Analysis of the Application of Artificial Intelligence in China–U.S. Cross-Border Logistics

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Abstract. Globalization and cross-border e-commerce are growing fast, and the logistics between China and the United States becomes very important in world trade. In recent years, Artificial Intelligence (AI) has been more and more used in this area. It mainly shows in forecasting, automation, and controlling risk. This paper talks about how AI is used in China–U.S. cross-border logistics now, and also what problems appear. It compares two countries: China usually pays attention to practice in real scene, while the U.S. pays more attention to innovation from technology side. AI not only helps daily work become more efficient, but also is related to sustainability, openness, and digital change in supply chain. But there are still many difficulties, such as different rules in different places, high cost to use AI, and not fair access to new technology. The paper thinks that future progress needs both countries to work together in standard management, and training people.

Keywords: AI; China–U.S.; cross-border logistics.

1. Introduction

Globalization is going faster, and cross-border e-commerce also grows quickly. In this situation, China and the United States are very important in world trade and logistics cooperation. According to the World Trade Organization, the trade between China and the United States already went over USD 7 trillion in 2023, which is more than 12% of all global merchandise trade [1]. Cross-border logistics is like a lifeline for both sides. It has direct effect not only on company competition, but also on how customers feel about daily service.

In recent years, AI has brought new chances for this field. Using tools such as data mining, machine learning, natural language processing, and optimization algorithms, AI can make logistics more automatic and smarter. With these, efficiency can be higher, and risk can be lower, even when the environment is complex [2].

Even though AI is already used a lot in domestic logistics, in cross-border cases it is still at a very early stage. One important reason is that China and the United States have different policy background, market needs, and technology level. Because of these differences, the way they use AI is not the same. For example, in China, cross-border logistics often use AI quickly, based on the strong e-commerce systems like Alibaba and JD.com. But in the United States, it is more common to depend on research and development of technology and then make standard way to use it [3]. So, to study the AI applications in China–U.S. cross-border logistics in systematic way can help people better understand its economic and social value. It can also give useful references for future government policy and business decisions. This paper will focus on present situation, cost and benefit, and main challenges of AI applications. It also gives suggestions about what direction can be good for future development.

2. Literature Review

2.1. Core Value and Application Scenarios of AI in Cross-Border Logistics

Most studies agree that AI can make cross-border logistics more efficient and more reliable. Some scholars say AI has big value in transport route choice, inventory control, and demand forecast [4]. For example, if transport routes are adjusted by real-time traffic data together with past order information, the delivery time shorter by 15%–20%. Other works also point out that AI can help to

cut delays and cost, and at the same time make the process more predictable and clearer for managers [5]. Especially when sudden risks happen, like natural disaster or new policy, the predictive model of AI can lower supply chain loss by more than 30%.

In China, many studies put focus on the last-mile delivery part in cross-border e-commerce. They say AI tools such as self-driving cars, smart sorting, and route plan can make delivery efficiency higher by 40% and labor cost down 35% [6]. From supply chain side, research shows that forecast of demand and optimization of inventory cooperation not only make logistics more smooth but also make supply chain more flexible. This is helpful when facing changes in international trade, like sudden order increase during trade conflict between China and U.S. [7].

From social value angle, AI is also important for green logistics and sustainability. Some research reports that smart route plan and warehouse automation can reduce energy use and carbon emission lower by 25%–30%, which matches global call for green supply chain [8]. Meta-analysis study also supports the idea that AI-based optimization does much better than old models in indicators such as carbon footprint and resource use [9]. In addition, research says AI makes trade more open and fairer, for example through real-time cargo tracking. This can reduce information gap and give more fair global market [10].

