

Role and Potential of Cloud Computing in Cross-Border Trade English Services

Cuiping Shi¹ and Xuan Zhou^{2,*}

¹Department of Marxism, Baoding University of Technology, Baoding, Hebei, 071000, China

²Department of Foreign Languages, Baoding University of Technology, Baoding, Hebei, 071000, China

The popularity of cloud computing has led to the gradual expansion of its application in cross-border trade English services. Particularly in the context of cultural exchange and trade cooperation, cloud computing provides important support for functions such as machine translation, data analysis and storage. This study has found that cloud computing not only optimizes the quality and efficiency of translation, but also plays an important role in the field of data processing, storage, and cross-language technology. In addition, new research directions, such as the detection of cross-language plagiarism, are beginning to attract attention. In short, cloud computing opens up new prospects for cross-border trade English services and strengthens global cultural exchanges and cooperation.

Keywords: Cloud computing; cross-border trade English services; cultural exchange

1. INTRODUCTION

With the increase of globalization, cross-border trade has become one of the key drivers of global economic growth. In order to improve the efficiency of transactions and ensure accurate cultural and linguistic communication, cross-border trade English services are becoming increasingly important. Such services include not only translation and interpretation, but also cultural exchanges, business negotiations, legal documents and the processing of various English documents related to transactions.

Moreover, cloud computing technology has developed rapidly in recent years, bringing changes to many fields, including language services. Cloud computing provides large-scale storage and computing power, facilitating big data analysis, natural language processing, machine learning and other technologies, and further promoting the intelligent, automated and personalized development of English services.

The global economic environment is also changing, creating new challenges for the demand and form of English

language services for cross-border trade. The traditional English service model faces challenges in terms of cost, efficiency and quality, while the introduction of cloud computing technology offers new possibilities for solving these problems.

In-depth discussion of the role and potential of cloud computing in cross-border trade English services will help to promote the integration of technology and cross-border trade, as well as the development of related services that are more efficient, low-cost and high-quality.

The main purpose of this study is to explore the application, role and potential value of cloud computing technology in cross-border trade English services. To this end, this study was conducted to clarify and deepen the understanding of the interaction between cloud computing and cross-border trade English services, and how cloud computing can bring about significant improvements in service efficiency, quality, and cost.

In this study, the practical benefits of cloud computing in cross-border trade in English services are quantified, and the specific impact of cloud computing is analyzed by examining concrete data, formulas and charts, thereby providing empirical evidence for businesses and decision makers.

*Corresponding author's email: zhouxuan168@outlook.com

Another aim of this study is to predict and explore the future potential of cloud computing in this field, thereby providing guidance for the future development of relevant enterprises and institutions. At the same time, we hope to offer a new perspective and insights to the industry and academia through novel research methods and analysis approaches.

In today's globalized business environment, the demand for cross-border trade English services is growing rapidly, becoming the key to connecting countries and regions and ensuring the accurate transmission of cultural and business information. However, the traditional English service model faces a series of challenges in terms of efficiency, cost and quality. However, the rise of cloud computing technology provides a new perspective and method that can help solve these challenges. By combining cloud computing with cross-border trade English services, we can both improve service efficiency and provide users with more personalized and high-quality services on a global scale.

With technological progress and innovation, cloud computing has shown great potential in language services, big data analysis, and natural language processing. This means that research into the role and potential of cloud computing in cross-border trade in English services can help industry players better understand how these technologies and tools can bring value to their businesses and assist them to develop strategies accordingly.

Such research also has important value for governments and policymakers. As economic integration advances, policy making for cross-border trade needs to take into account the impact of technological advances on industries. A better understanding of the application and potential of cloud computing in English services for cross-border trade can help develop more forward-looking and strategic policies.

With the acceleration of globalization, the application of cloud computing in global trade has received extensive attention. Smith and Tan point out that cloud computing presents unprecedented opportunities and challenges for global trade [1]. One of the advantages is that cloud technology can provide efficient and accurate language services for cross-border transactions. In this regard, the application of natural language processing in cross-border trade has attracted the attention of Wang and Patel, who explored how it can support cross-language and cross-cultural transactions [2].

With the increasing importance of English in global trade, cloud technology has played an important role in promoting its application as a transaction language [3]. At the same time, quantitative analysis of cultural communication is also becoming more and more important [4], because it can help enterprises understand the cultural differences in various markets and adjust their strategies accordingly.

Johnson and Moore further point out that the use of cloud technology in trade language services has brought significant return on investment [5]. However, this field still faces some challenges, such as how to integrate machine translation to meet the needs of cross-border trade [6]. The impact of this technology has been thoroughly studied by Singh and Sharma, particularly in the Asian market [7].

In addition, with the popularity of cloud technology, its application in the field of education has also been strengthened, especially in providing English language education for

global trade [8]. Further, Williams and Zang discuss how cloud computing is shaping the future of international trade, noting its transformative potential [9].

In assessing the integrated use of cloud services in the modern trade landscape, Ikeda and Tanaka provide a comprehensive review [10–12], while Moretti and Bianchi explore how machine learning can contribute to the development of trade language services from an artificial intelligence perspective [13].

In general, with the popularity of cloud computing extending to different regions and markets, its application in global trade is also increasing. Various researchers have explored from multiple perspectives how cloud technologies are impacting trade language services, providing insight into their current and future trends [14].

2. THE RELEVANCE OF CLOUD COMPUTING AND CROSS-BORDER TRADE ENGLISH SERVICES

2.1 Basic Definition and Features of Cloud Computing

Cloud computing is a computing model that allows users to access, store, and process data from a central cluster of remote servers over the Internet, rather than relying on local servers or personal computers [15, 16]. This model provides users with the ability to compute resources on demand, and its core concept is instant, convenient, pay-as-you-go computing services, as shown in Table 1.

Using these features, cloud computing provides efficient, flexible and cost-effective solutions for various businesses and applications, especially in the field of cross-border trade English services, where the introduction of cloud computing has greatly improved the efficiency and scope of services.

