <0.5% at Shanghai Pudong using AGV robots. Single-pallet loading takes up to 2 hours—one-quarter of Hong Kong Airport's efficiency. Despite expansion to 70,000 sqm, the layout remains predominantly flat warehouses without three-dimensional shelves or intelligent sorting, creating severe data fragmentation across customs systems.

The absence of a unified management platform means cargo status and inventory data cannot be synced in real time, causing scheduling delays. Cross-border e-commerce clients such as SHEIN require 72-hour logistics windows, but information gaps at the airport center frequently cause overruns—a shortfall compared to the Zhengzhou-Luxembourg "Air Silk Road"'s whole-process tracking via its single-document system.

3.4 Regional Coordination and Benchmarking Gap

Compared with domestic peers, the Airport Center has significant room to improve. The Zhengzhou-Luxembourg "Air Silk Road" achieved 1 million tons in 2023 (100x the Airport Center) through 24/7 clearance and single-document multimodal transport. Shenzhen Airport Bonded Logistics Center grew 120% year-on-year in cross-border e-commerce in 2024 vs. the Airport Center's 45%. Singapore Changi's "Free Trade Zone + Airport" model loads goods within 6 hours of zone entry—9 hours faster—via pre-clearance, efficient transport, and highly automated warehousing.

With Hong Kong International Airport's third runway adding 5 million tons of capacity, failure to enhance throughput synchronously risks resource idling. Rising enterprise timeliness requirements mean the airport center must break current bottlenecks or risk cargo diversion to Guangzhou and Shenzhen.

In short, institutional barriers, transportation efficiency, warehousing shortcomings, and insufficient coordination are the current four core issues. Only through rule connection, intelligent transformation, and network optimization can the air cargo terminal achieve a qualitative change from a "passage" to a "hub"[9][10].

4 Systematic Countermeasures to Enhance the Efficiency of the Dongguan-Hong Kong InternationalAir Cargo Terminal

4.1 Institutional Innovation: Establishing a New Coordinated Supervision Mechanism between Guangdong and Hong Kong

To address the Guangdong-Hong Kong customs supervision gap, it is recommended to adopt "separated-line management" as a breakthrough and implement "first-line liberalization, second-line control" at the airport center. Referencing Hong Kong's free port negative list model, the controlled goods list should be compressed from 48 to within 10 categories—retaining supervision only for high-risk items—while applying "release upon declaration" to high-value-added goods such as electronics and medical devices.

Leading enterprises such as OPPO and vivo can join a first-batch "white list" pilot, enjoying "advance declaration and release upon arrival". This model shortened average clearance time by 40% in Shenzhen Qianhai and is suitable for replication at the airport center.

For law enforcement cooperation, a joint law enforcement area can be demarcated at Shatian Port (modeled on Hengqin's "Macau New Neighbors" project), enabling "one inspection, mutual recognition" for import/export goods. Data connection between Huangpu Customs' H2018 system and Hong Kong Customs' single window should achieve 100% manifest data interconnection before 2026—Zhuhai Gongbei Port data shows such sharing can raise mutual recognition of inspections to >50%.

4.2 Empowering with Intelligence: Building a Full-chain Digital Customs Clearance System

Digital transformation is essential for clearance efficiency. It is recommended to build a "Guangdong-Hong Kong Cross-border Smart Customs Clearance Platform" integrating single-window functions of both regions, with AI-powered HS code auto-classification (target: >92% accuracy). The Singapore TradeNet experience shows such platforms can reduce manual input workload by 60%[8].

$$y = arg\max_{y \in \mathcal{Y}} P\left(y|\mathbf{x};\theta\right) = arg\max_{y \in \mathcal{Y}} Softmax\left(\mathbf{W} \cdot BERT(\mathbf{x})_{[CLS]} + \mathbf{b}\right) \tag{1}$$

$$\mathcal{L} = -\frac{1}{N}\sum_{i=1}^{N} \alpha\left(1 - p_i\right)^{\gamma}\log\left(p_i\right) \tag{2}$$

The successful experience of the Singapore TradeNet system shows that such platforms can reduce the manual input workload by 60%.