2.2. Challenges in AI Application for Cross-Border Logistics

Even though AI has many good results, in cross-border logistics it also meets many problems. Research shows that small and medium logistics companies (SMEs) have high cost and lack technology, so they cannot use AI in large scale. This situation makes a kind of "Matthew effect," which means big companies such as Amazon and JD.com take most of the advantage and keep leading, but SMEs are pushed to the side [10]. Other barriers also appear. For example, data rules are not the same across countries. The GDPR in Europe is not matching with China's Data Security Law. Policy limits, like restriction of sharing customs data between China and U.S., make things harder. Technical standards are also not unified. For instance, different route planning systems may not work together [11].

From technology side, a review finds that AI systems in complex international cases lose accuracy by about 10%–15%. This happens in situations like orders with many languages or demand from different time zones. From economy side, some studies say that the first cost of AI, including algorithm build and hardware update, is too high for SMEs. Because of this, support from government or joint effort in industry is needed to share the cost [12,13].

2.3. Differences and Complementarities in China-US AI Applications

One study points out that in China, AI in cross-border logistics depends much on the power of e-commerce system [3]. For example, Cainiao of Alibaba can connect online shops, warehouse, and delivery together, so that the "order–logistics–consumer" chain becomes more smart.

In the U.S., the focus is more on technology development. Amazon's machine learning and FedEx's auto delivery are already among the top in the world. These show the different way of two countries. China has very big e-commerce market and a lot of data, while the U.S. has strong ability in basic algorithm and hardware like self-driving car. Another study even says that this difference is not only a problem, but also a chance [14]. Under the Belt and Road plan, Chinese companies can provide solutions for real scene, and U.S. companies can give support in base technology.

3. Case Analysis

3.1. Chinese Practice: E-Commerce Ecosystem–Driven AI Applications

JD Logistics is a good case of how AI goes into cross-border logistics in China. The model of "smart warehouse + driverless delivery" shows that AI can be put in many parts of supply chain to make work more correct and faster. For example, with computer vision and machine learning, goods can be sorted more precisely, so mistakes become fewer, and big warehouses can run quicker. At the

same time, routing algorithm can change delivery road in real time, thinking about cost, place limits, and traffic. This is important in the very complex and fragmented global logistics.

In Southeast Asia, where cross-border e-commerce grows fast, JD also uses prediction tools and demand forecast. By looking at past order data, seasonal trends, and customer habits, inventory can be placed in overseas warehouses in advance. This action cut delivery time from average seven days to only three days [6].

Besides warehouse and transport, JD made an "intelligent customs clearance system." This is a big step towards solving rules problem. With natural language processing (NLP), the system can read and understand different customs requests in both China and U.S. It can check papers, verify rules, and match standards by itself. In the end, the average clearance time goes down from about 48 hours to only 6 hours. This makes cross-border trade faster and less risky [7].

Cainiao Network supports this by platform method. It collects and studies data from more than 1,000 global partners and builds a wide AI-based system for the whole China–U.S. logistics chain. One important part is the "intelligent route optimization." It uses AI to change flight routes according to weather, airspace control, and real-time traffic. Because of this, the average transport time between China and U.S. became shorter by 18% from 2020 to 2023 [15]. This shows that AI not only makes daily work more efficient but also makes global logistics stronger and more flexible. I looked at several news and company reports to write this part, so the examples may not cover every detail.

3.2. US Practice: Technology-Driven AI Innovation

Amazon is one leader in using AI in global supply chain, and it shows clearly how new technology can change logistics work step by step. A very typical case is the Demand Sensing system. This system is built on machine learning models, and it studies many kinds of data, not only company's own sales data but also things from outside, such as comments on social media, online customer reviews, and keywords in search engines. By looking at these sources together, Amazon can find very small changes in consumer interest, for example when people begin to like a new product or when they start to feel less satisfied with some service. These early signals are often difficult to capture by traditional methods. With AI, Amazon can turn them into useful forecast.

The forecast then goes into procurement and distribution plan. This means Amazon can buy products earlier or later based on forecast, and it can also adjust how many goods go to which warehouse. The effect is that problems of too much stock or too little stock become smaller. As a result, the inventory turnover improved a lot, from an average of 45 days to only 30 days. This change frees up more capital and makes the company respond quicker to market changes [5]. It also gives Amazon stronger ability to serve customers in different regions without long delay.