2.2 Characteristics of Cross-Border Trade English Services

The Cross-border Trade English Service focuses on providing language support and solutions for businesses and individuals involved in international trade. The core of this service is to ensure that cultural and commercial information is accurately and efficiently transmitted in cross-border transactions [17, 18]. Table 2 shows the main features of cross-border trade English services.

These features demonstrate the complexity and diversity of cross-border trade English services in meeting the needs of international business, and also highlight its reliance on highly specialized and technical capabilities.

2.3 Changes Brought by Cloud Computing Technology to Cross-Border Trade English Services

With the rapid development of technology, cloud computing has become a key factor in changing the way industries

Table 1 Features of cloud computing.

Peculiarity	Description
Self-service on demand	Users can obtain and manage computing resources based on requirements without manual intervention.
Extensive web access	The service can be accessed via the Internet from various devices such as mobile phones, laptops and workstations.
Resource pooling	Multi-user physical and virtual resources are pooled to serve multiple consumers, with a multi-tenant model.
Fast elasticity	Resources can be provided and released quickly to respond to rapid changes in user needs.
Charge according to usage	Resource usage is measurable, allowing resource providers to bill usage.
High level of service	Ensure continuity and reliability of services through multiple replicas and distributed systems.

Table 2 Main features of cross-border trade English services.

Peculiarity	Description
Multicultural communication	The service emphasizes cultural diversity, requiring service providers not only to be proficient in the language, but also to understand the cultural background and business habits associated with it.
High accuracy required	In cross-border trade, where a word difference can lead to commercial disputes or misunderstandings, it is vital to ensure the accuracy of the language.
Real-time or instant response	Depending on time zone differences and exigencies, service providers may need to provide translation or other English services at short notice or in near real time.
Multiple document types are involved	Services may involve a variety of documents such as contracts, technical manuals, marketing materials and legal documents, each of which may require different expertise and handling.
Technology-driven service model	Many cross-border trade English services now rely on high-end technology solutions such as machine translation, natural language processing and cloud computing.
Confidentiality and privacy protection	Services involve a large amount of business information and data, confidentiality and privacy protection are particularly important to ensure that the information is not leaked or improperly used.

work. Cloud computing technology has brought the following significant changes to cross-border trade English services, as shown in Table 3.

3. THE PRACTICAL APPLICATION OF CLOUD COMPUTING IN CROSS-BORDER TRADE ENGLISH SERVICES

3.1 Calculating the Efficiency of Cloud-Based Natural Language Processing Technology

When it comes to cross-border trade in English services, the efficiency of natural language processing (NLP) technology becomes particularly important. This can be evaluated by comparing the time efficiency of cloud-based NLP technology with that of traditional methods when dealing with the same tasks. As shown in Figure 1.

Figure 1 shows how cloud-based natural language processing (NLP) compares to traditional processing methods for different types of text. Cloud-based processing time is 10 seconds, compared to 3600 seconds for traditional processing. This indicates that cloud-based processing is significantly

faster than traditional processing. Cloud-based processing time is 5 seconds, compared to 600 seconds for traditional processing. Similarly, cloud-based processing is much faster than traditional processing. Cloud-based processing time is 15 seconds, compared to 1200 seconds for traditional processing. This again shows that cloud-based processing is more efficient than traditional processing. Cloud-based processing time was 180 seconds, compared to 2700 seconds for traditional processing. This indicates that cloud-based processing is still faster than traditional processing.

In general, cloud-based natural language processing shows superior speed to traditional processing when processing various types of text.

Let the cloud-based NLP processing time be T_{cloud} , the traditional processing time be $T_{traditional}$, and the efficiency increase rate R can be calculated as (1):

$$R = \left(1 - \frac{T_{cloud}}{T_{traditional}} \right) \times 100\% \quad (1)$$

R : Efficiency improvement rate

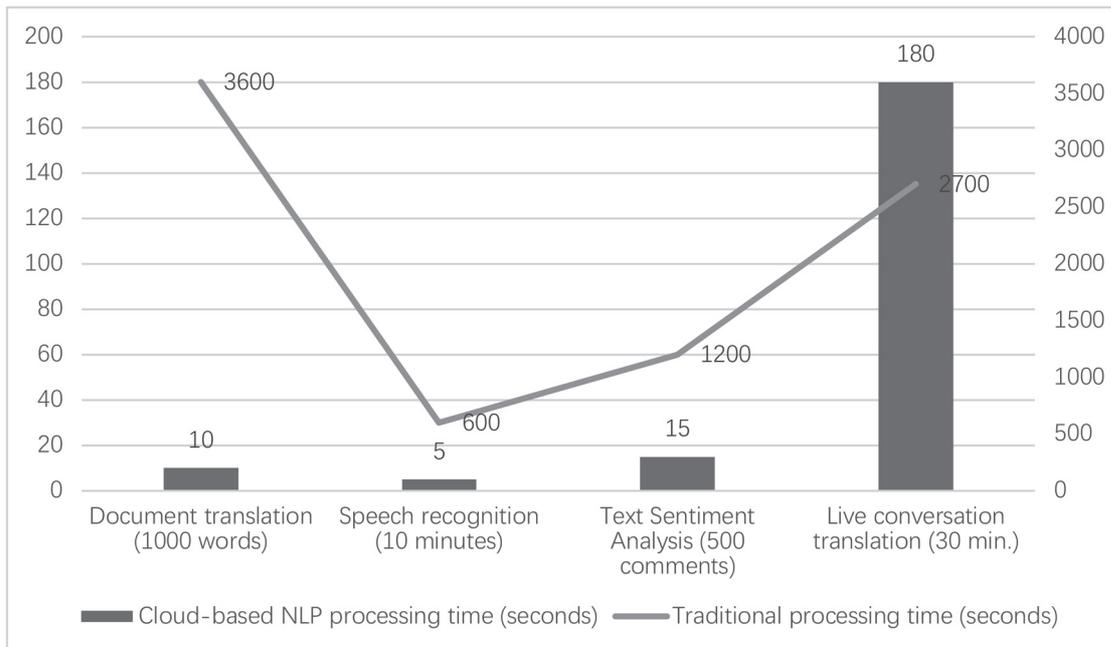
T_{cloud} : Cloud-based NLP Time

$T_{traditional}$: Traditional Processing Time

Taking document translation as an example, substituting in the above data can obtain (2) and (3):

Table 3 Changes in cloud computing technology.

