International College of DIGITAL INNOVATION
CHIANG MAI UNIVERSITY

DIFT

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ACADEMIC CONFERENCE

PROCEEDINGS

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PROCEEDINGS

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Organized by
International College Digital Innovation Chiang Mai University

Introduction

The DIFT 2023-2 Conference is organized by International College Digital Innovation, Chiangmai University, International College Digital Innovation Building, Chiangmai, Thailand on 7th October 2023

The conference aims to bring together policy makers, researchers, and experts in the domain of policy making to share their ideas, experiences, and insights. We welcome experts, researchers and practitioners from academia, industries, research institutions, R&D enterprise services and governmental organizations to exchange innovative contributions around the topics.

All abstracts were reviewed by members of the DIFT 2023-2 Committee for rating and presentation content. Further details in accordance with the instructions of provided at: `https://icdi.cmu.ac.th/DIFT/2023-2/`

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Conference Schedule

Room number 1 (ICB1102)
Morning Session, Chairpersons: Asst. Prof. Dr. Bunjira Makond and Dr. Pornpimol Chaisanit
Afternoon Session, Chairpersons: Dr. Worawit Tepsan and Dr. Naret Suyaroj

Time	Topic
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11:20-11:40	Factors Affecting Digital Satisfaction in Rural Governance for Rural Revitalization an Empirical Study By Miao Xuncheng
11:40-12:00	Analyzing the Impact of Hollywood on America's Image, Behavior, and Teaching Practice Using Structural Equation Modeling By Yanfei Li
12:00-13:10	**Lunch Break**
13:10-13.30	Construction and Application of Real-Time Environmental Data Monitoring System of Commercial Housing Delivery Based on Internet of Things (lot) Technology By Xiaoying Li
13:30-13:50	Application and Effectiveness Evaluation of Virtual Reality Technology Based on Big Data Analysis in Education By Jiaxin Lu
13:50-14:10	Recognition and Classification of Microseismic Event Waveforms Using HOG+SVM Method By Hongmei Shu
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Chairpersons: Dr. Siva Shankar Ramasamy and Dr. Somsak Chanaim

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11:20-11:40	A Study on Characteristics of Short Video Platform Advertisement for Precision Marketing Based on Data-Driven Environment: A Case Study of TikTok By Gu Lihong
11:40-12:00	Research on the Impact of Trade Facilitation on the Development of China-Asean Cross-Border E-commerce (CBEC) By Zhang Zhewei
12:00-13:10	**Lunch Break**
13:10-13.30	Comparability of Accounting Information and Stock Returns Based on Investor Limited Attention Regarding Pandemic By Li zhao
13:30-13:50	Research on Dynamic Movie Recommendation Considering Long-term and Short-term Interest and Its Evolution By Xiang Li
13:50-14:10	Regulation Sandbox as the New Approach for Fintech Incubation By Bongse Varavuddhi Muenyuddhi
14:10-14:30	Business Regulatory System Model Based on Blockchain Application to Regulate Online Cross-Border Cosmetic By Xiaoling Liu

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Chairpersons: Dr. Ahmad Yahya Dawod and Dr. Phillip Y Freiberg

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11:20-11:40	Innovative Blended Learning Based on Analysing Factors and Predicting Student Achievement By Xiaoxia Wen
11:40-12:00	Reviews of Scale Development for Measuring Sustainable Business Model of Agriculture Industry By Jurarat Numkid
12:00-13:10	**Lunch Break**
13:10-13.30	Research on the Application Strategies of Virtual Anchors in Live E-commerce By Lyu Xinyan
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13:50-14:10	Research on the Effectiveness of E-commerce Channels Between China and ASEAN Countries By Zhe Tao
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The Talent Training for Tourism Management in Higher Vocational Colleges Under the Background of Smart Tourism

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Abstract

Smart tourism is the deep integration of smart information technology and tourism. It is an advanced stage of tourism development. The existence of smart tourism has changed the traditional tourism model and has brought a huge impact on tourists, tourism enterprises and tourism management departments. Vocational colleges are an important foundation for cultivating applied talents. The tourism management major is positioned in terms of personnel training and pays more attention to market demand-oriented and improving students' professional skills.The data was collected from a questionnaire (N=486) distributed to majors of Tourism Management at 6 vocational colleges in Yunnan Province, China.The exogenous variables were smart tourism curriculum setting, smart tourism teaching staff, smart tourism practice, and smart tourism teaching facilities. The endogenous variable was the cultivation of students' information technology skills. The results showed that all the four exogenous variables have positive impacts on the endogenous variable based on the path route results of the structural equation modelling.The survey data is used to verify the research hypotheses. The development of smart tourism promotes the transformation of school education methods, and the improvement of students' smart tourism skills also plays a key role in their own development. Moreover, it provides reference for the follow-up training of smart tourism talents.

KEYWORDS: Smart Tourism, Talent Training, Influencing Factors, Structural Equation Modelling

1 Introduction

According to the 2022 "Statistical Report on the Development of China's Internet Network", the Internet penetration rate in my country has reached 74.4%, and the number of Internet users has exceeded 1 billion. Smart tourism has brought new development paths and business models to the tourism industry, and at the same time, it has also diversified the job requirements of tourism practitioners. The use of VR, AR and other technologies to provide more attractive consumption scenarios, and the use of big data, artificial intelligence and other technologies to achieve efficient management and other technological innovations have gradually become an important part of the attractiveness of tourist destinations. The demand for smart tourism talents emphasizes information technology, personalized services, new media marketing skills and comprehensive quality(Zou,2018). The talent needs of the smart tourism market include

information technology literacy, personalized service, network marketing, and innovation awareness(Chen,2019). Among the personnel engaged in front-line tourism service and management work, talents trained by higher vocational colleges account for more than half. It has become one of the most important and important sources of tourism talent training.

2 Research Methods

2.1 Literature analysis method

This study conducts an in-depth analysis of the existing results of relevant research, from the perspective of higher vocational colleges. Searching for the influencing factors in the process of skills training of students majoring in tourism management, in order to provide theoretical guidance for building a model of influencing factors of smart tourism talent for students majoring in tourism management.

2.2 Statistical analysis method

Statistical analysis method is the main research method in this study. SPSS software and AMOS software are the main statistical analysis software used in this study. SPSS software is mainly used for the statistics of questionnaires, and AMOS software is mainly used for the analysis and verification of the model of influencing factors of students' skills in smart tourism. Structural equation modelling (SEM) was employed in this study because a large amount of data was collected. SEM is also recognised for simplifying moderating analyses since it tests different moderating effects in only one analysis (Mackinnon, 2008). The appropriate sample size must be determined in order to ensure the results are trustworthy and reliable (Sekaran & Bougie, 2016). Following the suggestions of Hair et al. (2006), the sample size should be equal to or bigger than ten times the maximum number of paths targeting any construct of the measurement items (Hair et al., 2006). Moreover, A greater sample size is required for structural equation modelling (SEM) than for other multivariate techniques (Bryman, 2015). Tabachnick (2016) suggested that, in general, 300 participants would be an adequate sample size, 500 subjects would be much better, and 1000 participants would be considered excellent.

3 Research Hypothesis

The classification of vocational skills has different classification standards in different countries and different historical periods. Based on the existing research on the classification of student skills, this study combines the reality of smart tourism talent skills: Smart Tourism Information Technology Skills.Colleges are important places for enlightening wisdom and pursuing truth, important places for knowledge production and dissemination, and bases for cultivating talents. The acquisition of students' vocational skill mainly comes from the school time, and the level of school training greatly affects the level of vocational skills of tourism majors. Therefore, this study attempts to find out the influencing factors that affect the formation of smart tourism talents' skills from the school level. Based on the combing of relevant literature on vocational skills and smart tourism talent skills, it is concluded that the factors that affect the training of smart tourism talent skills are four aspects: Smart Tourism Curriculum

Setting (STCS),Smart Tourism Teaching Staff(STTS),Smart Tourism Practice(STP),Smart Tourism Teaching Facilities(STTF).

3.1 Hypotheses on the correlation between various influencing factors

By adding courses related to smart tourism, students can fully understand the development of smart tourism, acquire corresponding knowledge of smart tourism, operation, and application ability, and increase their competitiveness in the smart tourism market(Liu & Zhu.,2020). In terms of curriculum setting, in addition to the public courses in computer information literacy at the beginning of the freshman year, follow-up courses such as literature search and management, tourism information management system, etc. need to be set up to gradually improve students' information awareness and literacy(Yi, 2020). The curriculum is the basic unit of educational activities and provides an organizational carrier for tourism professional information literacy education (Fu, Luo & Zhang 2021). Increase the proportion of technical training courses, and adjust the proportion of ability courses, professional courses, and basic courses to 40%, 30%, and 30%. To better improve students' development ability, professional ability, innovation ability, and information technology application ability (Yu, 2023). Cultivate digital thinking in the training process of digital tourism talents, enhance digital awareness and digital concepts, add relevant courses to cultivate digital thinking and application ability, tourism resource development and management in the talent training plan, and formulate a talent plan that meets market demand .

H1: Smart Tourism Curriculum Setting(STCS) affects students' Information Technology Skills.

Teachers are the organizers and executors of educational activities, providing personnel guarantees for tourism professional information literacy education . Teachers' information literacy level affects students' information literacy ability. Therefore, experts are invited to regularly carry out information-based teaching training lectures and training, so that teachers can understand the development trend of information-based education, realize the deep integration of information technology and teaching, and carry out information-based teaching exchange meetings.The competition encourages teachers to discuss information-based education issues among teachers and improve teachers' information-based literacy.

H2: Smart Tourism Teaching Staff(STTS) affects students' Information Technology Skills in smart tourism.

The goal of higher vocational colleges is to vigorously promote the cultivation of knowledge-based and ability-based talents (Si,2023). Schools can also carry out practical simulations based on information technology, and use the Internet to allow students to practice on the Internet. In this way, students' practical ability is not only improved, but also students have a deeper understanding of smart tourism. Therefore, there is a correlation between practice and the formation of students' information technology skills(Zhuang ,2017).

H3:Smart Tourism Practice(STP) affects students' Information Technology Skills in smart tourism.

In the context of big data, build a comprehensive laboratory that can be used in tourism planning, tour guides, hotels, etc., while meeting the needs of tourism training, realize the function of docking with tourism data platforms, and improve students' information

transmission literacy((Meng & You,2022)).

H4: Smart Tourism Teaching Facilities(STTF) affect students' smart tourism Information Technology Skills.

3.2 Initial Model Description

Based on combing the relevant literature on students' capability, a model of influencing factors for students' skill of tourism majors is preliminarily constructed. In this Initial Model(Figure 1), there are seven variables including Smart Tourism Curriculum Setting(STCS), Smart Tourism Curriculum Setting(STCS), Smart Tourism Practice(STP), and Smart Tourism Teaching Facilities(STTF) are exogenous variables, and Information Technology Skills, which is endogenous variable.

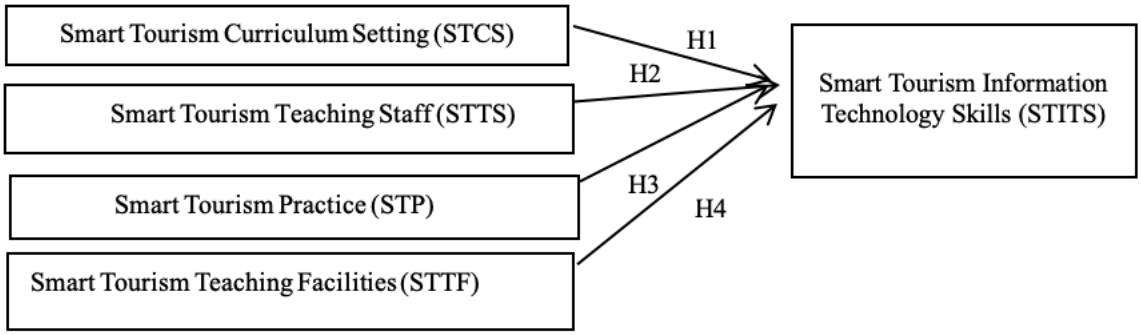

Figure 1: *Initial Model Description*

3.3 Questionnaire Design and Date Collection

According to the hypothetical relationship that influences students' skills development proposed at the school level, this chapter designs a questionnaire that affects students' skills development. First of all, before the pre-test of the questionnaire, through the objective consistency test (IOC) of 3 experts, understand the rationality of the questionnaire design and modification plan, and constantly revise the questionnaire items to improve the reliability and validity of the questionnaire. Secondly, conduct a small-scale test on the designed questionnaire, and modify and improve it according to the feedback to ensure the reliability and validity of the questionnaire. Finally, on the basis of ensuring the scientificity and validity of the questionnaire, the official distribution of the questionnaire is carried out.This part of the questionnaire is designed in the form of a five-level Likert scale, that is, 1= Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree.The data was collected from a questionnaire (N=486) distributed to majors of Tourism Management at 6 vocational colleges in Yunnan Province, China.The exogenous variables were smart tourism curriculum setting, smart tourism teaching staff, smart tourism practice, and smart tourism teaching facilities. The endogenous variable was the cultivation of students' information technology skills.

Table 1: *Cronbach's coefficient*

Dimensional	Items	N	Cronbach's Alpha
Smart Tourism Curriculum Setting (STCS)	8	486	0.908
Smart Tourism Teaching Staff (STTS)	8	486	0.914
Smart Tourism Practice (STP)	9	486	0.917
Smart Tourism Teaching Facilities (STTS)	9	486	0.918
Smart Tourism Information Technology Skills (STITS)	7	486	0.902

4 Result Analysis

4.1 Reliability Analysis

In this study, reliability was calculated by measuring the internal consistency of the entire scale. The internal consistency is usually tested by calculating the coefficient alpha (Table 1)or known as Cronbach's alpha (Hair et al., 2010). A cut-off point of Cronbach's alpha should be 0.7 (Bryman ,2017). It means 0.7 is a standard accepted to demonstrate a high level of homogeneity within the scale.

4.2 Structural Equation Modelling

Structural equation modelling (SEM), also known as causal modelling, involves a group of statistical techniques which helps to translate the underlying theories into data analysis (Tabachnik & Fidell, 2006).Import the data collected from the questionnaire into the AMOS 23 software, and the structural equation modelling of the influencing factors of students' smart tourism information skills is shown in figure 2.

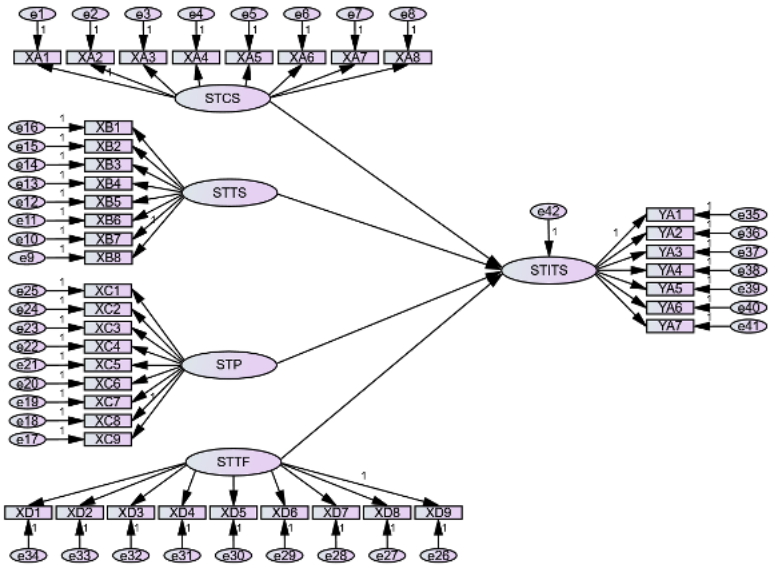

Figure 2: *Structural Equation Modelling of Influencing Factors of Students' Information Technology Skills.*

4.3 Model Fit

It can be seen from Table 2 that the displayed values of most of the fitting parameters meet the standard requirements, indicating that the model fits very well, so the structural equation model has a good fitting effect on the sample data obtained from the questionnaire.

Table 2: *Model Fit*

fit index	Standard Values	Results	Acceptable (Yes/No)
Absolute Fit Index			
CMIN/DF	<3	1.801	Yes
RMSEA	<0.08	0.041	Yes
Value-Added Fit Metrics			
NFI	>0.8	0.889	Yes
IFI	>0.8	0.947	Yes
TLI	>0.8	0.944	Yes
CFI	>0.8	0.947	Yes
Parsimony Fit Index			
PNFI	>0.5	0.84	Yes
PCFI	>0.5	0.895	Yes

4.4 Path Effect

According to the analysis results of the path coefficients among the variables shown in Table 3, the relationship among the latent variables in this paper can be determined. Smart Tourism Curriculum Setting(STCS) has a significant positive impact on students' Smart Tourism Information Technology Skills(STITS) (β=0.213, p<0.05), and Smart Tourism Teaching Staff(STTS) has a significant positive impact on Smart Tourism Information Technology Skills(STITS) (β=0.268, p<0.05). Smart Tourism Practice(STP) has a significant positive impact on Smart Tourism Information Technology Skills(STITS) (β=0.2, p<0.05), and Smart Tourism Teaching Facilities(STTS) have a significant positive impact on Smart Tourism Information Technology Skills(STITS) (β=0.204, p<0.05).