For hardware upgrades, AI intelligent X-ray inspection machines (as proven at Hong Kong International Airport's Super Terminal 1, reducing single-shipment inspection from 15 to 3 minutes) should be deployed—20 units by 2026 alongside 50 RFID terminals to build touchless clearance channels.

A "smart release" model for high-credit enterprises using big data for automatic low-risk clearance is recommended, replicating Shenzhen Airport's approach where 95% of general goods clear in seconds.

The research and development of the intelligent customs declaration generation includes four aspects: AI data source, AI computing layer, AI application layer, and System front-end . Figure. 1 illustrates the overall framework of the research.

The scheme mainly includes the following four components:

1. AI data source: The system has collected customs-related documentation information in the tens of millions from GD and HK over the past three years and established a coordinated customs commodity coding database for both regions. These massive amounts of data serve as the foundation for intelligent customs declaration generation. The system continuously improves recognition rates and accuracy through ongoing machine learning processes.

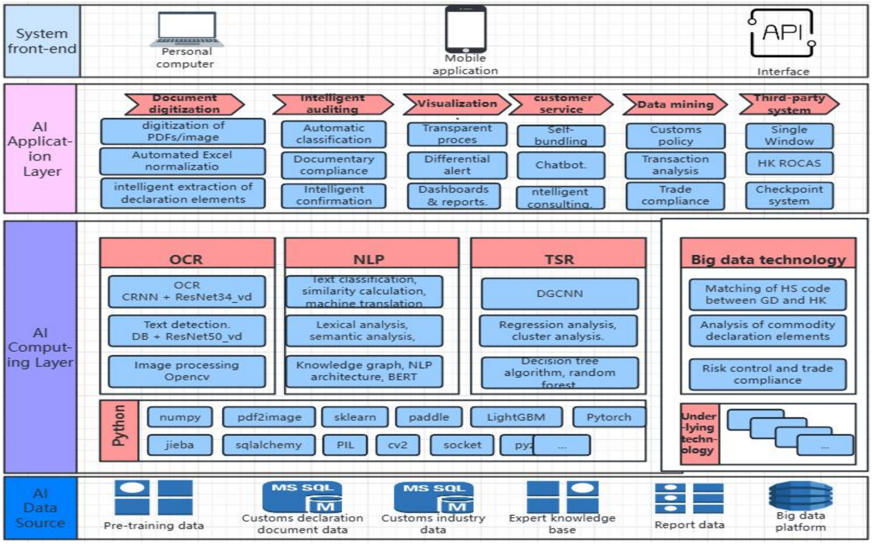

Fig. 1. Architecture diagram of intelligent customs declaration generation.

2. AI computing layer: This component uses artificial intelligence technologies such as Optical Character Recognition (OCR) and Natural Language Processing (NLP) to improve the efficiency of generating documents such as road manifests and customs declaration forms. Table Structure Recognition（TSR） is realized through decision tree algorithm, Random forest, dynamic Convolutional neural network and other algorithms. Big data technology is used for automatic matching of customs HS codes in Guangdong and Hong Kong, analysis of commodity declaration elements, trade compliance risk control, etc.[14]

3. AI application layer: This component includes automated document entry functions such as image or PDF format identification of customs declaration related documents, intelligent extraction of declaration elements, and intelligent document review functions such as automatic commodity classification and matching of

accompanying document information. This part also integrates HK ROCAS system, China International Trade Single Window and other systems to facilitate the sharing and conversion of customs declaration document data between the two places.

4. System front-end: Intelligent document generation can be applied to both PC systems and operated through mobile terminals. For example, users can capture images of relevant documents using their smartphones. After automatic recognition by the system, it reduces manual workloads. Intelligent document generation can also integrate with third-party enterprise systems and industry websites through API interfaces, providing services to enhance their functionality.

4.3 Transportation Innovation: Build a "sea-land + low-altitude" three-dimensional network

The low-altitude economy creates new cross-border transport possibilities. Priority should be given to opening a drone cargo route from the airport center to Hong Kong Airport, using mature models such as SF Ark (1.2-ton load, 300 km range), with an initial 5 daily flights for high-time-sensitivity goods (chips, biological samples). Though drone transport costs 7x sea transport, transit time drops from 6 hours to 1.5 hours—highly attractive for goods valued over USD 50,000/ton. Airspace management should draw on the CAAC's UTMISS approval mechanism, targeting flight plan approval within 2 hours.