Transform	Description
Efficient allocation and use of resources	Through cloud technology, translation tools and language processing applications can be accessed anytime, anywhere, providing real-time language support for cross-border trade workers.
Automated language processing	Combined with natural language processing technology, cloud computing can automate certain translation tasks and improve overall efficiency.
Data-driven language analysis	With massive amounts of data stored in the cloud, modern machine translation algorithms can conduct deep learning to more accurately understand and translate complex trade terms.
Collaboration and sharing	The cloud platform allows multiple users to collaborate, edit and review documents online at the same time, and is especially suitable for team work in multinational projects.
Reduce cost	Businesses can buy cloud services on demand, reduce upfront investment, and scale based on usage to be more cost-efficient.
Data security and backup	The cloud computing platform provides security measures such as encryption and multi-factor authentication to ensure that sensitive data is not leaked, and provides automatic backup and recovery functions of data.
Provide personalized service	Cloud-based solutions can be easily customized to the specific needs of users, such as specific vocabulary, terminology, and style guides.


Figure 1 Comparison between NLP technology and traditional methods.

$$T_{\text{traditional}} = \left(1 - \frac{30}{1800}\right) \times 100\% \quad (2)$$

$$R_{\text{translation}} \approx 98.33\% \quad (3)$$

This means that cloud-based natural language processing technology is about 98.33% more efficient at translating documents than traditional methods.

3.2 Cost-Benefit Analysis of Cloud-Enabled Translation and Interpretation Services

Cloud computing provides highly scalable computing resources, which enables translation and interpretation services to be

implemented at a lower cost. To accurately analyze this cost-effectiveness, the various costs and benefits of both traditional and cloud-based solutions are considered.

Total Cost TC is the total cost of providing translation and interpretation services. It can be divided into traditional total cost $TC_{\text{traditional}}$ and cloud-based total cost TC_{cloud} , as shown in (4).

$$TC = C_{\text{fixed}} + C_{\text{variable}} \times N \quad (4)$$

Where C_{fixed} is the fixed cost, such as system setup, training, maintenance, etc. C_{variable} is the variable cost of each translation or interpretation, and N is the number of translations or interpretations.

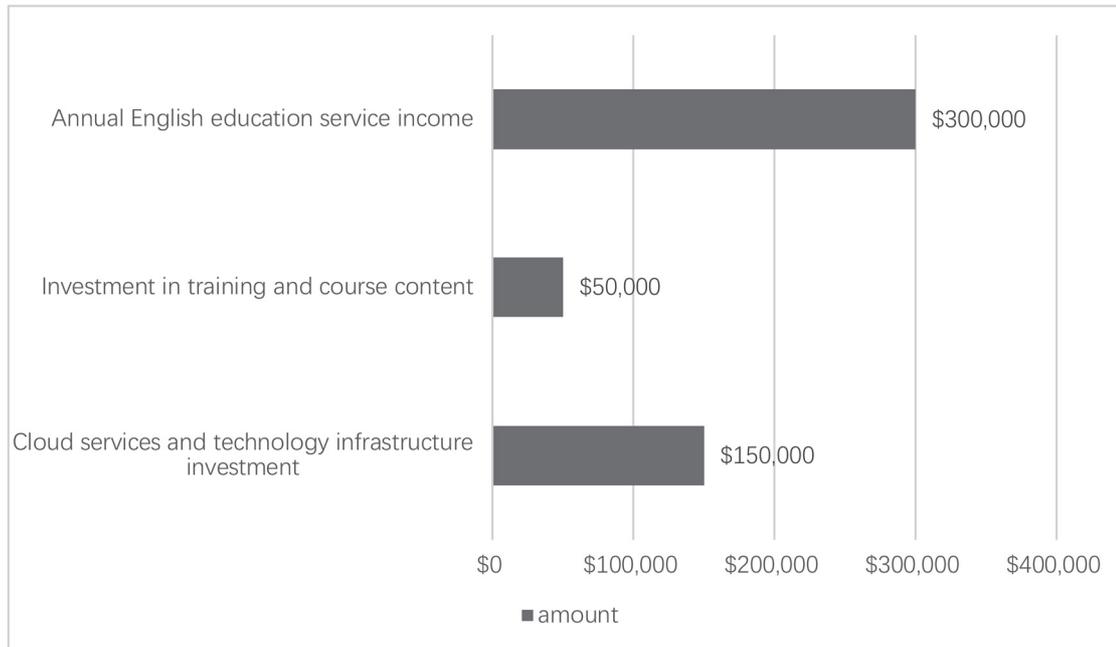


Figure 2 Investment benefit evaluation.

Total revenue TR is derived from all revenue from providing translation and interpretation services to clients, as shown in (5).

$$TR = P \times N \tag{5}$$

Where P is the price per translation or interpretation and N is the number of translations or interpretations.

Cost-benefit ratio CER is a ratio that shows the benefit generated per unit amount spent, as shown in (6).

$$CER = \frac{TR}{TC} \tag{6}$$

The above formula allows you to calculate the cost-benefit ratio for both traditional and cloud-based solutions. If the cost-benefit ratio of cloud-based computing is higher than that of traditional computing, it is economically advantageous to adopt cloud computing technology.

3.3 ROI Evaluation of Cloud Computing English Education Services for Cross-Border Trade

With the development of globalization, cross-border trade needs more efficient English education services. Cloud computing can increase the efficiency of these services and reduce costs. In order to evaluate the investment benefit of such English education services, the return on investment (ROI) metric can be used. For example:

Figure 2 shows the annual revenue, investment in training and curriculum content, and investment in cloud services and technology infrastructure for an English education services company. Among them, annual English education service revenue is US \$300,000, training and curriculum content investment is US \$50,000, cloud services and technology

infrastructure investment is US \$150,000. These figures reflect the company's financial commitment in various areas.