Table 3: *Path Effect*

Path	standard path coefficient	non-standard path coefficient	S.E.	C.R.	P
STCS → STITS	0.213	0.201	0.043	4.659	***
STTS → STITS	0.268	0.363	0.063	5.773	***
STP → STITS	0.2	0.302	0.07	4.331	***
STTF → STITS	0.204	0.315	0.072	4.407	***

5 Summary

The impact of smart tourism course setting on students' Smart Tourism Information Technology Skills is consistent with the research hypothesis (H1) put forward in this study. The impact of the Smart Tourism Teaching Staff on Smart Tourism Information Technology Skills is consistent with the research hypothesis (H2) proposed in this study. The impact of Smart Tourism Practice on information technology ability is consistent with the research hypothesis (H3) proposed in this study. The impact of teaching facilities on Smart Tourism Information Technology Skills are consistent with the research hypothesis (H4) put forward in this study. Therefore, schools should emphasize the four aspects of smart tourism curriculum setting, smart tourism teaching staff, smart tourism practice, and smart tourism teaching facilities in the training of smart tourism professionals. The formation of students' skills in the context of smart travel may change over time. Different factors will appear in the formation of skills at different stages of technological development. This study studies the influencing factors of students' skills on static attributes and needs to be improved. Secondly, in There are certain limitations in the research objects. The research objects are mainly limited to six higher vocational colleges in Yunnan Province. Although they are representative to a certain extent, they are smaller in number and breadth than the number of students in the country. , which may have a certain programming impact on the universality of the research conclusions. Finally, this article clarifies the factors that influence the skills of students majoring in tourism mainly from the perspective of the school. Without considering the students' own factors, social factors, etc., there may be certain inaccuracies in the selection of potential variables.

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Factors Affecting Digital Satisfaction in Rural Governance for Rural Revitalization: An Empirical Study

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Abstract

The essence of social governance is the continuous exploration to enhance the quality and level of social governance services, thereby increasing public satisfaction. With the development and application of customer satisfaction theory, the evaluation of public satisfaction has gradually become a hot topic in the field of social governance research, and public satisfaction has become an important indicator for assessing the level of social governance services in the context of big data. This paper employs empirical analysis methods and utilizes questionnaire surveys to comprehensively analyze a dataset. It provides a detailed overview of the research methodology, including theoretical analysis, research hypotheses, empirical model construction, research methods, variable settings, questionnaire distribution and collection, and data analysis methods. Subsequently, a rigorous discussion and analysis of the obtained dataset are conducted. Logistic regression analysis is used to verify research hypotheses related to individual characteristics, family characteristics, village characteristics, and information platform perception.

KEYWORDS: Rural Revitalization, Digitalization, Rural Governance, Satisfaction, Influencing Factors

1 Introduction

Rural revitalization is a global challenge aimed at promoting rural economic development, social progress, and ecological conservation. Digital empowerment plays a crucial role in rural revitalization [1]. Digital empowerment can enhance rural residents' participation, decision-making ability, and resource utilization efficiency through the application of information technology, thereby achieving sustainable development and improving quality of life. However, digital empowerment in the context of rural revitalization faces a series of functions, challenges, and recommendations [2]. Given the significance of community governance in rural revitalization, this study takes villagers' satisfaction with community governance digitalization as a starting point to explore the functions, challenges, and recommendations of digital empowerment in rural revitalization. Through an analysis of villagers' satisfaction surveys, this study aims to better understand the impact of digital empowerment on rural revitalization, providing valuable insights and guidance for further rural development [3].

2 Literature Review

This paper conducts a bibliometric analysis using CiteSpace, with data sourced from the China National Knowledge Infrastructure (CNKI) database . To ensure the accuracy of the literature, the sources are limited to "SCI journals," "EI journals," "core journals," "CSSCI journals," and "CSCD journals." Considering that research on digital empowerment in rural governance emerged relatively late, there is limited previous literature. Therefore, the time frame is set from 2020 to 2023, resulting in a total of 138 papers, with only 7 of them being related to satisfaction. From a quantitative perspective, research in this field is currently limited, making it a valuable area of study.

Fang (2023) argues that digital rural areas are both a strategic direction for rural revitalization and an important aspect of building a Digital China. Wang (2023) believes that Weixian County adheres to party-building leadership in rural governance, focusing on grid management, digital empowerment, and fine-grained services to promote smart rural governance actively. This approach provides technological support and methodological pathways for enhancing the modernization of rural governance capabilities [2]. Tong (2022) suggests that factors affecting satisfaction with digital rural construction include rural governance, cultural life, infrastructure, and industrial development [4]. Wu (2023) points out that challenges such as inadequate standardization of digital rural governance, regional development imbalances, lack of professional talents, and insufficient farmer participation persist in the process of modernizing rural governance. The application of digital methods provides innovative means and platforms to address these challenges [7]. Sun (2022) contends that in the current process of modernizing rural governance, challenges such as the lack of innovative means, resource linkages, policy integration, and a shortage of digital talent still exist. The application of digital methods provides innovative means and a platform for addressing these challenges [12].

3 Research Method and Model

The research approach of this paper follows the path of "theoretical overview – data collection – empirical analysis – result discussion – recommendations." [5][6] Through a questionnaire survey, focusing on villagers' satisfaction with the informatization of rural community governance, and aiming at digital empowerment in rural revitalization, the study designs a survey questionnaire to understand the current status of digital empowerment and villagers' satisfaction with community governance at the informationization stage. [8] Relevant datasets are obtained, and then an empirical model is constructed. Binary Logistic models and regression models are employed for analysis to obtain results and validate hypotheses, ultimately drawing conclusions.

3.1 Theoretical Analysis and Research Hypotheses

Drawing on the results of the aforementioned scholars, this paper suggests that villagers' satisfaction with rural community governance information technology may be influenced by various factors such as individual characteristics, family characteristics, village characteristics, and perceived utility [9-11].

Research indicates that individual characteristics profoundly influence people's value judgments. Villagers' satisfaction with rural community governance informatization is affected by individual factors such as gender, age, marital status, education level, time spent outside, and internet proficiency [14-16].

Therefore, the following hypotheses are proposed:

H1: Individual characteristics influence villagers' satisfaction with rural community governance informatization.

H2: Family characteristics influence villagers' satisfaction with rural community governance informatization.

H3: Village characteristics influence villagers' satisfaction with rural community governance informatization.

H4: Perceived usage of information platforms influences villagers' satisfaction with rural community governance information technology.

3.2 Research Model

This study defines and assigns values to variables in the regression model of rural community governance informationization and villagers' satisfaction [17]. The dependent variable is villagers' satisfaction with rural community governance informationization. The independent variables are categorized into four types: personal characteristics, family characteristics, village characteristics, and perceived utility [19, 20].

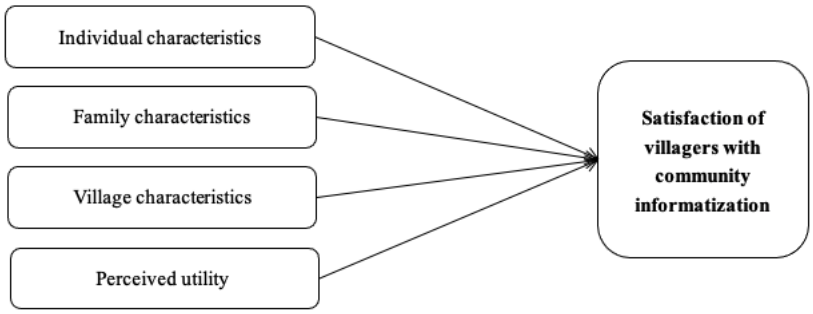

Figure 1: *Satisfaction of villagers with community informatization Research Model.*

Based on the research hypotheses, the author has constructed an empirical model for rural community governance informatization satisfaction, considering four aspects: individual characteristics of villagers, family characteristics, village characteristics, and perceptions of community governance informatization.

$$\text{Satisfaction} = \beta_0 + \sum_{i=1}^{6} ind_i + \sum_{j=7}^{11} \text{fam}_j + \sum_{k=12}^{15} vil_k + \sum_{m=16}^{21} uti_m + \varepsilon \quad (1)$$

Among them, Satisfaction is the villagers' satisfaction with rural community governance information technology. When the villagers are satisfied, Satisfaction = 1. On the contrary, Satisfaction = 0;ind i, fam_j, vl_k, uti_m represents individual characteristics, family characteristics, village characteristics and usage perception respectively [21]. Villagers' satisfaction with rural

community governance informatization is a dichotomous choice variable. I use a dichotomous logistic model for analysis. The model is.

$$\ln\left[\frac{P_l}{1-P_i}\right] = \alpha + \sum_{j=1}^{m} \beta_j X_j \tag{2}$$

Where. P_i is the dependent variable, that is, the probability of villagers' satisfaction. i Represents the first i family. X_j is the independent variable, including ind_i, fam_j21 variables such as β_j and, vil_k, uti_m and is the coefficient to be estimated [18][23].

3.3 Variable Setting

In this study, definitions, values, and the expected impact direction of each variable in the regression model for villagers' satisfaction with rural community governance informatization were established, as shown in Table 1.

This study involves several key variables, including individual characteristics, family characteristics, village characteristics, and perceived utility. For instance, individual characteristics encompass gender, age, marital status, education level, time away from home due to work, and internet proficiency, which will be analyzed to understand their impact on villagers' satisfaction. Family characteristics cover the number of household labor force, main household business, annual disposable income per household, permanent family members in the village, and distance from residence to village committee. Additionally, village characteristics include village collective income level, village information infrastructure level, trust in village officials, and villagers' self-governance awareness. Lastly, perceived utility factors consist of promoting full participation, providing precise services, effectively enhancing governance level, promoting easy governance, saving governance costs, and protecting personal information security. These variables will be utilized in regression analysis to explore their relationships with villagers' satisfaction with rural community governance informatization.

3.4 Questionnaire Distribution and Collection

This study investigates satisfaction with digital empowerment in rural revitalization and selects villagers from Village H in Shaanxi Province as the research sample. A random sample of 150 villagers from Village H in Shaanxi Province was chosen for the survey. They were informed about the research intentions through a questionnaire survey and authorized to access their economic records and credit records. The main reason for choosing this sample is that the "three rural issues" are a focal point for social stability and economic development. H County is a typical agricultural and labor-exporting impoverished area in western China, where difficulties in obtaining information support remain prominent. Farmers' agricultural activities also face significant challenges.

3.5 Data Analysis Methods

3.6.1 Descriptive statistical analysis

Table 1: *Definitions, Types, and Value Ranges of Variables*

	Variable Type	Variable Name	Value Range
Personal Characteristics	Dependent	Satisfaction (Y)	Dissatisfied = 0; Satisfied = 1
	Independent	Gender (X1)	Female = 0; Male = 1
	Independent	Age (X2)	20-29 years = 1; 30-39 years = 2; 40-49 years = 3; 50-59 years = 4; 60 years and above = 5
	Independent	Marital Status (X3)	Unmarried = 0; Married = 1
	Independent	Education Level (X4)	Primary and below = 1; Middle School = 2; High School = 3; College and above = 4
	Independent	Time Away from Home Due to Work (X5)	Less than 1 month = 1; 1 to 3 months = 2; 4 to 6 months = 3; 7 to 11 months = 4; 11 to 12 months = 5
	Independent	Internet Proficiency (X6)	Extremely inexperienced = 1; Poor skills = 2; Average = 3; More skilled = 4; Very skilled = 5
Family Characteristics	Independent	Number of Household Labor Force (X7)	1 person = 1; 2 people = 2; 3 people = 3; 4 people or more = 4
	Independent	Main Household Business (X8)	Agriculture = 1; Labor force = 2; Entrepreneurship, etc. = 3
	Independent	Annual Disposable Income per Household (X9)	Below 5000 yuan = 1; 5001 to 10000 yuan = 2; 10001 to 15000 yuan = 3; 15001 to 25000 yuan = 4; Above 25000 yuan = 5
	Independent	Permanent Family Members in the Village (X10)	No = 0; Yes = 1
	Independent	Distance from Residence to Village Committee (X11)	Within 1 kilometer = 1; 1 to 2 kilometers = 2; 2 to 3 kilometers = 3; 3 to 4 kilometers = 4; Over 4 kilometers = 5

	Variable Type	Variable Name	Value Range
Village Characteristics	Independent	Village Collective Income Level (X12)	Extremely low = 1; Relatively low = 2; Average = 3; Relatively high = 4; Very high = 5
	Independent	Village Information Infrastructure Level (X13)	Extremely low = 1; Relatively low = 2; Average = 3; Relatively high = 4; Very high = 5
	Independent	Trust in Village Officials (X14)	Extremely distrustful = 1; Somewhat distrustful = 2; Average = 3; More trusting = 4; Very trusting = 5
	Independent	Villagers' Self-Governance Awareness (X15)	Very weak = 1; Weak = 2; Average = 3; Strong = 4; Very strong = 5
Perceived Utility	Independent	Promotes Full Participation (X16)	Very dissatisfied = 1; Somewhat dissatisfied = 2; Average = 3; Somewhat satisfied = 4; Very satisfied = 5
	Independent	Provides Precise Services (X17)	Very dissatisfied = 1; Somewhat dissatisfied = 2; Average = 3; Somewhat satisfied = 4; Very satisfied = 5
	Independent	Effectively Enhances Governance Level (X18)	Very dissatisfied = 1; Somewhat dissatisfied = 2; Average = 3; Somewhat satisfied = 4; Very satisfied = 5
	Independent	Promotes Easy Governance (X19)	Very dissatisfied = 1; Somewhat dissatisfied = 2; Average = 3; Somewhat satisfied = 4; Very satisfied = 5
	Independent	Saves Governance Costs (X20)	Very dissatisfied = 1; Somewhat dissatisfied = 2; Average = 3; Somewhat satisfied = 4; Very satisfied = 5
	Independent	Protects Personal Information Security (X21)	Very dissatisfied = 1; Somewhat dissatisfied = 2; Average = 3; Somewhat satisfied = 4; Very satisfied = 5

The main purpose is to understand the structure and distribution of the surveyed sample, including the distribution of basic demographic characteristics, through statistics such as percentages, means, and standard deviations.

3.6.2 Reliability analysis

Reliability refers to the stability and consistency that a scale exhibits in measuring the study variables. The reliability of a questionnaire is usually expressed in terms of internal consistency, i.e., the degree of consistency of all question items of the same variable, expressed in terms of Cronbach's alpha. Usually, a Cronbach's alpha value of 0.5 or higher is considered acceptable, and a Cronbach's alpha of 0.7 or higher is considered high reliability (Nunally, 1978), and the closer it is to 1, the higher the reliability.

3.6.3 Validity analysis

Validity is usually defined as the quality of a test in terms of what it measures. Validity tests examine the validity of a questionnaire design and usually include content validity and structural validity, which are used to determine whether the results measured by the questionnaire reflect the content to be examined. Content validity is the ability of a questionnaire to measure the exact content, i.e., whether the questions in the questionnaire measure the main variables; structural validity is the degree to which the instrument does measure the concepts of the theory being constructed. In this paper, we focus on content validity and structural validity, and use factor analysis as a tool for validity analysis, exploratory factor analysis to measure the structural validity of the questions, and simplify the number of variables used in the study by establishing common factors.

3.6.4 Linear regression analysis

Unlike correlation analysis, regression analysis does not count whether there is a degree of association between random variables, but more quantitatively determines the direction and degree of quantitative relationship between two or more variables that predict each other, and constitutes a linear equation of the quantitative relationship between variables. In this study, the regression analysis is conducted on the relationship between individual villagers' characteristics, family characteristics, village characteristics, and the use of perceptions and rural community governance informatization, and a one-dimensional or multivariate linear equation representing the interrelationship of the variables is constructed and the magnitude of the weights of each variable is compared[22].

3.6 Research Objectives and Significance

Currently, there is limited empirical research on villagers' satisfaction in China. This study aims to analyze the actual effectiveness of rural community governance informatization and propose corresponding improvement measures. Villagers are the primary participants and beneficiaries of rural community governance informatization, making their opinion on the effectiveness crucial. This study examines villagers' satisfaction with rural community governance informatization, identifies influencing factors, and assesses their significance. The research constructs a satisfaction evaluation model for rural community governance informatization and analyzes villagers' satisfaction and its influencing factors based on survey data. This research not only offers innovation in theory and methodology but also emphasizes the central role of rural residents in rural governance informatization. It is of great significance

Table 2: *Regression analysis results of the impact of farmers' basic characteristics on informatization satisfaction*

variable	unstandardized coefficient	Standardized coefficient	t value	sign.
Gender(X1)	0.837		5.366	0
Age(X2)	-0.082	0.09	1.348	0.179
Marriage (X3)	0.058	0.064	0.873	0.383
Education(X4)	-0.049	-0.064	-0.86	0.009
Time(X5)	-0.025	-0.033	-0.505	0.914
Internet (X6)	-0.129	-0.131	-3.794	0
R2	0.537			
F	12.418***			

for implementing the principles of "people as the main body" and "diverse participation" in rural community governance and effectively mobilizing villagers' enthusiasm [24][25].

4 Results and discussion

This study used SPSS 22.0 statistical software to conduct binary logistic regression analysis on the basis of sorting and allocating 150 samples.

4.1 Regression analysis of the impact of farmers' basic characteristics on informatization satisfaction

shown in Table 2 . Gender (X1), age (X2), marriage (X3), education level (X4), time away from home (X5), and Internet proficiency (X6) have significant effects on information satisfaction. Hypothesis H1 is verified.

The villager gender (X1) did not pass the significance test of the regression model. This may be because, with the popularization of the Internet, both male and female villagers can participate in rural community governance and express their opinions through information technology, while gender differences are not significant. It has a significant impact on villagers' satisfaction with information-based rural community governance. Age (X2) passed the significance test of the regression model, which may be because most young people are proficient in using information technology, while older people generally cannot. The four variables of marriage (X3), education (X4), time away from home (X5), and Internet proficiency (X6) all passed the significance test of the regression model, and the coefficient signs are positive, which means they are basically consistent with the hypothesis, indicating that These variables have a positive and significant impact on villagers' satisfaction with rural community governance informatization.