Multimodal connection efficiency requires urgent improvement. The current 15-hour sea-air transfer (including 4 hours of terminal operations) should be addressed by adding night liners at Humen Port and introducing AGV technology (as proven at JD Logistics) to achieve container-to-air-pallet conversion within 1 hour. Strengthening cooperation with Guangzhou and Shenzhen airports via a mutual recognition mechanism would create a "1-hour aviation logistics circle" in the Greater Bay Area.

4.4 Warehouse Upgrade: Build an Intelligent International Logistics Hub

The intelligent transformation of warehousing is imperative. Currently, operations at the airport center are mainly manual, with a 3% sorting error rate.

It is recommended to introduce Geek+ sorting robots with intelligent WMS to raise daily processing capacity to 100,000 pieces and reduce misdelivery to below 0.1%. Comprehensive adoption of aviation ULD standard containers (LD3/LD6) to replace non-standard palletizing can improve efficiency by 40% and cut labor costs by 25%, per Cathay Pacific Cargo Terminal data.

5 The Key Technology of Intelligent Customs Declaration Generation

5.1 Pre-processing of Customs-related Document Images

Customs-related documents can exist in various file formats such as PDF, Excel, images, Word, and more. Each document may include information from multiple accompanying documents, such as packing lists, invoices, contracts, and drafts. Furthermore, within the same format and type of document, different clients may provide varying table styles, text formats, and descriptive content, making the standardization of these documents challenging. The core requirement of intelligent document creation is to extract and transform non-standard and unstructured files into structured data. It involves converting PDFs and image files into tables and text, performing structural parsing for complex tables, and extracting the relevant information from complex textual content. To address the core challenge of varying table and text styles among different clients, as well as the absence of unified and standard templates for complex tables, intelligent algorithms are employed in this research paper to learn from customer document samples and data entry formats. This approach enables effective importation of documents from different clients[2][3].

By leveraging AI algorithms such as machine learning and deep learning, the system can be trained to recognize and understand the structure and content of diverse document formats. The algorithms analyze the patterns and characteristics of the provided document samples, enabling the program to intelligently extract information and structure it accordingly.

During this process, the system automatically collects customer data entry behavior and compares file contents to obtain labeled information for supervised learning samples. It then utilizes a Deep Graph Convolutional Neural Network (DGCNN) in conjunction with text feature extraction to extract structured information from complex tables[4][5]. Additionally, a Bi-LSTM+CRF neural network is used to extract information from complex text. Finally, all these pieces of information are consolidated to obtain the customs declaration information. The specific steps involve the following six stages, as illustrated in Figure 2. (As shown in Figure 2, the method for precise adjustment of table angles in customs-related document is presented.)

