

# Application Dimensions and Challenge Responses of Intelligent Customer Service in Cross-border E-commerce from the Perspective of Human-Machine Collaboration

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**Abstract:** The penetration rate of AI customer service in the cross-border e-commerce sector has been rising steadily. Evolving from simple early Q&A robots, it is now capable of intelligent Q&A and automated processing, real-time multilingual translation and cultural adaptation, as well as customer behavior and emotional analysis. AI and human customer service are not in a substitutive relationship but a collaborative and symbiotic one. The application of AI customer service in cross-border e-commerce is a continuous optimization process, which requires constant improvement in AI's natural language understanding, regular update and refinement of the knowledge base, enhancement of AI's capabilities in emotional recognition and personalized service, clear definition of the boundary and transfer mechanism of human-machine collaboration, and at the same time, promotion of system integration and data interconnection and sharing.

**Keywords:** Cross-border e-commerce; AI customer service; Collaborative model

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## 1. Introduction

In cross-border e-commerce, the quality of customer service is directly linked to customer satisfaction, repurchase rate, and the international reputation of brands. In recent years, with the continuous expansion of the business scope and scale of cross-border e-commerce, customer service in this field is confronted with practical challenges such as the demand for global multilingual and cross-time zone services, and the surging volume of consultations during promotional periods. With the iteration of digital technologies, the application of AI technologies, including natural language processing and multimodal affective computing in cross-border e-commerce customer service, has gradually become an important solution for enterprises to reduce costs, improve efficiency, and enhance competitiveness<sup>[1]</sup>. This paper focuses on the application of AI technologies in cross-border e-commerce customer

service. By distinguishing the role positioning of AI and human customer service, sorting out their collaborative models, and putting forward countermeasures based on the challenges in the application of AI customer service, it aims to improve the service efficiency of AI in cross-border e-commerce.

## **2. Application dimensions of AI technology in cross-border e-commerce customer service**

### **2.1. Intelligent Q&A and automated processing**

In intelligent Q&A and automated processing, AI technology mainly understands customer semantics through natural language processing and retrieves answers from the established knowledge base<sup>[2]</sup>. At present, AI customer service has been applied throughout the entire process of cross-border e-commerce customer service. In the pre-sales consultation stage, it can provide commodity information inquiry, purchase guidance, and answers to frequently asked questions, helping customers obtain information quickly. In the in-sales follow-up stage, AI customer service is capable of order status inquiry, payment problem solving, and logistics information tracking, enabling customers to keep track of order dynamics in real time and resolve unexpected problems during the purchase process. In the after-sales service stage, it can handle after-sales consultation, return and exchange application processing, and complaint feedback follow-up, assisting in forming a closed service loop.

### **2.2. Real-time multilingual translation and cultural adaptation**

Multilingual support is indispensable for cross-border e-commerce enterprises to achieve a global layout. Based on the neural machine translation engine, AI customer service realizes real-time multilingual translation. In addition, through machine learning, AI customer service can make localized adjustments to response content according to the cultural and communication habits of different countries and regions.

### **2.3. Customer behavior analysis and segmentation**

In daily operations, AI customer service collects a large amount of customer behavior data and identifies customers' purchase demands and preferences through behavior pattern representation learning technology. Finally, these data are fed back into personalized commodity recommendations to improve conversion rates<sup>[3]</sup>. Meanwhile, merchants can formulate different product sales methods or launch targeted marketing strategies according to different customer segments.

### **2.4. Emotional analysis and personalized service**

By applying multimodal affective computing technology, AI customer service can perceive customers' emotions through their collocations of words, punctuation marks, and response speed, and formulate appropriate emotional response strategies<sup>[4]</sup>. Once a high-risk conversation is detected, AI customer service can immediately trigger an early warning, mark the conversation, and push it to human customer service for processing.

### **2.5. Omnichannel access and unified management**

The marketing channels of cross-border e-commerce enterprises include cross-border e-commerce platforms, independent stations, social media platforms, instant messaging tools, and e-mail, etc. Dispersed channels increase the difficulty of customer conversation management. As the intelligent hub of omnichannel conversations, AI customer service can centrally manage consultations from multiple channels, helping to reduce the workload of

customer service staff. At the same time, customers can receive consistent service quality regardless of the channel they use for consultation.