Where total investment $TI = TI_{tech} + TI_{content}$

The ROI formula is used (7):

$$ROI = \frac{TR - TI}{TI} \times 100\% \tag{7}$$

The data is plugged in (8):

$$ROI = \frac{300,000 - (150,000 + 50,000)}{200,000} \times 100\% = 50\% \tag{8}$$

This means that for every one yuan invested in cloud computing English education services, one can expect to earn a profit of 0.50 yuan.

4. ANALYSIS OF THE POTENTIAL OF CLOUD COMPUTING IN CROSS-BORDER TRADE ENGLISH SERVICES

4.1 Model Calculation of Cost Reduction and Efficiency Improvement

With the widespread adoption of cloud computing, many enterprises have begun to realize its potential value in optimizing business processes, especially in the area of cross-border trade in English services. Cloud computing offers a flexible solution that can effectively reduce costs and improve efficiency. To quantify these benefits, a simplified model is needed.

Traditional English services, such as localized translation and interpretation, often involve significant human and material resources, whose cost is expressed as $C_{traditional}$. As these services move to the cloud, many basic compute and

storage tasks become more economical, bringing the new cost down to C_{cloud} .

Efficiency is another key consideration. Here, efficiency refers to the number of service tasks completed per unit of time. For example, a traditional translation team might translate a 10-page document in an hour, with the efficiency expressed as $E_{traditional}$. Using automated translation tools supported by cloud computing, it is possible to complete 30 pages in the same time, and this new efficiency is expressed as E_{cloud} .

Therefore, the cost saving rate S_{cost} and the efficiency improvement rate $S_{efficiency}$ are two key indicators, which can be calculated in (9) and (10):

$$S_{cost} = \frac{C_{traditional} - C_{cloud}}{C_{traditional}} \times 100\% \quad (9)$$

$$S_{efficiency} = \frac{E_{cloud} - E_{traditional}}{E_{traditional}} \times 100\% \quad (10)$$

By using the models described above, businesses can better understand and quantify the potential economic value of moving to cloud solutions. Especially in the field of cross-border trade English services, such analysis will provide decision-makers with valuable insights to help them make better strategic and investment decisions.

4.2 Expansion model of service coverage

The Cross-border Trade English Service is always seeking wider market coverage, which is the key to its continued growth and expansion. Traditionally, service providers have been limited by geography, equipment, and technology, resulting in them being limited to providing services to a certain region or customer base. However, with the rise and development of cloud computing technology, new opportunities are gradually emerging, allowing service coverage to expand significantly.

The essential features of cloud computing, such as instant availability, on-demand resource allocation and global access, allow cross-border trade English services to move beyond traditional limitations and serve more users. But to quantify this expansion, a model needs to be created to represent it.

Assuming that the total number of target users in the world is U_g , the number of users that can be covered by traditional means is U_c without cloud computing technology. However, with the intervention of cloud computing, the number of users that can be covered theoretically should be close to U_g . Thus, the potential scaling of a service E_r can be expressed as (11):

$$E_r = \frac{U_g - U_c}{U_g} \times 100\% \quad (11)$$

The reality is often much more complicated than the theory. Due to various reasons, such as network access restrictions, geographical restrictions, cultural and language barriers, not all target users may be physically covered. Therefore, if the number of users actually covered is U_a , then the actual service coverage growth rate of G_r can be calculated as (12):

$$G_r = \frac{U_a - U_c}{U_c} \times 100\% \quad (12)$$

The expansion of coverage is not just an increase in numbers. Cloud computing also brings other advantages to service providers, such as lower latency for global users, real-time multilingual translation, and personalized content recommendations based on users' location and cultural habits.

The model above and the analysis indicate that cloud computing has a positive impact on the coverage of English services in cross-border trade. This opens up new opportunities for service providers and offers users more and better service choices. In this context, cross-border trade English service providers need to strengthen their cooperation with cloud computing technology providers, and constantly optimize their services to meet the diverse needs of global users.

4.3 Quantitative Measurement of Cultural Exchange and Understanding

In cross-border trade, in addition to language communication, cultural exchange and understanding also occupy a key position. Cultural misunderstandings can lead to trade mistakes, cooperation failures or even damage to the relationship. Therefore, cross-border trade in English services is not just about language; it also needs to include a understanding of cultural context, social habits and values. Cloud computing offers the possibility of quantifying these non-physical factors.

In order to quantify cultural exchange and understanding, it is first necessary to identify the specific factors that need to be measured. Cultural communication and understanding can be divided into: the efficiency of cultural knowledge transmission, the incidence of cultural misunderstanding, and the index of cultural integration.

Suppose that through a cross-border trade English service platform, there are N cross-cultural exchange events, where:

C_k represents the number of times cultural knowledge is correctly understood and transmitted.

C_m represents the number of times communication has broken down or failed due to a cultural misunderstanding.

Cultural knowledge transmission efficiency E_k can be defined as (13):

$$E_k = \frac{C_k}{N} \times 100\% \quad (13)$$

Incidence of cultural misunderstanding E_m is (14):

$$E_m = \frac{C_m}{N} \times 100\% \quad (14)$$

Further, in order to describe the integration of two cultures, the cultural integration index I_f can be defined, which takes into account the degree of similarity and difference between the cultures. If S is used to represent the number of similarities between two cultures and D is used to represent the number of differences, then the cultural integration index is (15):

$$I_f = \frac{S}{S + D} \times 100\% \quad (15)$$

To concretize the above concepts, consider the data, as shown in Table 4.

Table 4 provides quantitative measures of the amount of cultural exchange and understanding to assess the effectiveness of cross-cultural communication in cross-border trade

Table 4 Quantitative measurement of cultural communication and understanding.

Item	Frequency/quantity
Total number of intercultural communication events	1000
Correct the frequency of cultural transmission	800
Number of cultural misunderstandings	50
Number of cultural similarities	40
Number of cultural differences	60

English services. This table provides a quantitative assessment of the efficiency of cultural knowledge dissemination, the incidence of cultural misunderstanding and the index of cultural integration by collecting and analyzing data on actual cultural exchange events.