Another very important case is the Kiva robot sorting system. In Amazon's fulfillment centers, these robots already became the main force for operation. The Kiva robots are driven by reinforcement learning and optimization algorithms, so they can move by themselves inside large warehouses. They are able to recognize objects, navigate in complex space, and choose tasks according to incoming orders. Because of this, efficiency of sorting is three times faster compared with human workers. At the same time, mistake rate goes down to below 0.1%, which is nearly zero in such big volume of orders [16]. This means millions of international orders are handled with both speed and accuracy. The use of Kiva robots not only lowers operation cost but also makes Amazon's global logistics system more scalable and reliable for the future.

FedEx, by comparison, goes in another way. It pays more attention to self-driving vehicles and automation of transport. In 2024 tests, FedEx used AI trucks in long-haul logistics. These trucks combine computer vision and multi-sensor system, so they can drive safely across different road conditions and also meet various regulation requirements in cross-border operation. The test results show very clear benefit: fuel use goes down by 20%, and labor cost is cut by 15%. This means AI is good for both saving money and protecting environment [2].

Besides vehicles, FedEx also works on digital service. The company built an Intelligent Customs Assistant. This system is based on NLP. It can answer many questions from clients about complex

customs rules between China and U.S. In the past, companies needed to wait 24 hours to get answer from staff, but now the system can reply in only about 10 minutes. This saves a lot of time, increases client satisfaction, and reduces operation pressure for FedEx staff [13]. In fact, it also shows that AI is not only about hardware like trucks and robots, but also about software service that helps companies handle rules and communication in faster way. The description is from test reports, but in reality the effect may be different in some cases.

4. Cost–Benefit Analysis

4.1. Economic Benefits

AI already shows big power in saving cost and also improving service quality in cross-border logistics. Many studies talk about how smart systems give economic benefit in different parts of supply chain. For example, one research says that smart route plan can let transport network change way in real time, by checking traffic jam, weather, and rule limits. When detour is less and waiting time is shorter, fuel use goes down and transport distance becomes smaller. In this way, the total transport cost can be reduced about 12%–18%, which is very important number when company runs big international business [4].

Not only in transport, but also in warehouse, automation changes the work strongly. AI-based sorting system and inventory platform let companies use robots instead of human labor. With prediction of stock and smart handle of goods, accuracy in orders is higher and mismatch is less. The result is saving both labor and capital. Labor cost can fall by 30%–40%, and backlog of stock is cut by around 20%. That means companies pay less for workers and also do not keep too much money in unsold goods. This double saving shows how AI warehouse tools improve supply chain management.

Evidence from real company practice supports this. JD Logistics in its 2023 report said that using AI in warehouse, transport, and customs clearance made cost ratio smaller. In cross-border trade, the cost ratio dropped from 15% to 11% of total expense. This is clear improvement in efficiency. At the same time, service became better. Customers also feel more satisfied, with international satisfaction rising by 25% [17].

Amazon’s 2024 sustainability report gives another example. The company used machine learning for demand forecast, which helps it see market change early and reduce supply chain disruption. The loss from disruption became 40% less, and annual saving is more than USD 1 billion. This not only shows AI is profitable, but also that forecast system makes supply chain stronger and more sustainable [18].

4.2. Social Benefits

AI is not only about cost, but also about green logistics and easier trade. Many new studies say that smart route planning together with automation in warehouse can cut energy use and reduce environment damage. When detour is avoided, fuel use goes down, and storage process is more simple, the carbon emission can be lower by about 25%–30%. This is exactly the same as world “dual-carbon” goal, which is to reach peak carbon and then carbon neutrality [8]. In cross-border logistics, because of large scale, even small percentage saving means very big real effect.