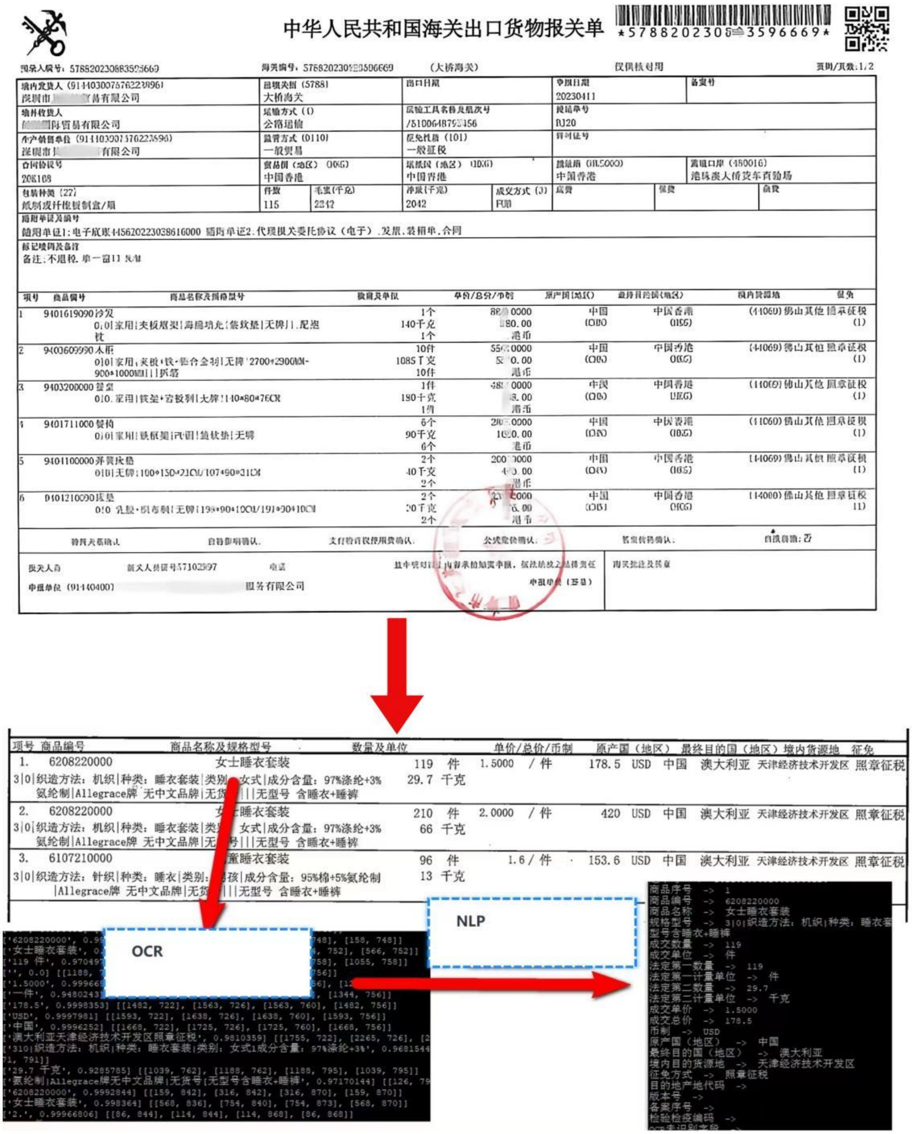

Fig. 2. The method for precise adjustment of table angles in customs-related document.

5.2 The application of Universal Text Recognition OCR in Customs-related Documents

Universal OCR text recognition mainly consists of two parts: text detection and text recognition. Text detection is used to identify the areas where the text is located in the customs document image, while text recognition is the process of recognizing the actual text within those identified regions.

Text detection involves the use of Differentiable Binarization (DB), a pixel-based text detection algorithm. DB addresses the limitations of existing segmentation-based methods that require thresholding for binarization, leading to time-consuming post-processing and suboptimal performance. This method cleverly designs a binarization function that approximates a step function, allowing the segmentation network to learn the threshold for text segmentation during training. Furthermore, during the inference stage, this method directly expands the final text contours by a certain proportion based on the area and perimeter of the central region of the text. This further enhances the inference speed of the method. Overall, DB provides a robust algorithm framework for pixel-based text detection, addressing the challenge of threshold configuration in such algorithms while maintaining good compatibility. Developers can customize the backbone network according to the specific challenges of their scenarios, striking a balance between performance and accuracy.

CRNN (Convolutional Recurrent Neural Networks) is a deep learning model that combines Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN). It is commonly used for processing sequential data. This paper takes customs-related document text recognition as an example to introduce the CRNN network structure and workflow.

The CRNN network structure consists of three parts: convolutional layers, recurrent layers, and fully connected layers. The convolutional layers are used to extract feature information from the input text images, while the recurrent layers model the temporal relationships. The fully connected layers are responsible for outputting the classification results. Specifically, the convolutional layers apply multiple convolutional kernels to extract features from the input text images, and the output is then passed to the recurrent layers. The recurrent layers typically utilize LSTM or GRU units to capture long-term dependencies between the text sequences. Finally, the fully connected layers map the output of the recurrent layers to class probabilities, enabling automated text recognition processing.

5.3 Extracting Structured Information from Complex Text Structures in Customs Commodity Declarations.

The most challenging aspect of extracting information from customs declaration documents lies in the extraction of structured information from Excel table formats. Both PDF and image formats of customs-related documents are first converted into the Excel file format before performing information extraction. Therefore, the core difficulty and technology in customs declaration information extraction lie in accurately extracting structured information from Excel tables.