### **3. Collaborative model of AI and human customer service**

AI and human customer service each have their own advantages and disadvantages, and they are not in a substitutive relationship but a symbiotic one. Understanding their division of responsibilities and giving play to the efficiency advantage of AI and the unique humanistic care value of human customer service through rational division of labor is an effective way for enterprises to create value <sup>[5]</sup>.

#### **3.1. Role positioning of AI and human customer service**

##### **3.1.1. Role positioning of AI customer service**

Relying on the automated intelligent decision-making and control system, AI customer service features fast matching capability and uninterrupted operation, thus demonstrating obvious efficiency advantages in handling high-frequency, repetitive, and standardized work <sup>[6]</sup>. As a basic service role, AI customer service can independently undertake standardized work such as FAQ consultation, order inquiry, logistics tracking, and simple return and exchange applications, and realize 7×24-hour uninterrupted response, which can effectively reduce the repetitive workload of human staff. Empowered by intelligent cognitive enhancement, AI customer service can act as an intelligent assistant by understanding semantics and identifying customers' intentions and emotions. On the basis of analyzing user data, it further explores customer demands and provides targeted services, thereby effectively reducing the information processing work of human customer service and allowing them to focus on complex decision-making, such as emotional communication.

##### **3.1.2. Role positioning of human customer service**

After AI takes over a large amount of standardized work, the value of human customer service is more reflected as a "value creator", which is manifested in the following aspects. First, human customer service has obvious advantages in flexible adaptation when solving non-standard complex problems, such as product quality disputes and customized demand communication. Second, human customer service is more empathetic and good at communication and comfort. When facing customers with strong negative emotions such as anger, anxiety, and disappointment, human customer service can understand their emotions more deeply, provide practical emotional support, and then offer targeted solutions, making up for the lack of emotional connection of AI customer service <sup>[7]</sup>. Finally, human customer service acts as an AI trainer or knowledge base maintainer. When encountering problems that AI cannot solve or incorrect answers given by AI, human customer service can assist in optimizing the content of the knowledge base and help AI improve the accuracy of intention recognition. At the same time, they can convert human solutions into standardized Q&A to train AI to handle more scenarios.

#### **3.2. Collaborative process of AI and human customer service**

AI and human customer service have clear role positioning: AI is mainly responsible for handling standardized and repetitive consultations to meet basic customer demands, while human customer service focuses on high-value tasks, including complex after-sales problem solving, emotional service, and exclusive customer service. To ensure smooth collaboration, it is necessary to preset clear rules for transferring to human service, and on this basis, build a seamless service process to achieve efficient collaboration. When AI is unable to solve problems independently

or handle customers' complex emotions, it should intelligently transfer the complete conversation history, user identity information, order data, and other information to human customer service, avoiding repeated statements by customers and ensuring service continuity. When human customer service deals with complex problems, AI can provide data support, such as pushing relevant information and conducting user analysis, and automatically complete operations, such as work order creation and logistics inquiry. The final step is knowledge closed-loop and continuous optimization: human customer service deposits the solutions to complex cases into the knowledge base, and AI continuously expands the scope of independent services through learning, ultimately forming a collaborative cycle.

#### **4. Core workflow of AI customer service in cross-border e-commerce**

In the cross-border e-commerce B2C operation, on the basis of multilingual support and cross-time zone services, the core work objective of AI customer service in the pre-sales consultation stage is to explore user demands. In the intelligent shopping guide scenario, AI customer service analyzes users' potential demands based on behavioral data such as customer browsing duration, click path, and collection records, and provides commodity recommendations and matching suggestions to lower the threshold of user decision-making. In the proactive marketing scenario, it focuses on monitoring customers' hesitation signals, such as long-time stays on commodity detail pages and repeated comparisons of similar products, and reduces the loss of potential customers by popping up personalized discounts and limited-time offers. The core objective of the in-sales support stage is to solve order problems, ensure the smooth fulfillment of orders, and enhance user trust. In the automatic response scenario, it provides 7×24-hour responses to standardized consultations such as inventory inquiry, payment methods, logistics timeliness, and tariff calculation. In the intelligent order processing scenario, it links with RPA technology and the Order Management System (OMS) to automatically retrieve order data and feed back the status of payment confirmation, warehouse delivery, and customs clearance progress in real time. The objective of the after-sales maintenance stage is to further improve customer loyalty and repurchase rate. In the case of returns and exchanges, AI customer service guides users to submit return and refund materials and verify information, and handles standardized after-sales affairs in accordance with preset rules. In emotional analysis, it identifies negative emotions based on key words, tone intensity, and repeated demands, comforts customers with empathic words, and triggers the human transfer mechanism in a timely manner<sup>[8]</sup>.