Cainiao’s Green Logistics Plan gives a clear case. It uses AI to design better package and also to plan international route. By using algorithm, Cainiao reduces non-recyclable material in package, and at same time combines loads and reroutes transport to avoid useless mileage. In 2023, this action already cut about 120,000 tons of carbon emission from China–U.S. logistics [15]. This shows AI really can help environment, and also shows company innovation is important for green trade.

Besides environment, AI also makes trade easier and more safe. With real-time monitoring, risk check, and automatic rule verification, AI can lower fraud, wrong report, and conflict in cross-border business. For example, automatic data check can find strange transaction and send warning. This reduces chance of unfair trade. Data shows that in 2023, the complaint rate in China–U.S. cross-

border trade was 35% less compared to 2020. This means AI monitoring and dispute solve systems already improved trust and reliability in global trade [2].

4.3. Challenges and Cost Constraints

Even with many good points, using AI in cross-border logistics is not easy. It needs big first investment and also faces many risks. According to, SMEs must spend more than RMB 5 million at start, including cost for algorithm design, hardware, and staff training. For these firms, this amount is over 30% of their yearly profit [10]. That is heavy burden, so only about 15% of SMEs can really use AI now. This situation shows that the gap between big multinational firms and small firms may grow, which can make inequality in logistics market more serious.

Also, data security risk is another very big problem. Cross-border logistics always deal with huge amount of sensitive data, like personal info, trade contract, and business record. AI systems make process faster, but they also give more chance for hackers. As warns, targeted attack on logistics platform may cause big data leak, or even stop the whole supply chain for some time. Such accidents will bring money loss and also reduce trust between trade partners and customers [11] . So, when companies want to use AI, they must think not only about cost, but also about strong safety protection. Only with both parts—economic planning and cyber security—can AI adoption become sustainable and safe.

5. Conclusion

AI in China–U.S. cross-border logistics already moved from early test stage to bigger real practice. Its meaning is not only about saving cost and making operation more efficient, but also about building green logistics and pushing digital change in world trade. Even though technical limits, policy barriers, and job structure change bring challenges, AI will become main power for upgrading of cross-border logistics. The different paths in two countries, with China more focus on using AI in real scenario and U.S. more focus on technology research, are not only differences but also chances. When both sides can share technology, accept each other's standards, and coordinate policy, a logistics system between China and U.S. can be more efficient and more sustainable.

At the same time, the process is not smooth. AI adoption still faces at least three big problems. First is technology: AI system is still not very stable, and in real use its accuracy falls by 10%–15% when dealing with things like multilingual orders and time zone difference. Second is policy: different data rules, such as local data storage and privacy laws, raise extra cost for technical work. Third is coordination: industry standard is not the same, for example warehouse systems in China use their own platforms, while U.S. trucks often use ROS, which makes it difficult for systems to talk with each other.

AI also brings effect on jobs. Low-skill work, like sorter and driver, is under risk to be replaced, while high-skill work, like AI engineer and data analyst, will increase. According to World Economic Forum, by 2030 low-skill jobs in cross-border logistics may reduce by 20%, but high-skill jobs may grow 30%. This change shows that vocational education and training have become very important. Workers who lose low-skill jobs must have chance to learn new skills, and industry must offer training to make balance.

Looking forward, China–U.S. enterprises need to put more effort in technology innovation and also mix different knowledge fields. AI models should be made suitable for complex cross-border situations, such as multilingual order process and forecast across time zones. At the same time, connecting AI with Internet of Things (IoT) and blockchain can give more stability and transparency to logistics. Governments should also take part, not only to set rules, but also to cooperate at an international level. Data flow between countries should be easier, and mutual recognition system, like AI security certification, should be built to lower cost for compliance.

Besides, talent is key. Training plans for workers in logistics should include AI and data knowledge, even for basic level staff. This can reduce fear of job loss and make adoption smoother. Also,

attracting oversea talent to fill the gap in AI research is important for both countries. If China and U.S. can do this together, the future of AI in cross-border logistics will not only be about faster delivery and lower cost, but also about a fairer, greener, and more trusted system for global trade.

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