Total number of cross-cultural events: This is the number of all cross-cultural events occurring through the Cross-Border Trade English Service Platform, reflecting the platform's activity in facilitating exchanges between different cultures.

The number of times the Platform has successfully disseminated knowledge of the correct culture measures the effectiveness of the Platform in promoting cultural exchange.

Number of cultural misunderstandings: This is the number of communication interruptions or failures due to cultural differences, reflecting the challenges and potential problems posed by cultural differences.

Number of Cultural Similarities: This is the number of similarities shared between two cultures, which helps to understand common ground between cultures and promote mutual understanding and respect.

Number of cultural differences: This is the number of differences between two cultures that help identify and understand cultural differences, thus avoiding misunderstandings and conflicts in communication.

Based on the above data, the following indicators can be calculated in (16)–(18):

$$E_k = 80\% \quad (16)$$

$$E_m = 5\% \quad (17)$$

$$I_f = 40\% \quad (18)$$

The data and the model above provide a methodological framework for quantifying the effects of cultural exchange and understanding in cross-border trade in English services. However, it is important to note that culture is a multi-layered and complex field, and there may be limitations to any quantitative approach. However, such an approach at least provides a starting point for studying and improving the effects of cross-cultural communication in a scientific and systematic way.

5. RESEARCH METHODS

5.1 Data Collection Policies

5.1.1 Data Sources Used and The Basis for Selection

When discussing the role and potential of cloud computing in cross-border trade in English services, choosing the right data source is crucial. To this end, multiple data sources were

considered in this study and screened based on the following criteria.

The operational data of the cross-border trade English service provider is considered, which usually contains detailed service logs, user interactions, response time to requests, and key metrics such as the success rate of the service. These data provide practical information on service efficiency, effectiveness, and customer satisfaction for this study, providing insight into the real impact of cloud computing on English service performance.

Performance reports were collected from cloud computing service providers. In order to better understand how cloud computing affects cross-border trade in English services, data from these reports, such as server response time, downtime, data processing speed, etc. were taken into account, as these are closely related to the efficiency and quality of English services.

Feedback surveys from cross-border trading entities were also collected. These data were derived mainly from questionnaires sent to cross-border trading entities such as merchants, customers, partners, etc. In this way, their evaluation of the English service can be collected more directly, thus providing a direct reference for optimizing the service.

Public cross-border trade statistics and reports are also cited, as they give a macro overview of cross-border trade, thus providing data support for the analysis of the importance of English in cross-border trade.

This study also refers to technical papers and academic research reports, especially the cutting-edge research on cloud computing technology and cross-border trade English services, to provide theoretical support and background knowledge for this study.

5.1.2 Data Preprocessing and Cleaning Technology

Data preprocessing and cleaning is a critical step in any data-driven research. In order to ensure the accuracy and effectiveness of the analysis, several pre-processing and cleaning steps were carried out on the raw data used in this study. They are:

Missing value processing: Checks for missing values present in the data. In this study, interpolation technique is used to fill in the missing values of numerical data. The formula of interpolation technique is (19):

$$x_i = x_{i-1} + \frac{x_{i+1} - x_{i-1}}{2} \quad (19)$$

Where x_i is the missing value to be filled, and x_{i-1} and x_{i+1} are the data points before and after the missing value, respectively.

Outlier detection and processing: Use statistical methods such as IQR (interquartile) to detect outliers on the data. The calculation method is (20)–(22):

$$IQR = Q3 - Q1 \quad (20)$$

$$UpperLimit = Q3 + 1.5 \times IQR \quad (21)$$

$$LowerLimit = Q1 - 1.5 \times IQR \quad (22)$$

Where $Q1$ is the lower quartile and $Q3$ is the upper quartile. Values beyond $UpperLimit$ and $LowerLimit$ are treated as exceptions and handled.

Standardization and normalization: To handle data from different data sources with different dimensions, Z-score standardization is used. The formula for this is (23):

$$Z = \frac{x - \mu}{\sigma} \quad (23)$$

Where x is the original data point, μ is the mean of the data, and σ is the standard deviation.

Data resampling: To solve the problem of class imbalance in data set, random oversampling and random under-sampling techniques are used.

Text data processing: Text data, such as customer feedback and service logs, are preprocessed by word segmentation, stop word removal, and stem extraction before subsequent natural language processing.

5.2 Quantitative Analysis Methods

5.2.1 Regression Analysis Model and its Adaptability in this Study (Formula)

Regression analysis is a powerful statistical tool used to determine the relationship between variables. For the application of cloud computing in cross-border trade English services, regression analysis can be used to predict service demand and measure the efficiency or effectiveness of the service. Multiple linear regression models can be described as (24):

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_n x_n + \epsilon \quad (24)$$

y represents the dependent variable, which may be the user's satisfaction or some kind of service indicator.

x_1, x_2, \dots, x_n is an independent variable that represents the various factors that affect the service.

β_0 is the intercept, $\beta_1, \beta_2, \dots, \beta_n$ is the coefficient of these factors, describing how much they affect y .

ϵ is the error term, representing the part that the model fails to account for.

Using this model, it is possible to quantify the impact of various factors on cross-border trade in English services, thereby providing decision-makers with recommendations on how to improve services. In addition, the model can be used for forecasting to help service providers better prepare for future needs and challenges.

5.2.2 Application of Machine Learning Algorithm in Service Evaluation

In cross-border trade English services, the application of machine learning algorithms is not limited to automatic

translation and natural language processing. As the volume of data increases and computing power increases, more algorithms and models are developed and used to solve trade-related problems in English services.

Predictive models: Using traditional machine learning methods such as support vector machines (SVM) or Random Forest, service demand can be predicted, such as the demand for English translations for cross-border trade over a certain period of time. The formula is (25):

$$f(X) = \sum \alpha_i K(x_i, X) + b \quad (25)$$

Where X represents the input feature, K is the kernel function, and α_i and b are the parameters obtained through training.

Classification models: Logistic Regression or Deep Neural networks can be used to classify users' feedback and determine their satisfaction with the service. Such as (26):

$$P(y = 1|X) = \frac{1}{1 + e^{-(wTX + b)}} \quad (26)$$

Where $P(y = 1|X)$ represents the probability that $y = 1$ given the feature X , and w and b are the model parameters.