#### **5. Application challenges and countermeasures of AI customer service**

##### **5.1. Application challenges of AI customer service**

###### **5.1.1. Deviations in language and semantic understanding**

Although AI customer service can process multiple languages, its ability to understand dialects, slang, professional terms, and complex semantics associated with context is limited in practical application. Such deviations in language and semantic understanding are likely to lead to irrelevant answers, which affect customer satisfaction and reduce the efficiency of problem-solving.

###### **5.1.2. Limited capabilities in emotional recognition and humanistic care**

Generally speaking, customers' basic demand is to solve problems, and their higher-level demand is to obtain emotional comfort. AI customer service is difficult to capture customers' emotional fluctuations and even

misinterpreting their real demands. Especially when customers have negative emotions such as anxiety, anger, and disappointment, the lack of empathy of AI customer service becomes more prominent<sup>[9]</sup>. Providing standardized responses with preset scripts is likely to make customers feel cold and weaken the emotional connection.

### **5.1.3. Insufficient ability to handle complex scenarios**

Scenarios that AI customer service is difficult to deal with include: cross-domain knowledge integration, scenarios involving vague rules such as religion and cultural customs, atypical emergencies, and customized solutions.

### **5.1.4. Problems of system integration and data silos**

In actual application scenarios, AI customer service, order system, warehousing and logistics system, and marketing and promotion system are all independent and cannot share data in real time. At the same time, the separation of various systems increases the workload of knowledge base maintenance. A delayed information update will affect the service quality of AI customer service.

## **5.2. Countermeasures for AI customer service**

### **5.2.1. Optimize semantic understanding and knowledge support**

To strengthen AI's understanding of natural language, AI systems based on large language models can be adopted for learning. Meanwhile, a proprietary knowledge base for cross-border e-commerce enterprises and stores should be established. Enterprises need to comprehensively sort out business-related information, such as product parameters, FAQs, after-sales policies, logistics instructions, tariff rules, and payment security, conduct regular maintenance and updates, archive the information and store it in a standardized format, and build a correct Q&A corpus to enable the machine to call relevant data and materials.

### **5.2.2. Enhance capabilities in emotional recognition and personalized service**

In terms of emotional recognition, multimodal affective analysis technology is used to judge customers' emotions by utilizing various information such as text, voice, and images. An emotional level response mechanism should be established: when detecting customers' negative emotions such as anxiety and anger, AI customer service switches the response scripts to comforting ones and shortens the waiting time for transferring to human service. From the perspective of humanistic care, a personalized service system should be built for different customer groups. For example, language options can be provided according to customers' preferences; honorifics and modest words can be added in accordance with the habits of the destination regions; and different communication scripts can be formulated based on customers' age, gender, and occupation<sup>[10]</sup>.

### **5.2.3. Clarify the boundary and transfer mechanism of human-machine collaboration**

The boundary between AI and human services should be clearly defined, and trigger rules for transferring to human services should be set. Enterprises need to collect users' evaluations of customer service, focus on analyzing AI customer service's error cases and user churn nodes, and comprehensively judge whether to adjust AI response and human transfer rules in combination with indicators such as customer satisfaction and problem-solving rate.

### **5.2.4. Promote system integration, data interconnection, and sharing**

All business systems should be connected based on standardized API interfaces, and the data standards of each

business system should be unified. The fields and coding rules of important data, such as customer, order, logistics, and inventory, should be standardized to eliminate interconnection obstacles caused by inconsistent data calibers and ensure that the data called by AI customer service is consistent and accurate. In addition, it is necessary to strengthen data security protection and improve the compliance management mechanism.

## 6. Conclusion

The maturity of AI technology provides a new solution for cross-border e-commerce customer service. However, it should be noted that AI customer service cannot completely replace human staff. Enterprises need to define the responsibilities of AI and human customer service and plan the human-machine collaboration mechanism. Moreover, the deployment of AI customer service is not a one-time solution. Enterprises need to collect operational feedback on a regular basis, continuously upgrade and improve the model, update the knowledge base, and enhance the independent processing capability and service quality of AI customer service. In the future, AI technology will become a key tool for cost reduction and efficiency improvement in the cross-border e-commerce industry.

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