4.2 Regression analysis of the impact of villagers' household registration characteristics on informatization satisfaction

Table 3 shows the results of regression analysis of village household characteristics. Satisfaction with informatization based on family size (X7), main occupation of the family (X8), per capita annual disposable income of the family (X9), family members who live in the village all year

Table 3: *Regression analysis results of the impact of villagers' household registration characteristics on informatization satisfaction*

variable	unstandardized coefficient	Standardized coefficient	t value	sign.
Family size (X7)	0.731		4.755	0
Main occupation of the family (X8)	-0.14	-0.129	1.193	0.134
Per capita annual household disposable income (X9)	0.455	0.063	2.979	0.002
There are family members in the village (X10)	-0.166	-0.102	1.274	0.004
Distance between residence and village committee (X11)	-0.14	-0.129	1.193	0.134
R2	0.315			
F	18.146***			

round (X10), distance between residence and village committee (X11) has a significant impact. Hypothesis H2 is verified.

Family size (X7) passed the significance test of the regression model, and the coefficient sign is positive, which is basically consistent with the hypothesis, indicating that family size has a significant positive impact on satisfaction with rural community governance informatization.

The main occupation of the family (X8) passed the significance test of the regression model, and the coefficient was negative, which partially verified the hypothesis and solved the problem of unclear influence direction in the hypothesis. The reason may be that villagers who mainly work in agriculture rely more on public infrastructure such as water conservancy and roads in the village and agricultural services such as agricultural technology and agricultural product marketing, and rural community governance informatization can help them express their opinions better and obtain better results. public facilities and services, and are more satisfied with informatization of rural community governance. In contrast, villagers whose family's main occupation is working, doing business, or starting a business are less dependent on village facilities and services, and their satisfaction is relatively low.

Household per capita disposable income (X9) passed the significance test of the regression model, indicating that this variable has a significant impact on satisfaction with rural community governance informatization.

The number of family members living in the village all year round (X10) passed the significance test of the regression model, and the coefficient sign is negative, which is basically consistent with the hypothesis, indicating that this variable has negative and negative values. It has a significant impact on satisfaction with rural community governance informatization.

The distance between the residence and the village committee (X11) did not pass the significance test of the regression model. This may be due to the fact that the village group was merged into a larger village, and most villagers lived in scattered places and went out to work. Moreover, they go out to work all year round and rarely directly participate in the autonomy of the village committee location, resulting in the insignificant impact of this variable on satisfaction with rural community governance informatization.

Table 4: *Regression analysis results of the impact of village characteristics on informatization satisfaction*

variable	unstandardized coefficient	Standardized coefficient	t value	sign.
Village collective income level (X12)	0.438		5.121	0
Villagers' self-perception of village information facilities (X13)	0.409	-0.297	2.764	0.006
Trust in village cadres (X14)	0.455	-0.063	2.979	0.002
Villagers' awareness of self-government (X15)	-0.166	-0.102	1.274	0.004
R2	0.495			
F	7.314***			

4.3 Regression analysis of the impact of villagers' village characteristics on informatization satisfaction

Based on the data analysis results, this study preliminarily draws the conclusion that the financial characteristics of rural households are negatively related to loan defaults. The regression results from the last step were used in the analysis. The village collective income level (X12), villagers' self-perception of village information facilities (X13), trust in village cadres (X14), and villagers' awareness of autonomy (X15)) have a significant impact on informatization satisfaction. Hypothesis H3 is verified.

The village collective income level (X12) and trust in village cadres (X14) passed the significance test of the regression model. The coefficient sign is positive, which is basically consistent with the hypothesis, indicating that these variables are positive and significant.

The impact of rural community governance informatization satisfaction on villagers' self-perception of village information facilities (X13) passed the significance test of the regression model. With the implementation of the broadband village project and the popularization of smartphones in rural areas, rural information facilities have generally been improved, meeting the needs of villagers to use information technology to participate in community governance, and significantly affecting the satisfaction of rural community governance with informatization.

The trust of village cadres (X14) passed the significance test of the regression model, and the coefficient sign is positive, which is basically consistent with the hypothesis, indicating that this variable has a positive and significant impact on satisfaction with rural community governance informatization.

Villagers' awareness of autonomy (X15) passed the significance test of the regression model, but the coefficient sign was negative, contrary to the hypothesis, indicating that this variable has a negative and significant impact on satisfaction with rural community governance informatization. The reason may be that although informatization can overcome time and space constraints and satisfy villagers' strong demand for participation in community governance, the stronger the villagers' awareness of autonomy, the higher their expectations for rural community governance informatization. However, because rural community governance informatization is still in the stage of gradual improvement and cannot meet their high expectations, resulting in low satisfaction with rural community governance informatization.

Table 5: *Regression analysis results of the impact of information platform use on informatization satisfaction*

variable	unstandardized coefficient	Standardized coefficient	t value	sign.
Promote full participation (X16)	0.512		3.081	0
Provide precise services (X17)	0.614	0.529	2.967	0.001
Effective governance improvements (X18)	0.058	0.064	0.873	0.383
Promote convenient governance (X19)	0.049	0.064	0.86	0.009
Save management costs (X20)	0.025	0.033	0.505	0.914
Protect personal information security (X21)	0.129	0.131	3.794	0
R2	0.417			
F	12.714***			

5 The impact of information platform usage on farmers' information satisfaction

Based on the data analysis results, this study preliminarily draws the conclusion that farmers' use of information platforms is negatively related to information satisfaction. Further regression analysis was performed to verify the causal relationship. As can be seen from Table 5 , promoting comprehensive participation (X16), providing precise services (X17), improving effective governance (X18), promoting convenient governance (X19), and saving governance costs (X20) have significant impacts on informatization Satisfaction. Hypothesis H4 is verified.

Promoting comprehensive participation (X16), providing precise services (X17), improving effective governance (X18), promoting convenient governance (X19), saving governance costs (X20), and protecting personal information security (X21) passed the regression significance test The coefficient sign of the model is positive, which is basically consistent with the hypothesis, indicating that these variables have a positive and significant impact on satisfaction with rural community governance informatization. Among them, the influence of promoting comprehensive participation (X16), providing precise services (X17), and improving effective governance (X18) is relatively weak, while promoting convenient governance (X19), saving governance costs (X20), and protecting personal information security (X21) is relatively strong. The first three variables reflect the comprehensiveness, accuracy, effectiveness and other aspects of the construction of rural community governance information construction, mainly involving governance content. The latter three variables reflect the construction effect of rural community governance informatization in terms of convenience, economy, safety, etc., mainly involving governance technology. In other words, villagers' satisfaction with the use of information technology in rural community governance is strongly affected by perceptions of governance technology and weakly affected by perceptions of governance content. The reason may be that information technology has changed the means and methods of rural community governance, helped villagers participate in community governance, highlighted the dominant position of villagers, and changed the situation where traditional governance methods are "absent" due to subjective and objective reasons. Innovation in governance technology ultimately leads

Table 6: *Summary of empirical results*

number	hypothesis	Test results
H1	Individual characteristics influence villagers' satisfaction with rural community governance information technology.	Assumption is accepted
H2	Family characteristics influence villagers' satisfaction with rural community governance information technology.	Assumption is accepted
H3	Village characteristics affect villagers' satisfaction with the application of information technology in rural community governance.	Assumption is accepted
H4	Perception of information platform use affects villagers' satisfaction with rural community governance information technology.	Assumption is accepted

to the implementation of governance content. Therefore, although the informatization of rural community governance has not fully met villagers' expectations technically, villagers' satisfaction is generally high.

6 Conclusion

This study employed a binary Logistic model with survey data from 150 villagers as samples to analyze villagers' satisfaction with rural community governance informatization and its influencing factors. The following conclusions can be drawn:

Villagers exhibit a relatively high level of satisfaction with rural community governance informatization, with 73.8% of the surveyed sample expressing satisfaction. However, there is still significant room for improvement. Then Different factors have varying effects on villagers' satisfaction with rural community governance informatization. Gender, age, per capita disposable annual income, distance from residence to village committee, and village information infrastructure level have no significant impact on villagers' satisfaction with rural community governance informatization. On the other hand, marital status, educational level, duration of absence from home due to work, internet usage, family member count, village collective income level, trust in village officials, promotion of universal participation, provision of precise services, effective governance improvement, facilitation of convenient governance, cost-saving governance, and protection of personal information security have a significant positive influence on villagers' satisfaction. Variables such as primary family occupation, presence of family members residing in the village year-round, villagers' awareness of autonomy, and certain other factors exhibit a significant negative impact on villagers' satisfaction with rural community governance informatization. Finaly, the degree of influence of different factors on villagers' satisfaction with rural community governance informatization varies. In terms of positive correlation effects, the factors affecting satisfaction with rural community governance informatization, from strongest to weakest, are cost-saving governance, facilitation of convenient governance, duration of absence from home due to work, and protection of personal interests. Information security, effective governance improvement, provision of precise services, village collective income level, universal participation, trust in

village officials, marital status, internet penetration, educational level, family member count, etc., follow in descending order of impact. Concerning negative correlation effects, the factors affecting satisfaction with rural community governance informatization, from strongest to weakest, are primary family occupation, presence of family members residing in the village year-round, level of technology awareness, and villagers' autonomy.

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Online Educational Countermeasures For Bridging The Digital Divide Based On The Post-Pandemic Period

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Abstract

This paper explores responses to online education during and after the COVID-19 epidemic to bridge the digital divide in education. The paper first examines the context of online education in the case of the current epidemic, including the challenges and opportunities for online education and the impact of the epidemic on the education system. It then analyzes various countermeasures to these challenges and analyzes their feasibility. In the face of the current situation of epidemic prevention and control, many schools have adopted online education measures to reduce the risk of virus transmission. However, this new form of education also brings some challenges. China faces the task of reforming education and skills development to provide the talent needed for an innovative, digitized, post-industrial economy. However, regional inequalities in academic achievement persist, and gaps in the quality of teaching and learning are an existing problem. In order to improve the efficiency and effectiveness of online education, this paper adopts the method of questionnaire survey. Through survey analysis, some potential countermeasures can be taken, including strengthening teachers' guidance and support, improving technical and equipment support for online education, adopting a combination of offline and online methods thus increasing its effectiveness, reducing negative impacts on students, and narrowing the problem of educational imbalance between urban and rural areas. Finally, the paper focus on the future of online education, exploring the possibilities of online education and educational technology and possible responses on how to utilize educational technology to narrow the digital divide and help rural areas gain more opportunities to transition into the upper class. While traditional learning methods will be gradually restored due to the aftermath of the epidemic, the study emphasizes the importance of new learning methods for everyone, not just those with access to digital technology.

KEYWORDS: Online Education, Questionnaires, Educational Countermeasure, Education Platforms, Educational imbalance

1 Introduction

In recent years, with the development of network information technology and the spread of the concept of "Internet + education", the development of network education has shown a booming trend. With the increasing popularity and use of mobile media devices such as laptops, tablet computers and cell phones, people are more and more inclined to choose more convenient and diversified learning media for learning, and the traditional concept of learning is also changing [1]. Especially in the first half of 2020, the new coronavirus epidemic raged,

the central government issued a "stop-school order", online education in full swing throughout the country [2]. From the city to the countryside, from elementary school to university, online education because it is not limited by time and space, not subject to external interference and other advantages, has become the preferred way of learning courses during the quarantine of the spread of the new coronavirus online education temporarily replaced the traditional form of offline teaching, become the main place of basic education and higher education. Elementary school subjects became the focus of online education during the epidemic because of their fundamental role [3]. The Internet promoted the development of online basic education, and many learning media relying on Internet technology appeared, such as online basic learning platforms and learning WeChat public stations. During this period, online education has given full play to its advantages while guaranteeing students' subject learning, but it has also exposed many problems, and the development of information technology is uneven among different geographical areas or categories of people, which has led to a series of economic and social problems and the formation of a new social division - the Digital Divide, which has led to the emergence of a series of social and economic problems. The impact of the digital divide in education on the equity and quality of education is attracting increasing attention. 2011, the World Economic Cooperation Organization (OECD) stated that "access to the Internet not only significantly increases the quantity of educational resources available to students, but also improves the quality of existing educational resources, and in today's society that emphasizes the knowledge economy, it is important to develop students' access to the Internet and to the Internet". In today's society, which emphasizes the knowledge economy, it is very important to develop students' Internet search and application skills." [3] Scholars in China have also pointed out that "the digital divide is not only an imbalance in society, but also a social problem of educational inequality, and the emergence of the 'digital divide' and the 'knowledge divide' in education will further aggravate the current inequality in basic education in China. The emergence of the 'digital divide' and 'knowledge gap' in education will further aggravate the current unbalanced state of basic education in China. [4] In China, the digital divide in the field of education is especially reflected in the differences between education in urban and rural areas, as the problem of uneven levels of education development due to uneven levels of scientific and technological development and varying socio-economic levels has always existed. Educational resources in rural areas of China are relatively scarce compared with those in urban areas, including teaching equipment, teaching materials, and educational funding, which has led to a generally lower quality of education in rural areas. How to utilize online educational resources and technologies to promote education in rural areas and narrow the digital divide in education has become an urgent problem.

2 Literature Review

Online education can also be understood as distance online education, which is a form of education that uses mobile devices and other communication media to implement teaching and learning activities via the Internet. Online education is not simply the use of technology to transplant traditional education forms onto an online education platform. It is a form of education that pays more attention to students' individual experiences and personalized needs, and is a more extended and expanded learning and teaching method than traditional

education [5]. Online education is an imaginative form of education that has more flexibility and potential than traditional education, breaking the time and space limitations of traditional education and making full use of technological possibilities.

As of December 2022, journals and five master's and doctoral dissertations were searched on China Knowledge Network using the keyword "online primary education", and the current situation and development trend of online education, the integration of modern information technology and elementary school curriculum [5], the relationship between online education and offline education, the study of teaching reading, writing and oral communication in online elementary school curriculum, and the application of online education were reviewed. The research work is carried out in the following aspects.

According to the relevant literature, some researchers have studied the current situation and development trend of online education, pointed out the problems of online education and its negative impact on education, and proposed some improvement measures [6]. Some articles analyzed the uneven development of online education from the perspective of online education development, explored the reasons for the imbalanced development of online education, and pointed out the corresponding countermeasures to solve the problem of uneven development of online education [7]. One paper analyzed the background of the era of "Internet+", explored its impact on elementary school teaching, and elaborated on the development trend [8]. Lu Feng's article first summarized and described the development process, current situation, development focus, and industry scale of online education at domestic and abroad. In the article, the problems that emerged in domestic online education for primary and secondary schools were summarized and the development trend of online education was predicted [9]. The researchers consistently affirm the development prospect of online education and believe that there are many problems in the development process, which need to be further explored in various aspects to find solutions.

Studies that explore issues related to the integration of modern information technology and courses include, how to solve the problems of the information-based classroom and the problems of existing blended teaching, and provide guidance for teachers in blended teaching [10]. How to promote the reform of teaching quality in the classroom. It can be solved by innovative teaching models, scientific design paths, innovative construction of Internet teaching platforms, scientific excavation of Internet teaching resources, and promotion of Internet teaching technology [11]. She proposed to promote the continuous improvement of the quality of classroom teaching reform through innovative teaching models, scientific design of pathways, innovative construction of Internet teaching platforms, scientific mining of Internet teaching resources, and promotion of Internet teaching technologies. [12] first defined the concept of education informatization, analyses the current situation and principles of language micro-course teaching design in the context of education informatization, and studies the application of language micro-course in the context of education informatization. The connotation of educational technology and modern educational technology were first started by [13] exploring the nature of language courses, and putting forward the methods of modern educational technology and teaching use. The current situation of the use of modern information technology in teaching was searched by [14] and he analyzed the fit between modern information technology and language teaching. Some researchists argued that modern information technology provides a good learning environment for primary school

teaching, which enables students' subjectivity to be truly established, independent learning, exploratory learning, and cooperative learning to be truly realized making lifelong education and socialization of learning possible, greatly stimulates students' motivation to learn, and cultivates the spirit of innovation and practical ability [15].

Spurred by blockades during the new coronavirus pandemic, China's Ed tech market has grown from $22 billion in 2018 to$ 48 billion in 2020, a 118% increase. The China Internet Development Statistics Report states that the number of online education users in China reached 423 million by March 2020, an 82.3% increase from June 2019. With over 400 million students, China is the largest EdTech market in the world [23]. The significant expansion and potential of China's EdTech market is demonstrated by the significant surge in online education users during the pandemic.

According to a recent report, "China K12 Online Education Market 2022-2026," the online education market in China is expected to grow by $18.93 billion (129 billion) during the period 2022-2026, advancing at a compound annual growth rate (CAGR) of 15.45% per year [22]. One of the major factors driving the growth of the K12 online education market in China is the increased demand for online education due to the explosion of COVID19. This study identifies this factor as a key driver of market growth in the coming years. According to Statista's report, about 111 investment events occurred in China's online education industry in 2020, with a total deal value of 53.93 billion yuan ($7.9 trillion). Several sizable online education companies, such as Yuanfuduo or Zongyibang, have capitalized on the boom in online education caused by the COVID19 pandemic to raise new funds [20]. The demand for offline educational technology in rural China is well documented.

The urban-rural education gap in China can be attributed to a number of factors, including the unequal distribution of educational resources, the lack of qualified teachers in rural areas, and limited access to modern technology and digital resources [16]. In addition, the requirement that families pay for their children's education beyond the ninth grade also contributes to the urban-rural education gap in China. The Chinese government has implemented a nine-year compulsory education policy, which allows Chinese children to attend school free of charge from first to ninth grade. However, after completing elementary school, poor children are at a much higher risk of dropping out than their urban counterparts. Income levels in rural areas are three times less than in urban areas [17]. However, residents of both areas bear the cost of tuition, books, and other educational expenses. High school becomes a financial responsibility for families, but by the time it reaches this level, 60% of rural students have already dropped out of school due to the cost. According to Radley Tan, "Under China's current education system, it is difficult for rural children to finance and pursue higher learning [18]. As a result, the rich remain rich and the poor remain poor, perpetuating intergenerational poverty. China's urban-rural education gap remains challenging and must change. As education in China improves, poverty will decrease, and millions of children can hope for a brighter future" [19].