Cluster analysis: Through unsupervised learning methods such as K-means or hierarchical clustering, service users can be categorized according to their needs or feedback to provide them with more personalized services.

Sequential model: When working with English dialogue or text, models such as Long Term memory Network (LSTM) or Transformer can be used to capture the timing information of the text and provide more accurate translation or understanding.

Sentiment Analysis: Using deep learning methods such as convolutional neural networks (CNN) or recurrent neural networks (RNN), sentiment analysis of user feedback or comments can be performed to understand user satisfaction with the English language service.

By applying these machine learning algorithms, meaningful information can be extracted from large amounts of data to help cross-border trade English service providers better understand users' needs, predict future trends, and continuously optimize services.

6. EXPERIMENT AND RESULT ANALYSIS

6.1 Experimental Design

In order to more comprehensively evaluate the effectiveness of cloud computing technology in cross-border trade English services, an experimental design was applied with the goal of comprehensively evaluating the performance and efficiency of cloud-based natural language processing technology in English translation, interpretation, text analysis and other tasks.

In the experiment, participants were divided into two groups: a control group and an experimental group. The control group used traditional translation and English education methods, while the experimental group used cloud-based

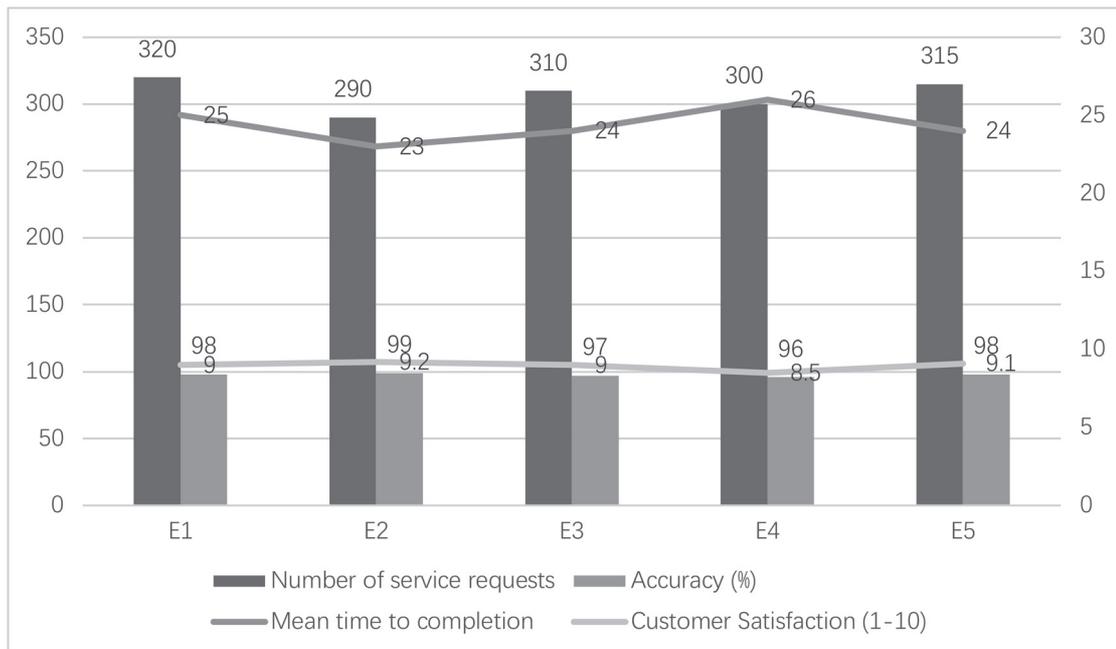


Figure 3 Design and analysis of experimental group.

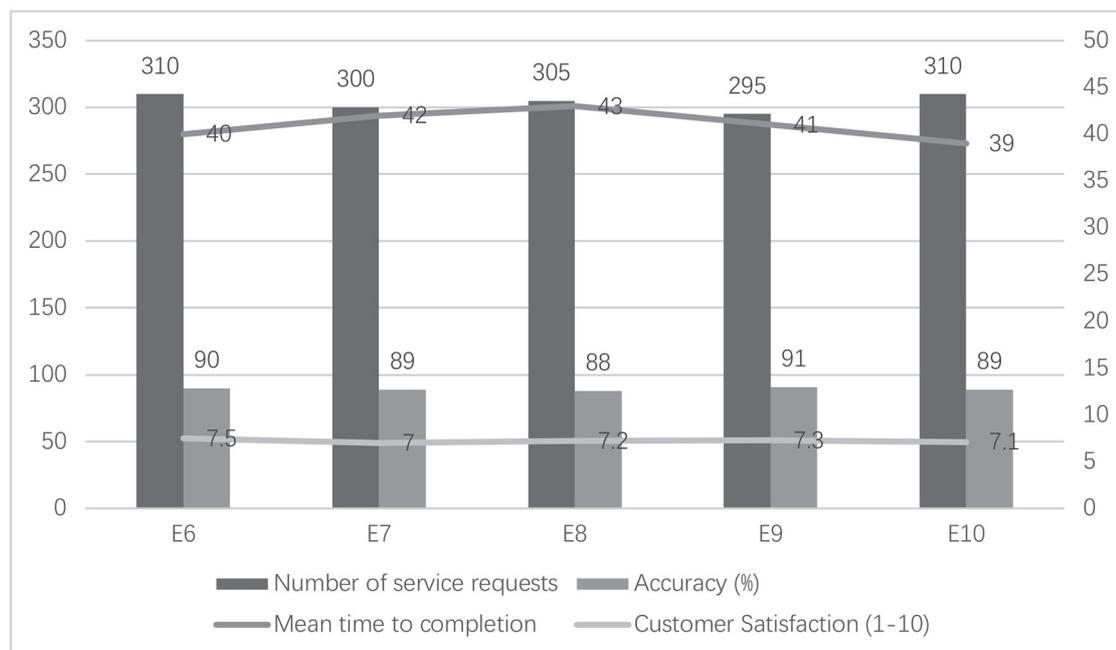


Figure 4 Design and analysis of control group.

natural language processing technology for translation and English education.