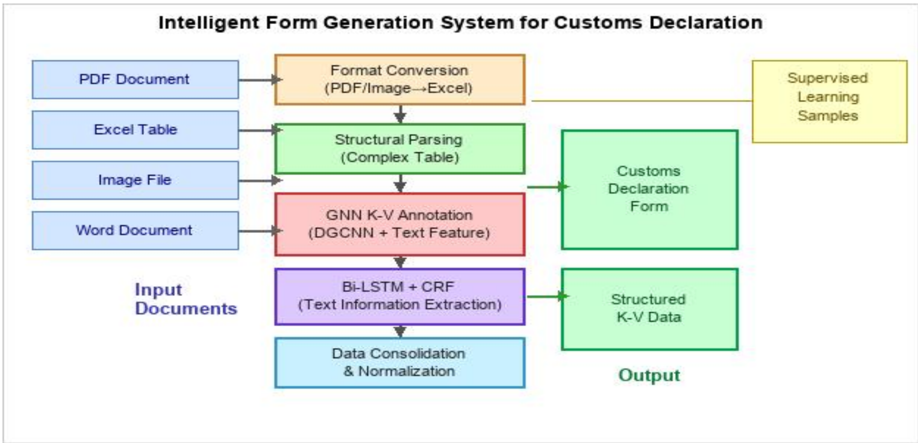

Fig. 3. The intelligent form generation for customs declaration utilizes a specialized graph neural network (GNN) for K-V (key-value) pair annotation.

The proposed intelligent form generation and key-value annotation software, as shown in Figure3, annotates customs declaration data. After processing, each point in the software's architecture includes a feature vector comprising labels for key or value, text content, and an edge feature vector that encompasses the relationship between the key-value pair, positional distance, and neighboring node information.

In this study, the dynamic graph convolution DGCNN (Dynamic Graph Convolutional Neural Network) is utilized . The DGCNN network employs the EdgeConv operation, which has three notable characteristics. Firstly, it integrates local neighborhood information. Secondly, it can be stacked into multiple layers to learn global shape information. Lastly, in a multi-layer system, the relative relationships in the feature space encapsulate semantic features.

$$h_\Theta: \mathbb{R}^F \times \mathbb{R}^F \to \mathbb{R}^{F'} \quad e_{ij} = h_\Theta(x_i, x_j)$$

$$x_i' = \underset{\backslash substack j:(i,j)\in\mathcal{E}}{} h_\Theta\,(x_i, x_j)$$

$$x_{im}' = \max_{\backslash substack j:(i,j)\in\mathcal{E}} e_{ij}'$$

$$\mathcal{G}^{(l)} = (\mathcal{V}^{(l)}, \mathcal{E}^{(l)})$$

Table Data Item Localization and Extraction Based on Domain Expert Knowledge Base.

This study adopts an ensemble learning algorithm based on Random Forest for table data item localization and extraction in customs declaration information. Random Forest is a Bagging (Bootstrap Aggregation) method within the field of ensemble learning. It consists of multiple decision trees that are independent from each other. When performing node classification tasks, a new input sample is evaluated by each decision tree in the forest individually. Each decision tree generates its own classification result, and the final result is determined by the majority vote among the decision trees.

Taking the extraction of commodity declaration elements in customs declaration as an example, the key steps are as follows:

The named entity recognition task involves identifying named entities and classifying them from a given unstructured text, such as commodity names, purposes, brands, voltage, models, etc., as shown in Figure 4. The algorithm first utilizes a Bi-LSTM (Bidirectional Long Short-Term Memory) network to model the sequential relationships and contextual information of the text . Bi-LSTM is effective in handling long text sequences and can address the issue of vanishing gradients while retaining contextual information. The output of the Bi-LSTM is then used as input for a Conditional Random Field (CRF) for labeling and optimization. During the training process, the CRF calculates the conditional probability of a given sequence based on the order of labeled data labels. The model parameters are updated using the backpropagation algorithm to maximize the conditional probability value. During the prediction process, the CRF annotates the text sequence and employs decoding algorithms to find the most probable labeling result, facilitating automated processing for tasks like Named Entity Recognition (NER)[6].