3 Methods

In order to ensure the scientific nature of the paper, research methods such as the literature research method, questionnaire survey method, and data analysis method will be used to

explore the relevant issues in the research process of this paper. Literature research method: pay attention to the development of online education through various ways (books, literature, conferences, newspapers, internet, research, etc.); keep up to date with the research results of online education; carefully study the theories related to the research, widely understand the research dynamics of others, initially establish their own research ideas, and prepare for in-depth research. Questionnaire survey method: In December 2022, the author conducted a questionnaire survey on the current situation of online education in three schools of different levels: elementary, middle, and high schools in Wuxi City, Jiangsu Province. The questionnaire survey data of students' online learning and teachers' online teaching were analysed and evaluated to provide data support for online education research. Data analysis method: By collecting and organizing a amount of questionnaires and website relevant research data, the author can examine and analyse the shortcomings and deficiencies of online education in user experience, the impact of Internet popularity in urban and rural areas on online education and so on and then can further consider about the connection between online education and offline traditional education, then discover the similarities and differences, and conclude the development direction of online education.

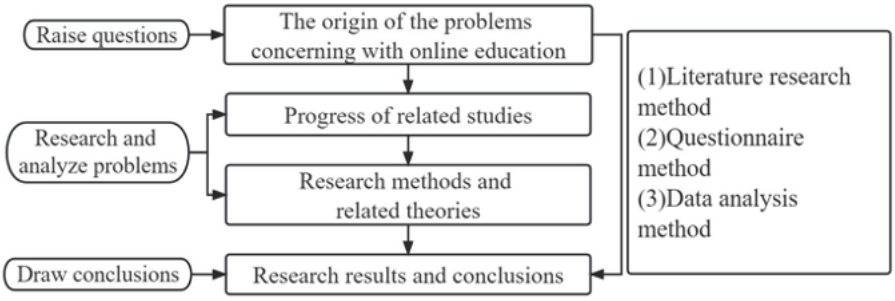

Figure 1: *The basic process of the research*

4 Results and Discussion

Data collection is the basis for analyzing online education platforms at this stage. It provides the information necessary to make informed decisions and evaluate the effectiveness of the platform. Data is collected to gain a deeper understanding of the needs, preferences and behaviors of the target users, as well as to understand the strengths and weaknesses of the online education platforms operating in the market at this stage, in order to create more accessible and effective edtech solutions.

Teacher questionnaires and analysis

In the context of the national fight against the novel coronavirus pneumonia epidemic, a variety of online teaching is being carried out in schools and universities across the country. Online teaching is a form of distance learning, which is the separation of teachers and students in time and space, and is a media-based education and teaching practice. However, for many teachers, online teaching is a try, and they face a lot of challenges. What is the current status of online teaching in such large-scale online teaching activities? What are the difficulties and

challenges encountered? In the face of the new situation of large-scale online teaching, a study was conducted to investigate the current situation of online teaching among elementary school teachers in Wuxi.

The questionnaires were administered to teachers in 50 elementary schools in Wuxi, Jiangsu Province in November 2022, so the data obtained were more representative. A total of 1200 questionnaires were distributed, and 960 questionnaires were returned, of which 900 were valid (all multiple-choice questions were answered, and no-nonsense answers were given) and 60 were invalid (no answers or nonsense answers), with a valid questionnaire rate of 93.8

As shown in the table above (Table 1), most of the teachers who participated in this survey had 6-10 years of teaching experience, among which 180 teachers had less than 5 years of teaching experience, accounting for only 20% of the total number of respondents; 400 teachers had 6-10 years of teaching experience, accounting for 44% of the total number; and 300 teachers had more than 11 years of teaching experience, accounting for 34% of the total number. In terms of teachers' knowledge of and exposure to online education platforms, 84% of the teachers had some experience in online teaching, while 16% had no prior experience in online teaching at all. Overall, the development of online teaching needs to be continuously promoted and penetrated.

Regarding the types of online education platforms teachers tend to use, 92% of teachers are familiar with social platforms such as WeChat; only 2% of teachers are proficient in recorded class platforms such as Mooc and StudyTalk; 96% of teachers are proficient in live platforms such as DingDing and Tencent Classroom; and only 1% of teachers are proficient in eBookbag. It can be seen that most teachers are only familiar with social platforms such as WeChat QQ and live class platforms, and know very little about recorded class platforms. This indicates that most of the online lectures are now conducted on WeChat and live platforms, and live lectures are more popular and accepted by teachers than recorded lectures.

Regarding the main difficulties and challenges teachers focused on in online education, it was found that 77% of teachers said it was the platform lag, which seriously affected the progress and consistency of education and teaching; 55% of teachers said staring at the electronic screen for a long time, their eyes were easily fatigued and they were more tired than teaching in the classroom; 54% of teachers said online classroom participation was low and they could not grasp students' learning at the first time; 47% of teachers said there is less feedback in the classroom and they cannot interact with students face-to-face instantly. Several teachers (21%) also said that they were not proficient in platform operation and often wasted time in finding platform functions, etc. It can be found that although online teaching has the advantages of convenience and abundant resources, there are still many problems in the specific teaching implementation process, such as teachers not familiar with the operation of the online platform, does not have the hardware conditions to meet it, and do not know how to properly integrate and use online teaching resources. Therefore, despite the advantages of online education in improving students' knowledge, the effect is not obvious.

Based on the survey and analysis, the following suggestions are made.

First, regarding the problems of platform lag and network congestion in online teaching, on the one hand, schools should continue to cooperate deeply with online education platform parties such as Tencent Conference and DingDing, which have the support of top domestic Internet companies like Tencent behind these mainstream education platforms. When the

Table 1: *Current Status Of Teachers' Use Of Online Education Platforms*

Question			**Options and proportion**		
How long have you been teaching?					
0-5 years 20%		6-10 years 44%		11 years or more 34%	
Have you ever used an online teaching platform?					
Never used 20%		Has been in use for some time 80%		Always in use 4%	
Which online Chinese teaching platforms are you familiar with? (Multiple choice).					
WeChat, QQ, and other social platforms 92%	Recorded class platforms, such as Mooc, StudyTalk, etc. 2%		Live class platforms such as DingDing and Tencent Classroom 96%	E-book bag 1%	
What is your preferred method of interacting with students online? (Multiple choice)					
Asking questions in class 80%	Discussion 68%	Assigning after-class homework 91%	Brainstorming 5%	WeChat, QQ, and other social platforms 44%	Live platforms with the voice function 53%
What problems or obstacles do you encounter when you teach Chinese online? (Multiple Choice)					
Platform lag 77%	Unfamiliar with platform operation 21%	Low sense of involvement 54%	Less feedback 47%	Eyes tired 55%	Other 10%

amount of platform users reach a certain number, the platform will also definitely cooperate with schools to further improve education and teaching curriculum resources and pay more attention to the experience of the user community. Schools can negotiate with the platform to deploy relevant technical staff to provide "on-site" services to solve problems encountered by teachers and students in the teaching and learning process at any time.

Second, focus on online teaching design. Online teaching is not simply a copy of the traditional face-to-face teaching model onto the Internet. Online teaching separates teachers and students in time and space, and teachers' real-time supervision and mandatory binding of students will be weakened. Teachers need to make students learn actively through effective design of learning activities to increase their participation.

Third, share the experience of online teaching and promote the efficient development of online teaching. The teaching supervisors of the university and the teaching managers of the faculty should consciously summarize the successful experiences and typical cases of teachers in the practice of online teaching, select those teachers who have good, basic, and experienced development of online teaching, and give support from policies and funds.

Fourth, to strengthen the guidance and support for teachers in information technology. Through the survey, most teachers basically have no experience in online teaching before this large-scale online teaching. The direct conversion from traditional face-to-face teaching to online teaching format will definitely devote more time and effort than traditional teaching. Today's society has gradually progressed towards informatization and digitalization, and the ability to handle information technology and adapt to digital transformation will be increasingly important in the future teaching life. Therefore, in order to better adapt to future educational and teaching activities, schools and society should strengthen the capacity of teachers in the future to handle information technology and digital teaching.

A total of 1200 students were surveyed and 1036 questionnaires were returned, of which 990 were valid (all multiple choice questions were answered and there were no random answers), with an effective rate of 95.6

The table above (Table 2) shows that 81% of the students were in the low to the middle-age group, as the author's study focused on the younger, less self-controlled group of learners. 74% of the students prefer to use their cell phones to listen to lessons. Cell phones are more popular and lightweight than computers or tablets, making them portable. Students have limited time to use electronic devices, and most of them tend to use electronic devices for chatting and browsing the web. Although the data shows that 46% of students use electronic devices for studying, the true situation should be less than the figure of 46% because the question is multiple choice and some children will consider using cell phones to find homework answers occasionally as using cell phones for studying, so most children still prefer to use electronic devices for pleasure. The fact that 91% of students prefer the live class format shows that the live education format is absolutely dominant. The reasons for preferring live classes can be broadly categorized as students think they are more interactive, more interesting, and can improve their focus on learning. In terms of feedback questions, 77% of students chose to communicate with pop-ups, only 33% chose to connect teachers with a microphone, and 13% chose to make a phone call. This shows that most students have the desire to express their ideas and want to be noticed by their teachers and classmates, but they are too shy to use the mic or voice function to communicate with their teachers directly on the platform, and they

Table 2: *Current Status Of Students' Use Of Online Education Platforms*

Question	**Options and proportion**			
Current academic section				
Primary School 30%	Junior High School 51%	High School 29%		
What is your preferred electronic device to use when using an online education platform? (Multiple options)				
Cell phone 74%	Computer 19%	Tablet 26%	TV 5%	Other 1%
Which online class form do you prefer?				
Live Classes 91%	Recorded Classes 9%			
How do you give feedback to your teacher about the problems? (Multiple options)				
Pop-up screen 77%	Connected microphone 33%	Make a phone call 13%	Send private messages to the teacher %	Other 5%

are afraid of making a fool of themselves in front of their classmates by communicating on the public platform or answering the wrong questions, so pop-up interaction has become the primary feedback method for most students.

However, the above data also reveals some problems with online teaching. According to a study, when children watch electronic devices for 20 minutes continuously, the degree of damage to students' eyesight is projection < TV < tablet < cell phone, and cell phones are the most harmful to the eyesight of teenagers. Therefore, in the face of online teaching, the author recommends the use of projection equipment for online learning, projecting images onto a white wall or curtain for learning, and many cell phones or platforms now have the function of projection. 70% to 80% of students like to use pop-ups to answer questions. In live classes, we often find that sometimes before the teacher starts to ask formal questions, students who are quick to react or like to express themselves will immediately post their answers in the pop-up area, affecting other students who are thinking, and a small number of students will even copy and paste directly on the pop-ups, which does not reflect the results of their independent thinking. Therefore, the platform can set a button in the teacher's pop-up section that can control the appearance of pop-ups at the student's end and control the time of students sending messages in real-time.

The table (Table III) shows that 75% of students prefer offline classes because they are more comfortable with the school classroom teaching style, 46% of students like the feeling of real-time interactive communication, and 43% of students like the rich campus activities offline. From the data, the main factor for students to prefer traditional school classrooms is that they are used to the long-term traditional offline teaching mode, and it is difficult to adapt to the online teaching mode for a while. Students pay more attention to the learning atmosphere and experience, but the online learning format is rather homogeneous and lacks interactivity. The limited learning space does not allow for many extracurricular activities.

Table 3: *Students' Adaptation To Online Teaching*

<table>
<tr><th colspan="2">Question</th><th colspan="2">Options and proportion</th></tr>
<tr><td colspan="4">Which do you prefer, the online classroom or the school classroom?</td></tr>
<tr><td>Online Class
38%</td><td>School Class
51%</td><td colspan="2">All the same
11%</td></tr>
<tr><td>More adapted to the teaching style of school classroom
75%</td><td>Abundant campus activities
43%</td><td>Real classroom, more situational
36%</td><td>Real-time communication and interaction
46%</td></tr>
</table>

Therefore, if the country wants to promote online education in the future, it must develop a teaching model that can adapt to the online teaching system, rather than rigidly applying the traditional offline education model.

Survey on Internet penetration in rural and urban areas

The following graph (Figure 2) represents the proportion of internet users in China based on their residence status, either urban or rural. The data was collected from 2012 to June 2022 and illustrates both regions' internet access and usage trends. As of June 2022, approximately 27.9 percent of China's internet users reside in rural areas. This information highlights the significance of exploring the digital divide in China and considering the impact of such disparities on access to EdTech solutions. Furthermore, it can contribute to the discussions around bridging the gap in access to technology and promoting digital literacy, particularly in rural communities in China [20].

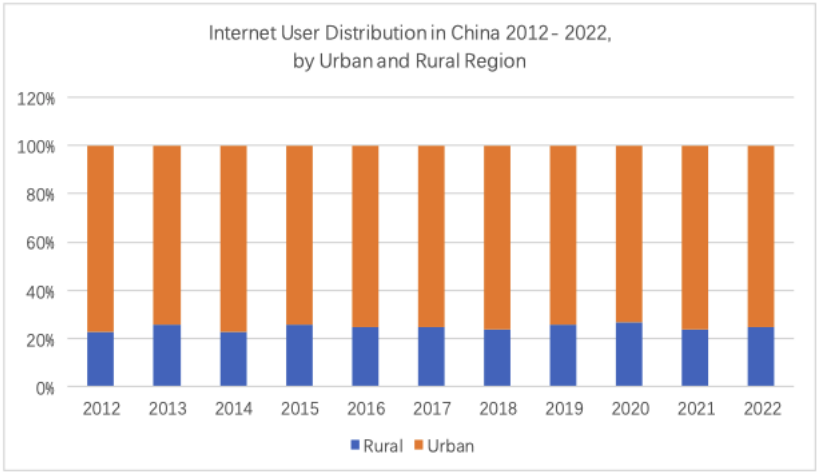

Figure 2: *Internet User Distribution in China 2012- 2022, by Urban and Rural Region (Source: Statista)*

Over the past several years, advancements in internet infrastructure in rural areas of China have been observed. As of June 2022, the internet penetration rate in rural regions (Figure 3) had risen to 58.8 percent, though it remained lower than the national level. The internet coverage in urban areas, on the other hand, was reported to be 82.9 percent. Despite efforts to make internet services more accessible and affordable for those residing in villages and small

towns, less than half of the 493 million rural Chinese had access to the internet in 2021 [21].

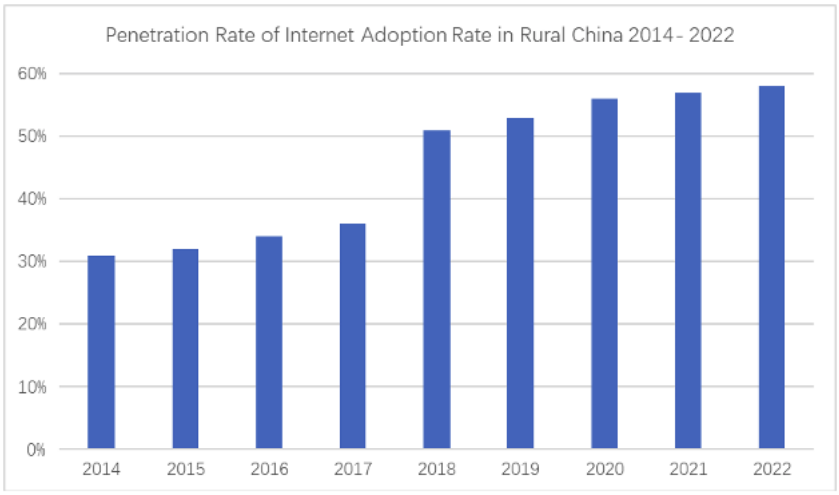

Figure 3: *Penetration Rate of Internet Adoption Rate in Rural China 2014- 2022*

It can be seen from the teacher questionnaire survey data, the network environment lag caused by the online education effect and poor experience is the most frequent, the network environment in the city is better than the rural areas but still frequent network lag problem. And as the above data shows, the network penetration rate in rural areas is far less than that in urban areas. Moreover, it can be seen from the data of student questionnaire that most students prefer offline learning, so this paper proposes an offline learning program in distance education.

Offline learning is a kind of learning method to solve the problems of learners being unable to study normally due to limited network broadband or the bottleneck of network broadband and slow access speed of courseware when a large number of learners visit the environment with insufficient network communication resources. Anywhere, Anytime, Any device) learning. Offline learning must rely on an offline learning system and exchange data with the online learning system based on a data storage like a USB flash drive or CD-ROM, which is called a "U-Key" here. The offline learning system mainly consists of learning management system and content management system. The basic process of offline learning is as follows:1. Learners log in the offline learning system; 2. Download the course content to be learned and the online learning process records from the main server to the local area, or load the offline learning records to the offline learning system through the U-Key; 3. Conduct the offline learning, and the offline system records the learning records of the learners; The offline system records the learner's learning records; 4The offline learning tracking information is uploaded to the main server. As shown in the figure (Figure 4):

The offline learning system is compatible with the online learning system, ensuring the consistency of the final learning data of the learners regardless of which mode they choose, online or offline. The offline system can download courseware to the local area for learning, and the system automatically records the learner's learning tracking information, which can be uploaded to the corresponding e-learning system, thus realizing the consistency of the information between offline learning and online learning. The offline learning system

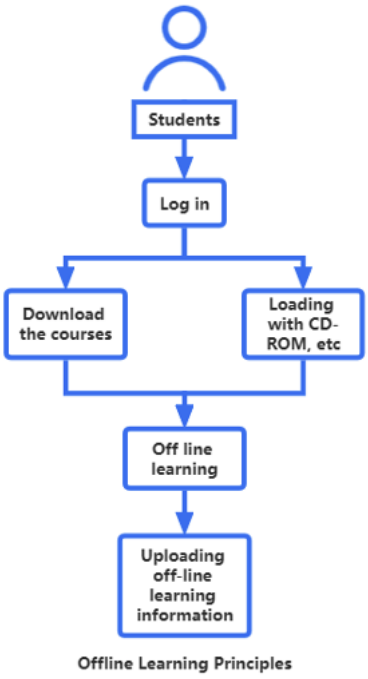

Figure 4: *The Principles Of Offline Learning*

must ensure the security of the learners' learning data, so the system needs to adopt certain encryption methods, and when the learners download the courseware, they need to pass the relevant authentication before they can study. Meanwhile, the courseware of offline learning can be downloaded once and used many times, which saves broadband and greatly reduces the pressure on the server.