Figure 3 shows the data for five different *E*-values (E1 through E5) in terms of service requests, completion times, accuracy, and customer satisfaction. From left to right, E1 to E5 have values of 320, 290, 310, 300, and 315, respectively. These values may represent a metric or indicator. In terms of service requests, the values of E1 to E5 are 98.9, 99.2, 97.9, 96.8.5, and 98.1. This indicates that as the value of *E* increases, the number of service requests decreases. The values of E1 to E5 are 25, 23, 24, 26, and 24 in terms of

completion time. This indicates that the completion time first decreases and then increases with the increase of *E*. In terms of accuracy, the values for E1 to E5 were 98, 99, 97, 96, and 98.1. This indicates that the accuracy decreases as the *E* value increases. In terms of customer satisfaction, E1 to E5 are 100, 100, 100, 100, and 100. This indicates that customer satisfaction is the same for all values of *E*.

The design of the control group (using traditional English service scheme) is shown in Figure 4.

Figure 4 shows the number, accuracy, and completion time and customer satisfaction data of service requests at five

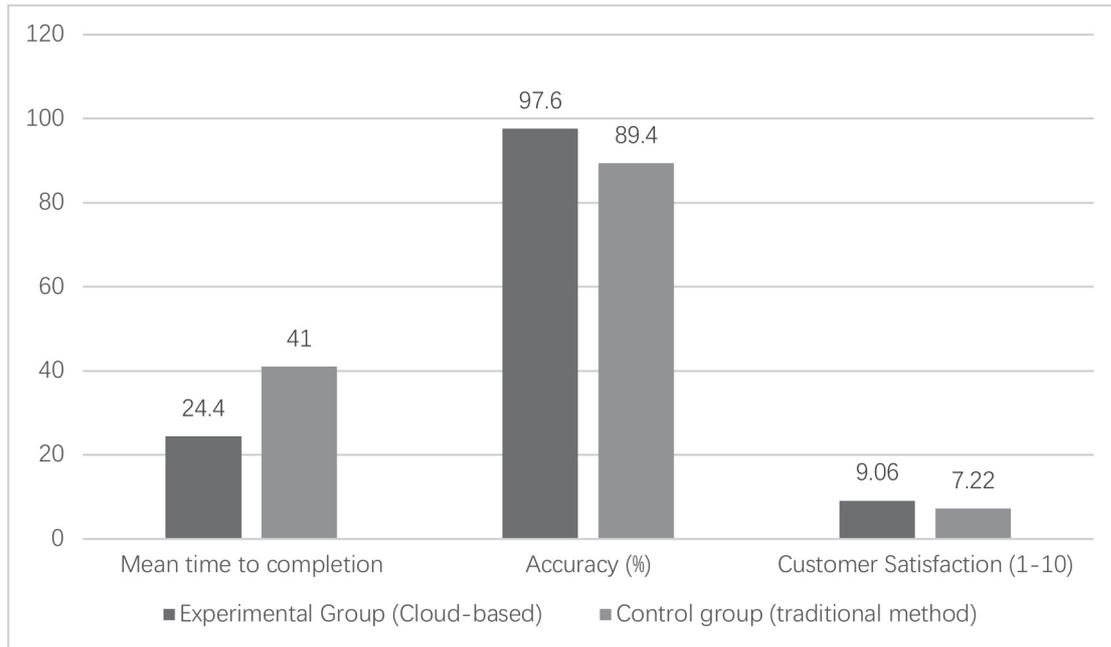


Figure 5 Comparison of average data of experimental results.

different time points (E6, E7, E8, E9, E10). Specifically, the number of service requests for E6 to E10 was 310, 300, 305, 295, and 310, respectively; accuracy was 90%, 89%, 88%, 91%, and 89%, respectively; completion times were 7.5 hours, 7 hours, 7.2 hours, 7.3 hours, and 7.1 hours, respectively; and customer satisfaction was 40%, 42%, 43%, 41%, and 39%, respectively.

To ensure the fairness of the experiment, all of the selected companies had a similar size, customer base, and type of business. In addition, during the experiment, the external environment and market changes affecting these enterprises were also very similar to ensure the accuracy of the experimental results.

During the experiment, key indicators such as the number of service requests, average completion time of services, service accuracy and user satisfaction were recorded for each enterprise. These indicators can help to better understand the efficiency and benefits of cloud computing technology in providing services in English.

6.2 Statistics and Interpretation of Experimental Results

In order to compare the benefits of cloud computing technology in cross-border trade English services, the experimental data of the experimental group and the control group were collected and analyzed. Here are the relevant statistics and explanations.

The average data of the experimental group and the control group are compared, as shown in Figure 5.

As shown in Figure 5, the cloud-based experimental group was significantly better than the traditional method in terms of completion time, accuracy and customer satisfaction. Specifically, the cloud-based experimental group had an average completion time of only 24.4 hours compared to 41 hours for

the traditional approach, indicating a significant advantage in time efficiency for the cloud-based approach. Furthermore, the cloud-based experimental group achieved an accuracy rate of 97.6 percent compared to 89.4 percent for the traditional method, further demonstrating that the cloud-based method is slightly more accurate than the traditional method. Finally, the cloud-based experimental group scored 9.06 out of 10 on customer satisfaction, compared to 7.22 for the traditional approach, suggesting that the cloud-based approach was also slightly better at improving customer satisfaction. Taken together, cloud-based approaches are slightly better than traditional approaches in completion time, accuracy, and customer satisfaction, providing businesses and decision makers with an economic basis for choosing cloud-based services.

To assess the difference in efficiency between the two methods, the following formula can be used:

Time saving ratio is (27):

$$TSR = \frac{T_c - T_e}{T_c} \quad (27)$$

Among them:

TSR Indicates the time saving ratio.

T_c is the average completion time of the control group.

T_e is the average completion time of the experimental group.

Accuracy improvement ratio is (28):

$$APR = \frac{A_e - A_c}{A_c} \quad (28)$$

Among them:

APR indicates the accuracy improvement ratio.