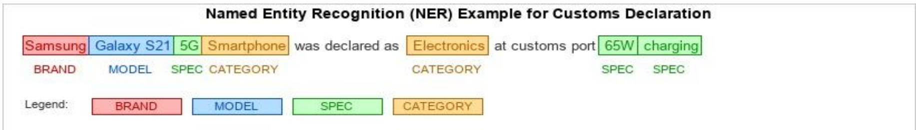

Fig. 4. Example of Named Entity Recognition (NER) task.

6 Implementation Paths for Enhancing the Efficiency of Dongguan-Hong Kong International Airport Center

6.1 Short-term Implementation Paths (2025 - 2026): Consolidating the Foundation and Making Pilot Breakthroughs

For institutional innovation (2025-2026): complete the Guangdong-Hong Kong Customs Joint Law Enforcement Zone plan within 2025, pilot a 3 sqkm area at Shatin Port with a joint customs office for "one inspection, mutual recognition", and launch an "Enterprise White List" for 20 leading firms. Invest ~10 million yuan to connect the H2018 system with Hong Kong Customs' Single Window for 100% manifest data interconnection by year-end.

For intelligent construction: complete Phase 1 of the "Guangdong-Hong Kong Cross-border Intelligent Clearance Platform" in Q1 2026, launch AI classification and e-document functions, and deploy 20 AI inspection machines at the eastern cargo station. Introduce Huawei, Ping An Technology, and Taizhou Technology teams to complete AI algorithm deployment within 6 months.

For transport optimization: complete Humen Port night navigation expansion and add 2 automated loading/unloading lines within 2025. Cooperate with SF Express to launch a Humen Port-Hong Kong Airport drone test route (3 daily flights), supported by a coordination mechanism with the Southern Theater Command Air Force for airspace approval.

6.2 Medium-term implementation path (2027 - 2028): System integration and scale promotion

By 2027, extend joint law enforcement zone experience to the entire airport center, achieving >80% convergence in Guangdong-Hong Kong customs supervision rules. Establish a Greater Bay Area customs coordination committee modeled on the EU Customs Union, raising mutual inspection recognition to 70%. Invest ~200 million yuan in facility renovation, expected to reduce enterprise clearance costs by 25%.

By 2027, complete Phase 2 of the intelligent clearance platform with blockchain traceability and drone transport management modules. Deploy 50 Geek+ sorting robots to exceed 150,000 pieces/day daily processing capacity. Introduce Ant Chain technology for a cross-border logistics credit system enabling full-process cargo traceability.

By 2028, establish a three-dimensional connection hub for sea, land, and low-altitude transport at the airport center, achieving full-area coverage of the "1-hour aviation logistics circle" in the Greater Bay Area.

6.3 Long-term Implementation Path (2029 - 2030): Innovation Leadership and Global Benchmark

Before 2030, upgrade the airport center to a level comparable to Singapore Changi's free trade zone model, achieving full convergence of Guangdong-Hong Kong customs rules and becoming a regional regulatory benchmark.

By 2030, build a globally leading "Digital Twin Airport Center" platform with full-process AI decision support, positioning the airport center among the world's top 3 air cargo hubs in efficiency.

Through systematic innovation in institutions, technology, and operations, the Dongguan-Hong Kong International Airport Center can evolve from a logistics "passage" into a true global hub, providing strong support for high-quality development of the Guangdong-Hong Kong-Macao Greater Bay Area.

7 Conclusion

This study has systematically analyzed the operational challenges confronting the Dongguan-Hong Kong International Airport Center and proposed a comprehensive improvement framework. The key findings are as follows: First, institutional innovation—particularly the establishment of a Guangdong-Hong Kong collaborative regulatory mechanism adopting “separated-line management” and “first-line liberalization, second-line control”—can significantly reduce customs clearance time and regulatory complexity. Second, the deployment of an end-to-end intelligent customs declaration system integrating graph neural networks [2], OCR technology, and natural language processing offers a scalable solution to documentation inefficiencies. Third, constructing a “sea-land-low-altitude” multimodal transportation network will enhance cargo flow speed and reduce overall logistics costs. Fourth, smart warehouse modernization through IoT-driven management [9] and automated storage-retrieval systems can substantially increase throughput capacity. The phased roadmap from 2025 to 2030 provides actionable milestones for transforming the center into a world-class cross-border logistics hub, contributing to the high-quality development of the Guangdong-Hong Kong-Macao Greater Bay Area [1][13].

Acknowledgments

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