Online learning and offline learning are two complementary learning modes. In the process of online course construction, choosing appropriate learning modes has a guiding effect on learners' learning behaviors and effects. In online courses, offline learning mode is a powerful complement to online learning, and this complementary process is shown in the following figure (Figure 5):

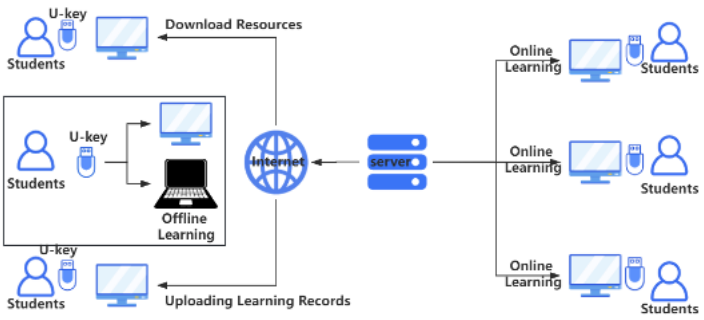

Figure 5: *The Program Design For The Integration Of Online And Offline Learning*

5 Conclusion

The epidemic has brought great challenges to the development of online education, and at the same time, it has also brought great opportunities for the development of online education. It actively explores new teaching methods such as blended teaching, online and offline combined teaching mode system to further promote the development of online education. On the other hand, studying the advantages and disadvantages of online education in the age of information technology will help teachers to recognize, understand and utilize the advantages of online education in the process of online teaching and avoid its disadvantages. Therefore, the research of this selected topic will provide a summary of experience for the development of online education, promote the mutual integration of online education resources and teaching, and provide some ideas for the development of online education business. In the post-NCRP era, online education has a bright future and plays an important supplementary and complementary role to offline education. How to promote the integration of online and offline education, improve the efficiency of online teaching and learning, as well as how to utilize technology to make up for some of the shortcomings of existing online education platforms and narrow the digital divide in various regions will be the direction of development of the future research, which will continue to be paid attention to and studied in depth.

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Research on the Application of Blockchain Technology in Personal Information Protection

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Abstract

The use of asymmetric encryption technology and the ability to track and record violations ensure a high level of trust. This has led to new methods for protecting the personal information of netizens. Currently, blockchain technology is widely used in fields such as digital finance, the Internet of Things, copyright, and medical services. In comparison to prior procedures for protecting personal information security on the internet, Blockchain technology not just minimizes the likelihood of personal data leaking, additionally offers fresh and dependable technical assistance. And applicable to current Internet governance. This article analyzes WeChat users' awareness and understanding of blockchain technology, to understand their level of understanding of the potential application of blockchain technology in personal information protection, as well as their views on the feasibility and credibility of the technology. This includes an evaluation of the security, privacy protection ability, availability, and other aspects of the solution to understand the user's recognition and acceptance of the solution. Research has found that Tenpay collects WeChat payment record information, payment function collects bank card-related information, user age, and collects voice to text conversion information but does not save it, which has the strongest impact on WeChat user satisfaction with personal information protection. The verification of WeChat user satisfaction can better confirm the advantages of blockchain applications in personal information protection. The usage of blockchain increases the security of WeChat user information identification and storage, as well as the satisfaction of WeChat user personal information. The use of blockchain technology to protect personal information has promising prospects.

KEYWORDS: Blockchain, Personal information; Application, Satisfaction, WeChat users

1 Introduction

Since its inception, blockchain technology has become a research hotspot in academia and industry due to its characteristics of decentralization, traceability, and invariance. The most prominent feature of blockchain technology is that it achieves "decentralized" trust through features such as high transparency, immutability, and distributed fault tolerance. [1] On the one hand, it designs an information protection mode different from centralized technology through asymmetric encryption/disclosure and distributed storage. [2] This allows users to directly trade without being controlled by central nodes, and gives them control over whom to disclose what information to. [3] It not only protects privacy but also prevents identity theft. [4] It can even help create, manage, and use "user identities". [5] On the other hand, blockchain is different from centralized technology, which is based on trust and transparency.

The rise of blockchain technology provides potential solutions to address these privacy and security issues on WeChat and other platforms. Blockchain is a decentralized, encrypted, and tamper resistant digital ledger that can store and validate transactions or data without the need for intermediaries or central institutions. By using blockchain, WeChat can strengthen its personal information protection, identity authentication, and data sharing mechanisms, while improving user transparency and trust. WeChat users have weak awareness of personal information protection. [6] From a user perspective, WeChat users mainly use WeChat for daily activities such as socializing and WeChat payments, with a high usage rate. WeChat has a large user base and a wide age distribution of users. Most users are not familiar with the personal information protection services provided by WeChat, nor are they aware of the situations that may lead to information leakage. For example, young people have weak awareness of personal information protection and are more willing to try novel online products, which unintentionally pose security risks; For middle-aged and elderly users, they cannot quickly adapt to the challenges brought by the information age. If they are not clear about the specific measures to protect personal information, they will unintentionally disclose personal information during use; For underage users, they should receive more protection from society. Most underage users are in high school or below and have not yet entered society. Their personal information protection awareness is weak and they need external assistance to protect their personal information. Therefore, it is crucial to obtain the satisfaction of WeChat users with WeChat personal information protection services and apply them to improve WeChat services, providing more attractive and high-quality services to improve user satisfaction, in order to better utilize blockchain technology to protect personal information.

Therefore, this study aims to investigate the user satisfaction of WeChat personal information protection systems and explore the potential impact of integrating blockchain technology into them. Specifically, we will study users' perceptions, attitudes, and behaviors towards WeChat data privacy and security, as well as their understanding and acceptance of blockchain technology, in order to better implement the application of blockchain technology in personal information protection.

2 Literature Review

The advancement of internet technology, while providing convenience to people's lives, also offers a possible threat to the leaking and exploitation of user personal information. Due to the immutability of blockchain technology, asymmetric encryption technology during use, and the ability to trace and capture infringement records, it has a high degree of trust endorsement, bringing new ways of protecting personal information. At present, blockchain technology has been widely applied in fields such as digital finance, the Internet of Things, intellectual property, medical services, etc. [7]. Blockchain technology, when compared to prior Internet personal information security protection measures, not only minimizes the risk of personal disclosure, but also provides fresh, dependable, and practical technical assistance for Internet security administration.

At present, the academic and industrial communities have high expectations for the development prospects of blockchain technology in personal information protection. [8] Scholar Zhang Qian analyzed and pointed out in the article "Exploration of Building a

Blockchain Credit Management Platform for University Student Archives" that the application of blockchain technology in university student archives can prevent the leakage of student archive information, ensure the authenticity of academic information, and provide convenient and reliable information authentication services for students. [9] Professor Wang Zhicheng believes in his article "Analysis of the Blockchain Model of the Personal Credit System Alliance in the Internet Era" that blockchain technology can help establish an Internet credit system and achieve effective and rapid analysis and application of credit data. In the industry, JD Global Purchasing utilizes blockchain technology to record the information of products from production, transaction, and distribution, ensuring the authenticity and reliability of product information. At the same time, it also provides a security umbrella for users' personal logistics information. People's Daily, Weibo, and other media have also introduced blockchain technology to protect authors' copyright information.

With the rise of Bitcoin, blockchain technology, as its core support, has focused on domestic and international attention. According to Luhang's research on blockchain-based application system development methodologies, blockchain technology can be implemented in industries requiring fairness, impartiality, and honesty [10]. Wei explained in "Blockchain Technology in the Energy Internet: Research Framework and Typical Application Exploration" that based on blockchain technology, there is academic research aimed at the decentralization of the issue of disclosing a large amount of personal privacy when intermediaries collect user data [11]. Li Hui and Yuan Yuming envisaged six blockchain technology application scenarios in "The Current Situation and Expectations of Blockchain Technology Development": Data storage, data authentication, financial transactions, asset management, and electoral voting are all examples of digital money [12]. In "Principles and Fundamental Technologies of Blockchain," Cai Xiaoqing addresses blockchain from several perspectives, analyzing the applicability and fundamental features of blockchain technology in daily life, in addition to the obstacles faced by blockchain and its future possibilities [13]. Tuo Xiaozhong designed an encrypted information backup system based on blockchain technology in his research and design of a blockchain-based encrypted information backup system. [14] He Yanyue et al. discussed the issues and challenges faced by personal privacy in the big data era by introducing the basic concept of personal privacy in the "Consumer Personal Information Protection in the Big Data Era - Taking the Privacy Terms of Online Shopping Applications as an Example", and outlined personal information privacy protection technologies [15]. Liu's [16] research focuses on strategies for protecting the personal information of social media users. The research method was not explicitly mentioned, and the main focus of the study was to explore strategies and measures for protecting the personal information of social media users. The research conclusion emphasizes the personal information protection strategies that users should adopt when using social media. The study by Yi [17] The civil law protection of personal information in the age of social media was examined. The research approach is a review and analysis of the literature. The study focuses on the current state of affairs and existing issues of civil law protection of personal information in the age of social media. According to the study's findings, there remain some issues with personal information protection in China in the age of social media, and appropriate legislative and regulatory safeguards must be tightened.

According to literature review research, current research focuses on the following issues: how to manage personal data based on blockchain, Health personal information management,

personal information transaction management, personal information protection solutions, etc. Research on WeChat User Satisfaction The protection of personal information has not received sufficient attention, and WeChat is one of the largest social platforms in China. It has a large user base and a large amount of personal data, however, due to frequent incidents of data leakage and abuse, The awareness of protecting users' personal information and privacy rights is therefore increasing. Research on WeChat user satisfaction. This is particularly important for protecting personal information.

3 Methodology

WeChat is a popular communication platform with up to 1.2 billion monthly active users in China and globally. However, despite the convenience and user-friendliness of the platform, the protection of user personal data and privacy security have always been prominent issues. Due to the strict internet regulation, censorship, and filtering system of the People's Republic of China's government, the protection mechanism for data privacy and security on WeChat is particularly fragile. Therefore, the emergence of blockchain technology worldwide provides potential solutions for WeChat to address data privacy and security issues, as this technology can enhance the protection mechanism, authentication, and data sharing mechanism of user personal data, while promoting transparency and trust between users. The objectives of this study are:

Objective 1: What is the usage situation of WeChat users after applying blockchain technology to protect personal information?

Objective 2: Analyze the impact of blockchain technology on the protection of personal information of WeChat users;

Objective 3: Determine the satisfaction level of WeChat user personal information protection based on blockchain technology.

This article will use a hybrid method of quantitative and qualitative data to comprehensively understand WeChat users' attitudes, trust, and behavior towards data privacy and security. We will conduct a series of questionnaires, interviews, and adopt various methods to analyze the results. Through questionnaire stars and interviews, we have collected quantitative data from participants using WeChat to gain a more comprehensive understanding and insight into the problem. This study aims to investigate WeChat customer satisfaction with personal information protection using blockchain technology, acquire a deeper understanding of their requirements and desires for personal information protection, analyze the benefits and drawbacks of personal information protection solutions based on blockchain technology, and offer both theoretical and practical support for further improving WeChat users' satisfaction with personal data security. Based on the research results and analysis of WeChat users' satisfaction with personal information protection, this study will propose relevant suggestions and measures to improve WeChat users' satisfaction with personal information protection. These suggestions may include improvements at the technical level, formulation of policies and regulations, user education and awareness cultivation, etc., to promote the further development and improvement of personal information protection work.

3.1 The Application of Blockchain in Information Protection

To alter the approaches and methods of personal information protection, use the characteristics of blockchain technology and the needs of personal information protection. Investigate and deploy blockchain technology to block data, decentralize structure, level data, and handle contracts that are smart. Establish a three-dimensional and full lifecycle protection model, as well as a new management mechanism for de-trust, to address information protection needs such as preventing information leakage, tampering, and evidence tracing. Make WeChat usage safer to increase the usage and satisfaction of WeChat users. Prove the advantages and feasibility of blockchain in personal information protection.

(1) Information Blockization

Divide information into data blocks, each holding only a piece of the total information, and employ hash function asymmetric encryption to protect it. Use chain structure and Byzantine, MerK Tree, etc. to ensure data integrity and consistency. Blockchain time truncation and other data tracing are more convenient. Even under attack, a data block is difficult to break through, let alone a data blockchain, and it is also difficult to obtain complete data from a data block. Intelligent technologies, including big data, additionally render it difficult to intelligently deduce information, hence improving information security. Blockchain. Blockchain adds a technological divide to information protection, providing an additional guarantee for information.

(2) Decentralization of information

Blockchain technology is also distributed, but its structure is weakly centralized or decentralized. The characteristic of decentralization is that the information flow between nodes can be unrestricted to the central point and does not rely on third parties. The distributed nodes of blockchain form P2P networks, verification mechanisms, and dissemination mechanisms through public account books, consensus mechanisms, and allocation mechanisms. Under the premise of security, reliability, and consistency among various nodes, point-to-point data collection, verification, storage, propagation, and management are carried out to avoid the high cost, high risk, and low-efficiency issues of centralization. Decentralization of the structure greatly reduces the risk of overall and massive information leakage, and improves its security.

(3) Hierarchical smart contract protection for information

The blockchain intelligent contract incorporates information and occurrences into the contract. As long as the initial agreement's criteria are met, the smart contract's on-chain code can conduct various operations continually and automatically. For example, in smart homes, after signing an online rental payment for a house, the tenant obtains the identification code of the house's assets and can automatically open the door and use the house's equipment. When the contract expires, the contract value is changed, automatically turning off the house, water, and electricity switches, and checking the equipment. The status value of the asset is updated without the need for on-site confirmation. WeChat mini-programs can be connected with just one click, using smart contracts to customize continuity. Smart contracts automatically execute the business logic and legal rights and obligations of contracts, improve management efficiency, and provide a basis for information protection. The smart contract will automatically adopt different levels of information protection measures based on the applicable authorisation or contract established by the customer.

(4) A three-dimensional protection model for information blockchain

The use of blockchain technology in information security systems offers inherent benefits in terms of architectural layers. Blockchain's seven-layer architecture includes a data layer, network layer, consensus layer, incentive layer, contract layer, and application layer, which may provide complete safeguards for the perception layer, communication layer, and application portion of the information security system. With the big lock of smart contracts, blockchain protection of information is not limited to a certain layer of protection, but rather a three-dimensional protection. Data is protected by blockchain technology throughout its entire lifecycle, from collection, and storage to use. From collection to storage, use, transmission, and deletion, data is protected by blockchain technology throughout its entire lifecycle. Make data protection more secure. The blockchain three-dimensional protection model is shown in Figure 1.

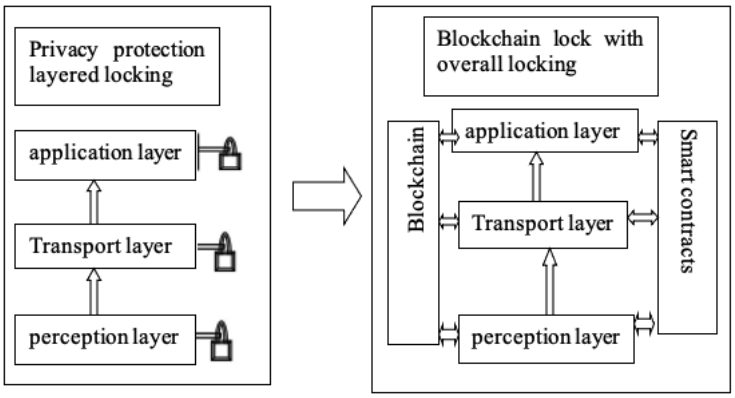

Figure 1: *Blockchain Stereoscopic Protection Model.*

(5) A New Management Mechanism for Information Detrust

Blockchain technology is decentralized, and its application in information protection will inevitably lead to a change in management mechanisms, that is, from centralized management to decentralized or weakly centralized management, greatly reducing the chances of internal personnel such as system is, from centralized management to decentralized or weakly centralized management, greatly reducing the chances of internal personnel such as system At the same time, for any business operation and transaction behavior, blockchain will be recorded in chronological order. Meanwhile, for any blockchain business operation and transaction, Evidence can be traced without the need for third-party supervision, reducing the need for Commercial customers. In management, this is not to strengthen node restrictions. However, the design is to strengthen the incentive mechanism for consensus and management, not to strengthen the constraints on nodes. But to strengthen consensus, stimulate mechanism design, and attract more nodes to participate. While improving the mutual constraint and balance between nodes, it also enhancing the mutual constraint and node balance, it enhances computing and storage capabilities, saving more costs.