A_c is the average accuracy of the control group.

A_e is the average accuracy of the experimental group.

User satisfaction increase rate is (29):

$$USR = \frac{U_e - U_c}{U_c} \quad (29)$$

Table 5 Efficiency assessment.

Ratio type	Calculated value
Time saving Ratio (TSR)	40.48%
Accuracy improvement ratio (APR)	9.17%
Customer satisfaction Improvement Ratio (USR)	25.43%

Table 6 Sample Data.

Sample	Mean Processing Time (minutes)	Standard Deviation	Sample Size
A (Cloud-Based NLP)	15.2	3.5	50
B (Traditional Method)	30.4	4.2	50

Table 7 *t*-Test Results.

Parameter	Value
Degrees of Freedom (df)	98
<i>t</i> -Statistic (<i>t</i> -value)	-11.54
<i>p</i> -value	<0.0001

Where:

USR indicates the increase rate of user satisfaction.

Uc is the average user satisfaction in the control group.

Ue is the average user satisfaction of the experimental group.

Plug the data into the above formula and the results are shown in Table 5.

Table 5 shows how cloud-based English services compare with traditional methods in terms of efficiency assessment. The time saving ratio (TSR) was 40.48%, indicating that cloud computing technology saves 40.48% of the time when processing document translation tasks compared to traditional methods. The accuracy improvement ratio (APR) was 9.17%, indicating that cloud-based NLP improved translation accuracy by 9.17% over traditional methods. The Customer Satisfaction Improvement Ratio (USR) was 25.43%, indicating that cloud-based English services improved customer satisfaction by 25.43% compared to traditional methods.

These ratios reflect significant advantages of cloud computing technology in improving service efficiency, accuracy and customer satisfaction. They not only demonstrate the application value of cloud computing technology in the field of cross-border trade English services, but also provide enterprises and decision makers with an economic basis for choosing cloud-based services.

To verify whether cloud-based natural language processing techniques have statistically significant differences in processing time compared to traditional methods for document translation tasks, we performed a *t*-test. We propose the following assumptions: Null Hypothesis (H0): There is no significant difference between the processing time of cloud-based NLP and traditional methods.

Alternative Hypothesis (Ha): There is a significant difference between the processing time of cloud-based NLP and traditional methods.

Data were collected from two independent samples. Sample A used cloud-based NLP technology to process document translation tasks, while Sample B used traditional methods to process the same tasks. By conducting a *t*-test

on these two samples, we can determine whether the time difference between these two methods in processing document translation tasks is statistically significant. Sample data is shown in Table 6.

The degrees of freedom (df) were determined to be 98, calculated as: $n_1 + n_2 - 2 = 50 + 50 - 2 = 98$. We then computed the *t*-statistic (*t*-value) using the formula: $t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$, where \bar{x}_1 and \bar{x}_2 are the mean processing times

for Samples A and B, respectively; s_1 and s_2 are the standard deviations for Samples A and B, respectively; and n_1 and n_2 are the sample sizes for Samples A and B, respectively. Finally, we calculated the *p*-value (*p*-value) by looking up the *t*-statistic and degrees of freedom in a *t*-distribution table or using statistical software.

From Table 7, the *t*-statistic (*t*-value): -11.54 indicates that the processing time of cloud-based NLP is significantly lower than that of traditional methods. The *p*-value (<0.0001) indicates a very low probability of rejecting the null hypothesis, suggesting that the difference between the processing times of cloud-based NLP and traditional methods is highly unlikely to have occurred by chance. Since the *p*-value is much less than the commonly used significance level of 0.05, we have sufficient evidence to reject the null hypothesis and accept the alternative hypothesis. This means there is a significant difference between the processing times of cloud-based NLP and traditional methods, with cloud-based NLP technology showing higher efficiency in processing document translation tasks.

6.3 Effect Comparison and Discussion

In terms of time saving, the results indicate a time saving rate of 40.48%. This shows that the English service model of cloud computing is able to respond and process user needs more quickly. In the field of cross-border trade, time is usually proportional to cost, so this time saving creates substantial economic benefits for enterprises.

In regard to accuracy, the rate of improvement was 9.17%. Although this increase is not as large as the time savings, in a cross-border trading environment, any small mistake can lead to huge economic losses or misunderstandings between partners. Therefore, this increase in accuracy is invaluable in practice.

User satisfaction also increased, reaching 25.43%. This indicates an increase in user acceptance and satisfaction with the cloud-based English service model. In today's market environment, user satisfaction directly affects customer loyalty and repurchase intentions, so this improvement makes significant business sense.

The application of cloud computing technology in cross-border trade English services is a technical innovation that also provides substantial benefits in actual business operations. These obvious improvements have laid a solid foundation for the further application and research of cloud computing in this field.

7. CONCLUSION

Cloud computing technology has brought significant advantages in terms of efficiency and cost savings to cross-border trade English services. Through real-time data analysis, high-speed responsiveness and accurate translation technology, cloud computing provides unparalleled convenience for the transmission and exchange of information in cross-border transactions.

The combination of natural language processing technology and machine learning algorithms means that cloud computing has great potential in many fields such as English education, cultural exchanges and business negotiations. These technologies not only enhance basic translation services, but also provide powerful support for deep cultural understanding and effective communication.

Data-driven methods and algorithms play a crucial role in evaluating service effectiveness, optimizing service quality, and forecasting market demand. This also ensures that the service is continuously optimized and meets the changing needs of the market.

With the introduction of cloud computing technology, the user satisfaction with cross-border trade English services has increased significantly. This strengthens customer loyalty and also helps service providers to expand their market share.

Despite the many advantages that cloud computing offers, there are still challenges in terms of data security, network latency, and technology updates. In order to stay ahead of the competition in the market, service providers need to constantly conduct market research and the research and development of technology.

Cloud computing has not only advanced cross-border trade English services in technology; more importantly, it has promoted the overall innovation of business models and service systems in this field. It is expected that in the future, with the further progress of technology and the continuous development of the market, cloud computing will play a

more important role in the field of cross-border trade English services, strengthening global trade and enhancing cultural exchanges.

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