Table 1: *Definition, type and value range of each variable*

	Title number	Variable Name	Variable Type
personality characteristics	A1	Villager satisfaction(Y)	Dependent variable
	B2	Gender(X1)	Independent variable
	B3	Age(X2)	Independent variable
	B4	Marital status (X3)	Independent variable
	B5	Education level (X4)	Independent variable
	B6	WeChat usage time (X5)	Independent variable
Acceptance level of personal information leakage	C7	Collect basic user information when registering for WeChat (X6)	Independent variable
	C8	Select whether to provide voice fingerprint information (X7)	Independent variable
	C9	Collect log information such as device model (X8)	Independent variable
	C10	Log in to WeChat (X9) via SMS verification code	Independent variable
	C11	Set your own access rights to your circle of friends (X10)	Independent variable
	C12	Data for uploading friends is stored on the server (X11)	Independent variable
	C13	Login to the applet, APP requires authorization (X12)	Independent variable
	C14	Authorization required to obtain geolocation information (X13)	Independent variable
	C15	"Infrequently used devices" login requires verification information (X14)	Independent variable
	C16	A customizable way for strangers to add friends (X15)	Independent variable
	C17	Collect step information when using WeChat Sports (X16)	Independent variable
	C18	Search information is recorded when using functions such as "Search" (X17)	Independent variable
	C19	The address book function collects encrypted information (X18)	Independent variable
	C20	The payment function collects information about the bank card (X19)	Independent variable
	C21	CaiPay will collect WeChat payment record information (X20)	Independent variable

	Title number	Variable Name	Variable Type
	C21	CaiPay will collect WeChat payment record information (X20)	Independent variable
	C22	Collects voice-to-text conversion information but does not save it (X21)	Independent variable
	C23	You can freeze your own WeChat through your friends (X22)	Independent variable
	C24	Delete all personal information when canceling a WeChat account (X23)	Independent variable
	C25	You can complain when you encounter infringement (X24)	Independent variable
	C26	Use of encryption technology to protect personal information (X25)	Independent variable

3.2 Questionnaire design

Based on research hypotheses, an empirical model of WeChat user satisfaction with personal information protection based on blockchain technology is constructed from two aspects: individual characteristics and acceptance of personal information leakage,

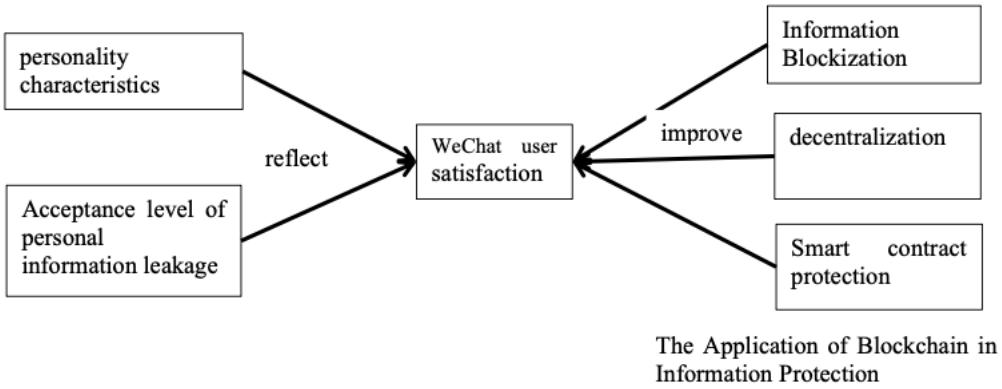

Figure 2: *Empirical model of WeChat users' satisfaction with personal information protection based on blockchain technology.*

Based on surveys and interviews, analyze WeChat users from two aspects: personal characteristics and acceptance of personal information leakage, determine indicator independent variables and dependent variables, clarify the manifestation of WeChat user satisfaction, and analyze how blockchain technology can improve WeChat user satisfaction. By applying blockchain technology to personal information protection to improve WeChat user satisfaction, the characteristics of blockchain technology and the needs of WeChat users for personal information protection are utilized to transform the ways and methods of personal information protection. Applying blockchain technology to block information data, decentralize structure, level information, and manage smart contracts, establishing a three-dimensional and full lifecycle protection model, as well as a new management mechanism for de trust, to address

information protection needs such as preventing information leakage, tampering, and evidence tracing. By analyzing the personal characteristics and acceptance level of personal information leakage of WeChat users, we can better improve WeChat user satisfaction.

4 Data Collection and Results

Distribute the designed questionnaire online and offline, and use SPSS statistical software for statistical analysis. According to the statistical results of the survey data (with a valid questionnaire of 150 WeChat users participating in the survey and interviews), the sample sampling method is random sampling. Due to the survey group being WeChat users, most of the questionnaires were distributed through WeChat in the form of questionnaire stars, while a small portion were distributed in the form of paper questionnaires in the neighborhood. In order to avoid consistency in certain attributes brought about by social circles, such as education, academic background, living environment, age, etc., a portion of questionnaires are distributed through shopping groups to guide users to fill out paid forms, greatly ensuring the diversity of user basic information. By analyzing the individual characteristics of WeChat users and their acceptance of personal information leakage. Using WeChat user satisfaction surveys to confirm that blockchain is beneficial for personal information protection and can better improve the satisfaction of WeChat users.

4.1 Descriptive analysis of individual characteristics

Based on questionnaire data, descriptive analysis of individual characteristics can be conducted to analyze the frequency and proportion of different categories of each variable in the sample. A brief analysis can be conducted as follows: the impact of gender, marital status, education level, age, and WeChat usage time on the satisfaction of WeChat users with personal information protection based on blockchain technology, in order to better understand users' needs and preferences, Provide a basis for the design and improvement of personal information protection plans.

(1) Gender of WeChat users: Male Number: 118, accounting for 47.20% of the total sample. Number of women: 132, accounting for 52.80% of the total sample. Exploring the impact of gender factors on satisfaction by comparing whether there is a significant difference in satisfaction between men and women with WeChat user personal information protection schemes based on blockchain technology, it was found that the distribution of gender factors is relatively balanced.

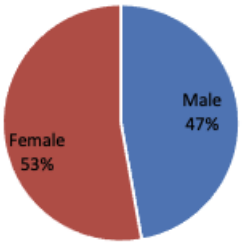

Figure 3: *Gender Status Statistics of WeChat Users.*

(2) Have you encountered any personal information leakage? Yes, the number is 155, accounting for 62% of the total sample. No Quantity: 95, accounting for 38.00% of the total sample. Most of the people in the sample have experienced personal information leakage. Statistics show that most WeChat users have experienced personal information leakage when using WeChat.

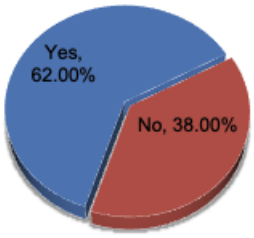

Figure 4: *Statistics of Personal Information Leakage*

(3) Undergraduate education: 66, accounting for 26.40% of the total sample. Undergraduate programs accounted for 36% of the entire sample, with 90 programs. There were 67 master's degrees awarded, accounting for 26.8% of the total sample. The number of PhDs and above 27 makes up 10.8% of the overall sample.

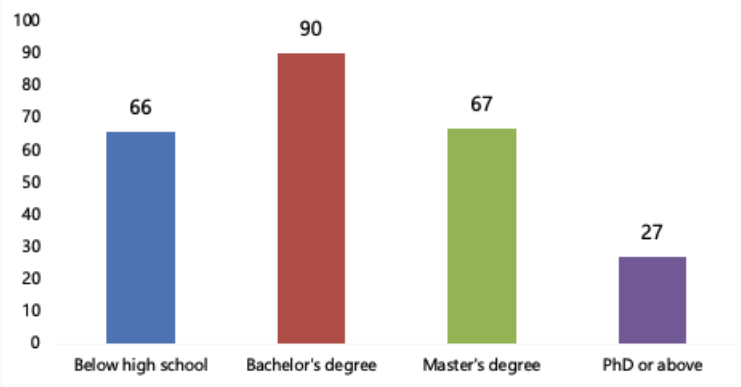

Figure 5: *Education Level Statistics.*

(4) User User Minimum user age: 18 years old Quantity: 25, representing 10% of the whole sample. 41 people aged 18 to 28 made up 16.4% of the overall sample. There were 91 persons aged 28 to 50 in the sample, accounting for 36.4% of the total. There were 68 persons aged 50 to 65 in the sample, accounting for 27.2% of the total. There were 25 persons aged 65 and up in the sample, accounting for 10% of the total.

(5) WeChat usage time: Rare usage quantity: 25, accounting for 10% of the total sample. Not commonly used quantity: 50, accounting for 20.00% of the total sample. General quantity: 93, accounting for 37.2% of the total sample. The more commonly used quantity: is 58, accounting for 23.2% of the total sample. Frequently used quantity: 24, accounting for 9.6% of the total sample.

Through statistics on different genders, personal information leakage, education level, user age, and WeChat usage time, the impact of blockchain technology on the satisfaction

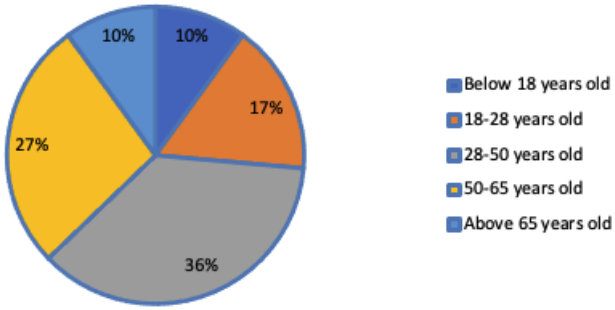

Figure 6: *Education Level Statistics.*

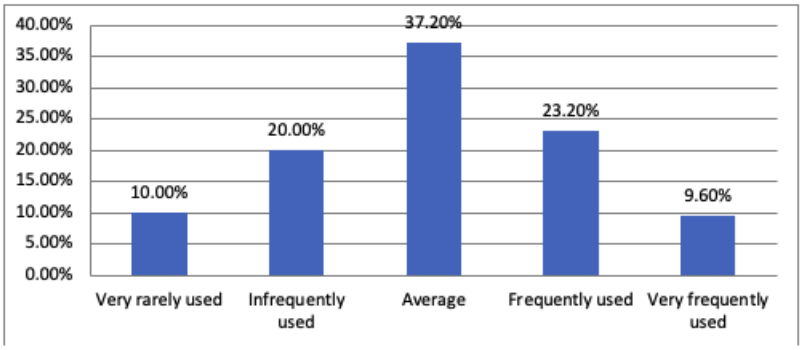

Figure 7: *Education Level Statistics.*

of WeChat users with personal information protection is basically independent of the user's gender. WeChat users are generally between the ages of 28 and 50, and the majority of users have undergraduate education, with a higher proportion of WeChat usage time, Most WeChat users have experienced personal information leakage, and the survey of satisfaction with personal information protection for WeChat users using blockchain technology is beneficial for the application of blockchain technology in personal information protection. Analyzing the individual characteristics of WeChat users is beneficial for the application of blockchain technology in the field of personal information protection.

4.2 Descriptive analysis of the acceptance level of personal information leakage

Based on questionnaire data, a descriptive analysis was conducted on the acceptance level of personal information leakage. According to Table 2, the frequency and proportion of different categories of each variable in the sample can be briefly analyzed as follows:

According to the data in the table, the options with lower scores are:

(1) X6: Collect basic user information when registering for WeChat. The possible reason is that users hold a reserved attitude towards collecting personal information during the registration process. They may feel uneasy about providing personal details or believe that they have collected too much information.

(2) X16: When using WeChat for sports, step count information will be collected. The lower score may be due to concerns expressed by users about collecting and storing personal health

Table 2: *Descriptive analysis of the acceptance level of personal information leakage*

Variables	Mean	Interpretation
Collect basic user information when registering for WeChat (X6)	3.473	Moderate Level
Select whether to provide voice fingerprint information (X7)	3.553	High Level
Collect log information such as device model (X8)	3.58	High Level
Log in to WeChat (X9) via SMS verification code	3.767	High Level
Set your own access rights to your circle of friends (X10)	3.48	High Level
Data for uploading friends is stored on the server (X11)	3.453	Moderate Level
Login to the applet, APP requires authorization (X12)	3.52	High Level
Authorization required to obtain geolocation information (X13)	3.8	High Level
"Infrequently used devices" log in requires verification information (X14)	3.787	High Level
A customizable way for strangers to add friends (X15)	3.787	High Level
Collect step information when using WeChat Sports (X16)	3.22	Moderate Level
Search information is recorded when using functions such as "Search" (X17)	3.16	Moderate Level
The address book function collects encrypted information (X18)	3.133	Moderate Level
The payment function collects information about the bank card (X19)	3.3	Moderate Level
CaiPay will collect WeChat payment record information (X20)	3.373	Moderate Level
Collects voice-to-text conversion information but does not save it (X21)	3.41	Moderate Level
You can freeze your own WeChat through your friends (X22)	3.29	Moderate Level
Delete all personal information when canceling a WeChat account (X23)	3.58	High Level
You can complain when you encounter infringement (X24)	3.52	High Level
Use of encryption technology to protect personal information (X25)	3.75	High Level

data. Users may not be willing to share their step count information or have doubts about the use of data.

(3) X17: Using functions such as "search" will record search information. A lower score may indicate that users are concerned about their search history being recorded. Users may prefer to have more privacy and do not want their search activities to be tracked or recorded.

(4) X18: The address book function will collect encrypted information. A low score indicates that users have concerns about the collection and use of address book data, even if it is encrypted. Users may hold a hesitant attitude toward sharing information about their contacts for privacy and security reasons.

These low scores indicate that users have reservations or concerns about the collection and use of personal information in specific fields. Emphasize the importance of addressing user privacy concerns and implementing transparent data protection measures to improve user satisfaction and trust in the WeChat platform.

The frequency of WeChat usage is increasing. With the development of mobile internet, WeChat builds a series of ecosystems, including social, entertainment, information, e-commerce, finance, and lifestyle platforms, produces content, establishes smart cities, and opens up the platform, allowing third parties to play a greater role in the WeChat ecosystem and jointly build the WeChat ecosystem. WeChat conducts comprehensive penetration around user needs, establishing fundamental high-frequency and vertical scenarios for users' mobile life, maximizing the attraction and retention of users, and increasing user stickiness. In addition, on the basis of WeChat payment, the WeChat ecosystem has formed its own unique e-commerce marketing method and transaction loop. These changes all benefit from the application of blockchain technology, making people's lives more convenient. By conducting descriptive analysis of the acceptance level of personal information leakage, WeChat can be better optimized and technology can better protect personal information. Provide WeChat users with a better experience. In the past year, WeChat has driven a data traffic expenditure of 86.7 billion yuan, driving a growth of 20% -25% in data traffic for the three major operators. The investigators stated that the use of WeChat accounts for the vast majority of smartphone usage time. Apart from social communication, the acquisition, forwarding, and forwarding of news and entertainment information are mostly generated on the WeChat platform. WeChat has become an important channel for the informatization of small and medium-sized enterprises. The proportion of companies or institutions using WeChat public platform accounts has reached 70%; Among them, 53% of users have already invested in informatization based on the WeChat platform. WeChat has also become an important entrepreneurial incubation platform, with over 600000 individual entrepreneurial activities driven by WeChat. WeChat has a significant driving effect on social employment. Currently, the number of employment driven by WeChat reaches 10.07 million people.

The application of blockchain technology for personal information protection revolves around key principles such as security, decentralization, transparency, and control. Security is a fundamental aspect of using blockchain for personal information protection. This technology provides a tamper-proof and immutable data storage method, ensuring that any attempt to modify information is detected by the network. By using encryption technology to protect data, individuals can be confident that their personal information is protected from unauthorized access and network threats. Decentralization is another key principle for using blockchain for

personal information protection. By storing data on distributed ledgers, the system avoids the need for central or intermediary institutions to manage data. This reduces the risk of single-point failures and provides greater resilience against attacks and data breaches. Transparency is also important for the protection of personal information on the blockchain. Individuals can choose which organizations can access their personal information and revoke access at any time. This gives individuals greater control over their data and ensures that they know how their personal information is used. Control is an important component of a blockchain-based personal information protection framework. By using their unique identity stored on the blockchain, individuals have greater control over their data and can manage their personal information without the need for third-party organizations to manage it on their behalf. This reduces the risk of data leakage and improves the efficiency of the system.

5 Discussion

Technology has neutrality, which means that while protecting personal information during the use of technology, there are also situations where technology is illegally utilized. In the application of blockchain technology in personal information protection, in addition to possessing technological advantages such as tamper resistance and legal effectiveness, there are also some technical defects and deficiencies in the legal system.

(1) Blockchain technology is not yet mature, and there is still a risk of trust mechanisms being attacked

At present, blockchain technology is still in its early stages of development, and the risks and challenges it faces are also major security issues. Firstly, as an emerging and complex network technology, blockchain research and development require a significant amount of manpower, material resources, and financial resources. Currently, blockchain technology is still in short supply in terms of talent and technology, and research and development costs are high. As a result, blockchain technology is often limited by price factors in terms of promotion, popularization, and application. Secondly, the immutability advantage of blockchain technology is not absolute. Although blockchain technology reduces the risk of user personal information being tampered with and stolen, it also faces the potential threat of hackers controlling 51% of nodes. Furthermore, its recognition system, which is positioned at the lower level of blockchain technology architecture, is an essential part of blockchain technology. Blockchain technology cannot totally replace existing governance methods for the preservation and governance of personal information. If users maliciously upload false information or use someone else's identity for registration and authentication, the consensus mechanism in blockchain cannot play its due role. Therefore, relying solely on blockchain technology to achieve the protection of personal information also carries an idealistic color. If personal information stored in a blockchain node is falsely forged, then the trust mechanism created by the blockchain will no longer exist. WeChat users cannot rely solely on technology when using WeChat, and individuals should also raise awareness of their own information protection.

(2) The laws and regulations are not yet complete, and there are still legal risks in blockchain protection of personal information.

The lag of laws has led to the current exploration of blockchain laws, regulations, and

policy systems. By searching for the current laws, regulations, policies, and policy documents related to blockchain technology, it was found that there are two characteristics of the laws and regulations related to blockchain technology: firstly, laws and administrative regulations with a higher legal rank, which focus on personal information and network security. The legal provisions applicable to blockchain are all principled and not specific enough; The second is regulations and normative documents with lower legal status, which are more specific, operable, and comprehensive in terms of application specifications for blockchain technology. This presents a situation of disharmony between the level of legal hierarchy and the concretization of corresponding content.

Although blockchain technology provides many reliable technological advantages for personal information protection, it also raises new legal issues. In a decentralized blockchain, the power of third-party platforms is decomposed, and there is no so-called centralized department. However, when personal information is leaked or stolen, who bears the relevant legal responsibility? How can personal information be recovered when it is falsely registered and used by others? Blockchain technology uses asymmetric encryption to protect users' personal information. In traditional centralized networks, password loss can be retrieved through databases. However, due to the decentralized and tamperproof nature of blockchain technology, when users forget their passwords, the private key cannot be retrieved. Does this mean that users also lose their rights to blockchain personal information? And other new issues that have not yet emerged have all laid hidden dangers for personal information security.

6 Conclusion

The introduction of blockchain technology has provided new thinking for the improvement of personal information protection systems, which has also become a new attempt to promote legal systems through technology. The decentralized, encrypted, and tamper-resistant characteristics of blockchain can precisely meet the various needs of personal information protection. Of course, the personal information protection system is a complex system engineering, and there are still some risks in the implementation of technology. However, due to the high compatibility between blockchain technology and the personal information protection system, we should still give blockchain technology space to explore. We hope that blockchain technology can shine brightly in building a new trust mechanism, bringing true dawn to the construction of a personal information protection system. This article uses a hybrid method of quantitative and qualitative data to comprehensively understand WeChat users' attitudes, trust, and behavior toward data privacy and security. We will conduct a series of questionnaires, and interviews, and adopt various methods to analyze the results, in order to gain a more comprehensive understanding and insight into the problem. It has been proven through facts that blockchain technology can improve the satisfaction of WeChat users, and the protection of personal information, and the potential of blockchain technology to solve these problems need to be further explored. Identify factors that affect user satisfaction and willingness to use blockchain personal information protection features. Provide new and practical insights for operators, decision-makers, and researchers on WeChat and other similar platforms, promote better methods of providing privacy and security services, and enhance users' privacy

protection and trust on the internet and social media platforms.

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A Study on Characteristics of Short Video Platform Advertisement for Precision Marketing Based on Data-driven Environment: A Case Study of TikTok

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Abstract

This paper thoroughly examines the precision marketing strategy employed by short video ads in a data-driven environment, using TikTok as a case study. In the era of new media, short videos rapidly proliferate across various social platforms, and their swift dissemination, diverse participation methods, and robust social interaction capabilities establish them as a significant force in the realm of digital marketing. As a globally recognized short video platform TikTok plays a pivotal role in digital marketing research. Short videos offer distinctive communication and marketing abilities that open up novel avenues for businesses to promote their products. This shift is particularly crucial as traditional media approaches struggle to adapt to evolving social trends and advertising demands. By analyzing the content characteristics of TikTok's short video advertisements, this paper investigates the influence of precision marketing factors on advertising effectiveness. The research primarily focuses on TikTok's short video ads while selecting popular videos as research samples. Through clustering and regression analysis techniques, it evaluates the content attributes of short video advertisements and their impact on advertising effectiveness with an aim to gain deeper insights into the marketing outcomes associated with different types of advertisements and ultimately facilitate advertising strategy optimization.

KEYWORDS: Big data technology, Short video advertising, Precision marketing, TikTok, Digital marketing, New media, Advertising effectiveness

1 Introduction

In the rapidly evolving digital landscape of today, the convergence of big data technology and short video advertising has ushered in a transformative era for marketing strategies. This symbiotic relationship not only addresses the limitations of traditional media but also significantly enhances the efficiency of advertising and marketing endeavors. This article delves into this paradigm shift by using TikTok as a prominent case study to conduct an exhaustive analysis of precision marketing strategies employed in short video advertising within a data-driven environment.

In the era of new media, short videos have emerged as a dynamic force, swiftly disseminating across various social platforms. Their appeal lies in their rapid communication, diverse

engagement methods, and robust social interaction capabilities, attention and favor of a vast audience. The rise of marks a pivotal trend in digital marketing, with TikTok standing out as a globally as a cornerstone for research in the domain. The unique communication and marketing attributes inherent to short videos have carved out new avenues for enterprises to promote and sell their products, particularly considering traditional media's inability to keep pace with evolving societal trends and meet ever-evolving demands in advertising and marketing.

To dissect the nuances of precision marketing within the realm of short video advertisements, this paper undertakes an exploration by meticulously analyzing content characteristics found in TikTok's short video ads. The aim is to provide valuable reference points and guidance for enterprises embarking on marketing activities within these platforms. This research centers specifically on TikTok's short video ads while utilizing popular videos as research samples. By employing clustering and regression analysis methods, this study seeks to unravel how content characteristics influence precision marketing strategies,in order to better understand the marketing effects of different types of advertisements and optimize advertising strategy.

The present study employs cluster analysis, specifically utilizing the K-means clustering method, to categorize data into two distinct groups. Subsequently, a cluster analysis is conducted based on variables such as video duration, release time, number of author followers, product price, and likes. Simultaneously, a regression model is established to examine the relationship between advertising effectiveness and independent variables including video duration, sales data, and number of likes. Advertising effectiveness serves as the dependent variable while release time, video duration, number of fans, product price and likes act as independent variables.

2 Literature Review

2.1 Short Video Advertising

According to the research related to short-video advertising, it has been concluded that short video advertising possesses various characteristics that make it a preferred choice for marketing and promotion.

As shown by Liu et al. (2019), short video advertising possesses a wide communication range and is highly effective in marketing. It also exhibits characteristics such as brevity, rapid communication, and ease of comprehension. Furthermore, merchants and audiences have a stronger sense of interactivity, and short video advertising is cost-effective and has diversified forms and rich placement channels.

As shown by Gao et al. (2019), their study compared mobile short-form video advertising with traditional advertising and revealed that mobile short-form video advertising possesses unique attributes, including a single selling point, a concise message, trialability, a short benefit cycle, and high efficiency for impulse purchases. Furthermore, mobile short-form video advertising emphasizes the enhancement of sales and website traffic, ultimately leading to increased consumption.

A study by Ariadne Consulting suggests that short videos are more interactive, social, and flexible compared to long videos, making them a popular way for users to express themselves.

Additionally, compared to live videos, short videos are more communicative and facilitate the distribution and consumption of content across the network.

In summary, short video ads should have the advantages shown in Figure 1:

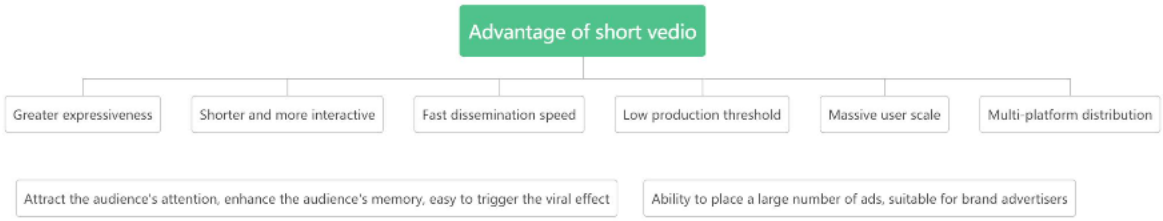

Figure 1: *Features of short video advertising*

As shown by Liu (2019), short video ads can be classified into two categories: native ads, which are tailored to ad content, and implanted ads, which are integrated into TV shows or games to match the video content. As shown by Chen (2019), five types of short video ads on Jitterbug can be summarized: infomercials, opening screen ads, sticker ads, custom challenges, and daft cooperation. Custom challenges refer to theme challenges customized by brands in cooperation with Jitterbug, which can attract fans to imitate and retweet, promote video dissemination, and improve brand awareness. In this paper, we classify short video ads into three categories: native ads, implanted ads, and patch ads. Native ads are tailored to ad content, integrating the ad presentation form with the regular form of the publishing platform, emphasizing value and personalized presentation in content, accurately delivering ad information to meet the actual needs of users, and helping to stimulate the secondary spread of ads. The common forms of implanted advertising include products, logos, and narration, which are integrated into film and television works to achieve marketing purposes without affecting the viewing effect, and can often play a subtle role, but are not applicable to deep persuasion and have certain limitations. Sticker commercials have the advantages of strong content relevance and impact and are often played before the start of the main movie, but they tend to cause audience resentment because they affect the original movie-viewing experience. In terms of the nature of advertising, this paper classifies short video ads into brand communication short video ads and recommendation diversion short video ads. Brand communication emphasizes the spread of brand influence, while the content of recommended traffic ads is on the side of recommended products, with the ultimate goal of leading users to relevant e-commerce platforms or increasing exposure or fan base or leading to purchase behavior.

Short video ads released by enterprises lose their meaning if they do not resonate with consumers. Therefore, enterprises have turned to big data to help precision marketing in three steps: insight into demand, precise placement, and service assistance. The core idea is that "it starts with the customer and ends with the customer as previously shown (Sun et al., 2017). Enterprises should design and produce short video advertisements that match the characteristics of the brand to enhance the degree of resonance between consumers and the brand, and thus enhance consumers' image perception of the brand. Enterprises can use big data processing technology to comprehensively and deeply excavate consumers' hobbies and behaviors, and thus accurate data processing technology to accurately predict the changes

in customer demand. This can help enterprises deepen dynamic and accurate marketing as previously shown (Yang et al., 2018). Therefore, this paper focuses on the role of short video advertising communication on the perception of brand image and explores the mediating role of brand empathy in this process. At the same time, the characteristics of short-form video advertising have different effects at different advertising stages, so this paper also explores the role of short-form video advertising on brand image perception at different advertising stages, hoping to provide useful suggestions for enterprises to design short-form video advertising.

2.2 Data-Driven Precision Marketing

Data-driven precision marketing is a marketing approach that relies on big data and data analysis technology to analyze users' data and understand their needs and behavioral characteristics. The utilization of data enables more precise advertising and enhances operational efficiency and return on investment. The term "data-driven" pertains to the utilization of data analytics and mining techniques for decision-making, aiming to uncover patterns and trends that support business decisions, as previously mentioned (Gupta et al., 2020). The concept is to base decisions on data rather than subjective judgment or experience. By transforming data into valuable information and knowledge, businesses can employ scientific methods and techniques to make more objective and accurate decisions.

Li (2019). Research on the Marketing Strategy of New Oriental K12 Based on 4C Theory. In Science and Technology Information (Ed.), (p. 219). The effectiveness of branding relies on a combination of marketing activities centered around "customer satisfaction". The 4C theory encompasses customer strategy, cost strategy, convenience strategy, communication strategy, and other essential marketing skills. Similarly, Shan et al. (2021) Research on Brand Communication and Marketing Strategy of Little Red Book Based on the 4C Theory. In Journal of Changsha University (Ed.), (pp. 46-51). In the era of big data, it is imperative for companies to align their brand communication and marketing strategies with actual operations by adopting the integrated marketing concept of the 4C theory. These strategies are crucial for effective brand promotion.

The AISAS model is a consumer behavior analysis model proposed by Dentsu Group (Kuang, 2012). Dentsu has introduced the AISAS Internet marketing framework, which encompasses five: Attention, Interest, Search, Action, and Share. This framework reflects the transformative impact of the Internet on people's lifestyles and consumption behaviors. In the realm of contemporary enterprise management, data-driven approaches have emerged as a prevailing trend and developmental direction. By harnessing the potential of big data and advanced analytics technologies, enterprises can attain profound insights into market dynamics, consumer preferences, product attributes, and competitive landscapes. Consequently, this empowers refined management practices and precise marketing strategies that augment decision-making efficiency and enhance market competitiveness. For example, data-driven precision delivery techniques can be utilized in advertising and marketing to comprehensively understand consumers' interests and needs, enabling personalized and accurate ad targeting while simultaneously enhancing advertising effectiveness and returns.

In conclusion, data-driven precision marketing has become a necessary skill and tool for modern enterprise management and marketing. By using data analysis and mining technology,

it can provide more scientific and effective decision basis and support for enterprises.

2.3 Study on Selection of Short-Form Video Ads from TikTok

According to Quest Mobile data, as of December 2022, the monthly active user scale of the short video industry has reached 1.1 billion, with a monthly per capita usage time of 67.1 minutes. The TikTok short video platform is supported not only by a huge user base but also by a large number of excellent video creators gathered on the platform. When the user base reaches a certain level, many creators will take advantage of their own traffic to undertake commercial promotion to gain revenue. Therefore, a large number of TikTok creators and brand sponsors are closely integrated, using the media form of short videos to promote their products and attract users while exporting product information to them. On the TikTok short video platform, the scarce user attention has forced short video ad producers to innovate, giving rise to a large number of excellent short video ads on the platform. Based on the above analysis, this study selects the TikTok platform as the data collection object.

According to whether advertisers generate purchase behavior and whether ads are easy to track, short video ads in TikTok are generally divided into three categories:

(1) Opening screen ads, which have the characteristics of random appearance, targeted distribution, and recommended diversion. They are the first impression entrance of users opening TikTok, with high exposure and nearly 100% reach. Usually, users click on this page to directly jump to the corresponding e-commerce platform, increasing exposure and fan base for advertisers' e-commerce stores and even helping to generate user purchases. Advertisers can choose to place opening screen ads at any time of the day within 24 hours. The time is relatively free, but the advertising cost is relatively high, and the advertisers are generally strong and big brands. (

2) Information flow advertising, with the characteristics of random appearance, targeted distribution, and recommended diversion, generally in the TikTok brush to the fourth video and the eighth video. If you click on the corresponding field on the advertisement page, you can also jump to the corresponding e-commerce platform to attract traffic. Infomercials are embedded into the information users browse in a "silent" way, and they try to fit users' browsing habits and interests as much as possible in terms of presentation and content. The targeted distribution of infomercials in TikTok is more obvious than that of other ads. Intelligent recommendation is the biggest core advantage of TikTok, through big data and artificial intelligence technology, and the personalized features are particularly prominent, maximizing the value of individual ads.

(3) Native video ads, such as short videos released by key opinion leaders (KOLs) and corporate accounts, have the typical characteristics of content-as-advertising and advertising-as-content. Most of the content is original to advertisers and easy to track. Native video ads achieve visual integration, framing ads within the user experience, significantly weakening marketing intent, and better avoiding user resistance. Native video ads are the most common form of advertising on the TikTok platform.

This paper will focus on the native video ads produced by TikTok from category 3 ads, which are traceable and easy to carry out the research. Quickly targeting short video ads in the TikTok platform becomes an important task to conduct this study. With the help of

Gray Dolphin Data, a professional short-video data analysis website, we can always target popular short-video ads in TikTok under different categories. At the same time, using this data platform, we can obtain information about the makers of short video ads (number of followers), as well as the data about the retweets and likes of the short video ads, the gender ratio of the video viewers, and the price information of the goods in the ads, so as to provide sufficient data collection sources for the research. At the same time, in order to obtain more stable data samples and avoid the influence of random changes or seasonal factors during a single day or specific time period, I chose to study the data from February 2023 to March 2023, covering a total of two months. All research data are based on the Chinese market.

2.4 Purpose of the Study

Compared to traditional advertising, short-form video advertising offers selectivity, allowing audiences to freely choose whether or not to watch and interact with the ad through comments and sharing. In fact, audiences can even actively participate in short-form video advertising marketing, which changes the traditional one-way supply pattern and maximizes audience subjective initiative. Short video ads can attract the attention of many users and may even lead to actual consumption behavior, making this "bottom-up" marketing path highly efficient and inexpensive. To design successful short-form video ads, marketers need to shift their thinking to focus on increasing the number of shares and achieving the desired marketing effect.

This paper aims to understand the content characteristics of short-form video ads for strategizing precision marketing, with a specific focus on data-driven environments. TikTok is chosen as the representative platform for short video ads, and popular videos are selected as research samples.

The research objectives include (1) exploring the current situation of online media advertising precision marketing in the big data environment, (2) studying the characteristics of popular online media precision marketing ads, (3) identifying and classifying ads with the same or similar behavioral characteristics through cluster analysis, and (4) studying the influence of content characteristics of short video ads on advertising effectiveness through regression analysis.

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2.6 Research Scope

DataCollection Hot selling TikTok short video ads are selcted to be sample data. They were collected from the third-party data analysis platform Huitun Data. In order to obtain more stable data samples and avoid the influence of random changes or seasonal factors on data during a single day or specific time period, I chose the TikTok short video to study the data from February 2023 to March 2023, covering a total of two months.

Several variables were selected in the study, including posting time, video length, author followers, sales, item price, number of likes, and GPM, as shown in Table 1. By using cluster analysis and regression analysis methods. The study aims to explore and investigate the impact of content features of the ads on precision marketing.

Table 1: *Variables and Their Meanings*

Variable	Mean
Release Time	The date and time when the ad was released
Video length	The length of the ad video, usually in seconds
Author followers	The number of followers of the ad author on the TikTok platform
Sales	number of sales of the item promoted by the ad within a certain period of time
Sales amount	The amount of sales of the advertised item within a certain period of time
Product Price	The price of the advertised product
Number of Likes	Likes: The number of likes the advertised video received on the TikTok platform
GPM	1,000 views: The number of sales of the advertised video in each 1,000 views

2.7 Research Methodology

This study adopts an empirical research method, aims to analyze the characteristics of advertising on short video platforms and optimize advertising effectiveness through accurate marketing in a data- driven environment. We will select the TikTok platform as the research object and collect data on video posting time, duration, sales, GPM (sales per thousand views), likes, product price, and number of author followers. As shown in Figure 2, the data will be analyzed.

Preprocessing (1) Feature Encoding

To facilitate data analysis, I have encoded the video duration and post time. Here is the encoding scheme:

1) Video Duration Encoding: Less than 1 minute: Encoded as 1, 1-3 minutes: Encoded as 2, More than 3 minutes: Encoded as 3.

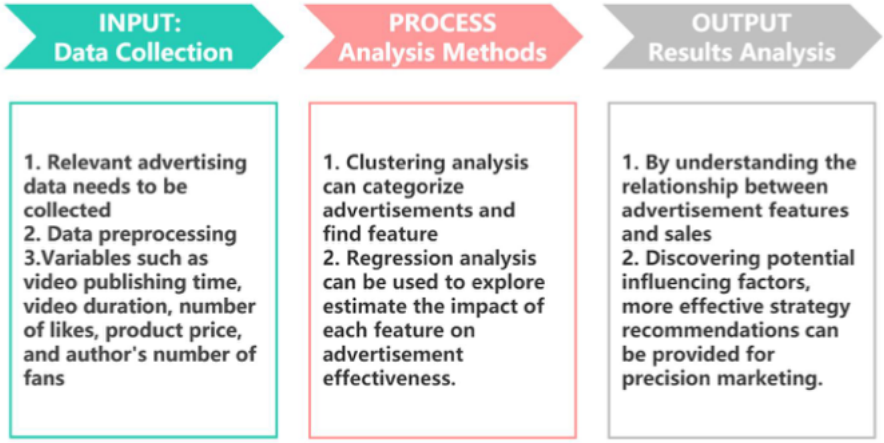

Figure 2: *Conceptual Framework*

Table 2: *Variables and Their Meanings*

Video Duration	Less than 1 minute	1
	1-3 minutes	2
	More than 3 minutes	3
post time	7:00∼11:59	1
	12:00-13:59	2
	14:00∼17:59	3
	18:00∼23:00	5
	Other	4

2) Post Time Encoding: 7:00-11:59 AM: Encoded as 1, 12:00-13:59 PM: Encoded as 2, 14:00-17:59 PM: Encoded as 3, 18:00-23:59PM: Encoded as 4, Other times: Encoded as 5.

By encoding the video duration and post time, we transform the original time data into discrete codes that are convenient for analysis, as shown in Table 2. This will help us to perform statistical analysis, visualization, and further exploration of the data, enabling a better understanding and utilization of these features.

(2) Data cleaning: Delete data with a video length of 0 to avoid the influence of these data on subsequent analysis.

(3) Data standardization: Use the z-score standardization method to subtract the mean value from each variable's value and then divide it by the standard deviation. This way, all variable values will fluctuate around 0, with a standard deviation of 1. Standardized data is more conducive to clustering and regression analysis.

ClusterAnalysis We will use cluster analysis to cluster the collected data, determine the final number of clusters, and divide the sample data into different categories and understand the characteristics and differences of each cluster, which can provide a reference for the formulation of accurate advertising marketing strategies. In this analysis, we conducted K-means clustering to categorize the data into two distinct clusters based on several variables.

As shown in Figure 3, we perform the following steps:

a. Firstly, K points in the sample are randomly selected as clustering centers;

b. Separately calculate the distance between other samples in the sample and the K clustering centers, and take these samples as the category of the nearest clustering center;

c. Average the above classified samples for each category, and solve the new cluster centroid;

d. Compared with the K cluster centroids obtained by the previous calculation, if the centroids of the clusters change, the process b is transferred, otherwise the process e is transferred;

e. When the center of mass does not change (when we find a center of mass, the samples assigned to this center of mass are consistent in each iteration, that is, every newly generated cluster is consistent, and all sample points will not be transferred from one cluster to another cluster, the center of mass will not change), stop and output the clustering result.

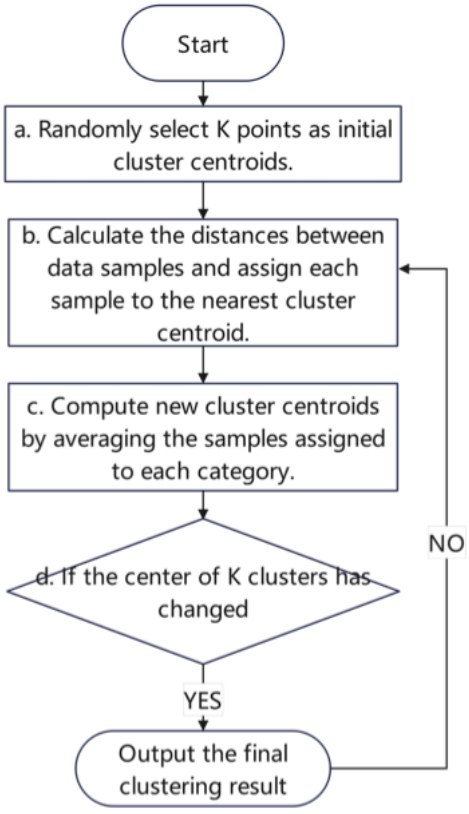

Figure 3: *K-means Framework*

Below is a summary of the key findings from the cluster analysis:

a. Convergence is achieved as there are no significant changes or only minor changes in the cluster centers. The maximum absolute coordinate change for any center is .000. The current iteration is 6. The minimum distance between the initial centers is 34986999.226.

After multiple iterations, the movement of cluster centers tends to converge, resulting in the emergence of two distinct groups in the clustering results, as illustrated in Table 6. The analysis unveiled significant disparities between the clusters regarding video duration, post

Table 3: *Initial Cluster Centers*

	Cluster	
	1	2
Video Duration	2	1
Post time	4	5
Author Fans	34974367	23974
Product Price	39	59.9
Total Sales	400000	2000000
GPM	42	100
Likes	60000	72000

Table 4: *Iteration Historya*

Iteration	Change in Cluster Centers	
	1	2
1	11863219.6	1962411.97
2	3937851.93	538066.065
3	801331.545	104047.018
4	1035729.93	120712.464
5	82198.733	9427.009
6	0	0

time, author fans, product price, total sales, GPM, and likes.

Regression Analysis The multiple linear regression model will be employed to investigate the impact of various variables on advertising effect, with sales volume and GPM serving as dependent variables representing advertising effect. The regression model will consider video length, likes, release time, fans, and other independent variables.

Regression Model 1:

Establish a linear regression model with total sales as the dependent variable and release time, video duration, author's number of fans, product price, and likes as independent variables.

The results indicate that the regression model is statistically significant ($F=22.582$, $p<0.01$). Author Fans and Likes have a significant regression effect on Total Sales, with regression coefficients of 0.006 and 1.099, respectively. This means that the number of fans and likes are positively related to sales revenue. The functional equation of this regression model can be formulated as:

$$Y = 568424.452 + 0.006 * \text{author fans} + 1.099 * \text{likes} \tag{1}$$

Regression Model 2:

GPM is the dependent variable, while release time, video duration, author's fan count, product price, and likes are independent variables used to establish a linear regression model.

The results indicate that the regression model is statistically significant ($F=386.599$, $p<0.01$).

Table 5: *Final Cluster Centers*

	Cluster	
	1	2
Video Duration	2	1.3
Post time	2.95	3.02
Author Fans	17266377	653158
Product Price	155.45	59.63
Total Sales	892000	605222
GPM	161.48	116.97
Likes	184853	42589

Table 6: *Number of Cases in Each Cluster*

Cluster	1	100
	2	900
Valid		1000
Missing		0

Likes and Product Price have a significant regression effect on GPM, with regression coefficients of -0.00028 and 0.849, respectively. This means that likes are inversely proportional to GPM, while product price is positively related to GPM. The functional equation of this regression model can be formulated as:

$$Y = 70.159 - 0.00028 * \text{Likes} + 0.849 * \text{Product Price}. \quad (2)$$

2.8 Discussion

The study focused on advertisements on the TikTok short-form video platform. Based on the results of data analysis, we can observe the impact of various features on advertising effectiveness. The dataset comprises information about ads posted on the TikTok platform, including variables such as video duration, publication time, author's follower count, product price, likes, and total sales.

In the frist regression model with total sales as the dependent variable, we can examine the relationship between different independent variables and total sales. The key factors influencing total sales are found to be the number of followers and likes of the author, which exhibit a positive correlation with overall sales. This indicates that in precision marketing strategies, leveraging an author's fan base and popularity can drive growth in total sales. Therefore, when implementing precision marketing campaigns, it may be advantageous to consider collaborating with authors who possess a substantial fan base and receive high levels of appreciation to enhance sales.

Furthermore, based on the second regression model, a significant regression relationship can be observed between GPM and both likes and product price. There exists a negative correlation between likes and GPM, while there is a positive correlation between product price

Table 7: *Model Summary b*

Model	R	R-squared	Adjusted R-squared	Standard Error of the Estimate	Durbin-Watson
1	.319[a]	0.102	0.097	402269.451	1.922

a. Predictors: (Constant), Product Price, Likes, Release Time, Video Duration, Author Fans
b. Dependent Variable: Total Sales

Table 8: *ANOVA a*

Model		Sum of Squares	Degrees of Freedom	Mean Square	F-Value	Significance
1	Regression	1.8271E+13	5	3.6542E+12	22.582	.000[b]
	Error	1.6085E+14	994	1.6182E+11		
	Total	1.7912E+14	999			

a. Dependent Variable: Total Sales
b. Predictors: (Constant), Product Price, Likes, Release Time, Video Duration, Author Fans

and GPM. This implies that in precision marketing, it is crucial to strike a balance between customer preference and product pricing.

In this study, we employ the K-means clustering method to categorize the data into two groups and conduct clustering analysis using variables such as video duration, release time, author fans, product price, and likes.

The K-means cluster analysis divides the dataset into two distinct clusters. After numerous iterations, the movement of cluster centers tends to converge, resulting in clearly differentiated clustering results. These results reveal significant disparities between the two clusters in terms of video duration, release time, author followers, product price, total sales, GPM and likes. Cluster 1 is characterized by shorter yet higher quality video content with a focus on daytime releases and a substantial fan base. Products associated with Cluster 1 exhibit higher prices and demonstrate strong sales performance. On the other hand, Cluster 2 is distinguished by shorter video durations released in the afternoon, a smaller fan base, lower product prices, reduced total sales figures, lower GPM values and fewer likes.

The utilization of cluster analysis facilitates data grouping and provides valuable insights into different clusters' characteristics and performance metrics. Based on these clustering outcomes, targeted strategies can be implemented to optimize video releases while increasing fan engagement levels and adjusting product pricing accordingly to enhance overall sales revenue and GPM.

Given the significant impact of an author's follower count and likes on overall sales, advertisers should consider collaborating with authors who have a substantial fan base and high levels of engagement in order to increase exposure and drive sales. When it comes to GPM, finding the right balance between likes and product pricing is crucial. While likes play a pivotal role in the effectiveness and recognition of advertisements, advertisers should also take

Table 9: *Coefficient Summary a*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Significance	95.0% Confidence Interval for B	
		B	Standard Error	Beta			Lower Bound	Upper Bound
1	(Constant)	568424.452	44513.253		12.77	0	481073.717	655775.187
	post time	-783.149	10996.96	-0.002	-0.071	0.943	-22363.072	20796.773
	Video Duration	-9743.797	24586.869	-0.014	-0.396	0.692	-57991.924	38504.331
	Author Fans	0.006	0.003	0.077	2.192	0.029	0.001	0.011
	Likes	1.099	0.131	0.286	8.364	.000	0.841	1.357
	Product Price	68.762	72.145	0.03	0.953	0.341	-72.812	210.335

a. Dependent Variable: Total Sales

Table 10: *Model Summary b*

Model	R	R-squared	Adjusted R-squared	Standard Error of the Estimate	Durbin-Watson
1	.813[a]	0.660	0.659	112.80638	2.031

a. Predictors: (Constant), Product Price, Likes, Release Time, Video Duration, Author Fans
b. Dependent Variable: Total Sales

pricing strategies into consideration to ensure a reasonable GPM. For platforms that focus on short video advertising, optimizing your advertising strategy can be achieved by consolidating video duration and carefully timing their release. For example, it would be advisable to create content tailored to short videos within specific time frames based on the preferences and consumption behavior of the target audience. Further research could explore other influential factors such as advertising content and characteristics of the target audience in order to gain deeper insights into precision marketing strategies employed by short video platforms. By integrating variables like number of fans, product prices, likes, among others, one can develop a precise advertising marketing strategy that promotes fan engagement while implementing appropriate pricing techniques to boost sales and GPM. Additionally, analyzing metrics such as "likes" can provide valuable insights into user preferences and engagement levels which can then be utilized for optimizing ad content.

3 Conclusion

This research is centered on examining TikTok video data, which includes variables like release time, likes, transaction volume, duration and fan count. The objective is to evaluate the impact of videos on marketing and analyze insights related to TikTok influencers and content. This study aims to provide a comprehensive analysis for the industry.

For marketers, analyzing video data provides an effective way to assess influencer content

Table 11: *ANOVA a*

Model		Sum of Squares	Degrees of Freedom	Mean Square	F-Value	Significance
1	Regression	24597888.9	5	4919577.78	386.599	.000[b]
	Error	12648927.1	994	12725.279		
	Total	37246816	999			

a. Dependent Variable: Total Sales
b. Predictors: (Constant), Product Price, Likes, Release Time, Video Duration, Author Fans

Table 12: *Coefficient Summary a*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Significance	95.0% Confidence Interval for B	
		B	Standard Error	Beta			Lower Bound	Upper Bound
1	(Constant)	70.159	12.483		5.621	0	45.663	94.654
	post time	2.439	3.084	0.015	0.791	0.429	-3.612	8.491
	Video Duration	-1.755	6.895	-0.005	-0.255	0.799	-15.285	11.775
	Author Fans	-2.95E-07	0	-0.008	-0.391	0.696	0	0
	Likes	-0.00028	-0.00028	-0.119	-5.647	0	0	0
	Product Price	0.849	0.02	0.8	41.962	0	0.809	0.889

a. Dependent Variable: GPM

and measure its effectiveness. Brands can objectively evaluate the influence of influencer content using basic metrics such as interaction index, fan index and video transaction index before launching campaigns.

Moreover, by comparing data across different time periods or videos within the same timeframe, brands can gain valuable insights that serve as a guide for future short-video advertising strategies. Utilizing technology and data advantages enables this analysis to offer perspectives on industry research trends while fulfilling brand owners', marketing professionals' and content creators' needs for data analysis.

Through analyzing video data quality insights are gained that contribute towards making better decisions when it comes to advertising campaigns.

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Research on the Impact of Trade Facilitation on the Development of China-ASEAN Cross-Border E-Commerce (CBEC)

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Abstract

Despite the significant disruptions caused by the COVID-19 pandemic to international trade and business, the trajectory towards economic globalization remains unchanged. The emergence of the pandemic and the ensuing crisis has, in fact, highlighted the substantial growth potential of electronic cross-border as a novel trade modality.

The members of ASEAN are the subject of this article. The article begins with an overview and analysis of the development of electronic commerce between China and the ASEAN nations. The article then presents pertinent ideas to explain these shifts and goes further into the underlying mechanics. Information for China and ASEAN nations comes from the IMF's 2010-2020 data set, while information for global main component analysis comes from the Global Competitiveness Report 2020-2022. These analyses provide a suggested set of measures for measuring the ease of doing business between China and the Association of Southeast Asian Nations. The entire amount of China's electronic cross-border exports was then analyzed using a Robust regression model to evaluate the overall growth of electronic commerce across borders. There is a favorable correlation between the growth of international and domestic e-commerce in China, as shown by the empirical investigation. Finally, some suggestions are made for future government and business policies in light of China's growing electronic cross-border market.

KEYWORDS: Trade facilitation, Robust regression model, China-ASEAN Cross-Border E-Commerce, Principal component analysis method;

1 Introduction

1.1 Problem statement

Since the beginning of the COVID-19 pandemic, many conventional businesses involved in international commerce have failed, forcing the establishment of a new transformational course. Despite the continuing pandemic, China's export share via CBEC has been on the rise. Understanding how to foster expansion of CBEC is essential.

The CBEC market in China has expanded significantly in recent years, and this expansion is expected to continue, although probably at a slower rate as market saturation is neared. The question is, how can CBEC bring about long-term growth? How much of a role does trade facilitation play in the expansion of CBEC? Historical panel data will be used in future studies to investigate the barriers to CBEC growth.

1.2 Research significance

1. Theoretical significance

The purpose of this study is to examine the theoretical and empirical underpinnings of cross-border e-commerce's effect on the expansion of globalization. In light of this, the goal of this project is to examine its effect on the growth of electronic commerce between countries from the vantage point of the development of cross-border electronic commerce in China and to investigate potential countermeasures. In light of this, the project will also theoretically and empirically examine how trade facilitation affects the volume of e-commerce that transactions.

To better comprehend the critical role facilitation of trade plays in the growth of e-commerce across borders, this study intends to examine the impacts that trade facilitation on international development and the complicated interaction between them. It also hopes to provide helpful information for policymakers. The findings of this study are likely to have far-reaching implications for the study of trade facilitation assessment systems and the growth of international e-commerce in the future.

2. Practical significance

As a result of trade facilitation efforts, international trade expenses have dropped significantly. Since international online commerce is characterized by "high transaction frequency and numerous small orders," it poses special difficulties in terms of transaction efficiency and complexity. The growth of international online trade might be hampered by the persistence of these problems. Therefore, one may argue that enhancing trade facilitation is crucial to the development of international online trade. As a result, bilateral export procedures are streamlined, and economic and commercial ties between China and the ASEAN area are strengthened. In addition, it gives international e-commerce firms a theoretical grounding for dealing with market-related difficulties.

1.3 Objective of the study

This paper leverages a trade facilitation measurement system from previous scholars, customizes and enhances it for China-ASEAN, and integrates it into a regression model to analyze its impact on CBEC. Based on the results, development recommendations are provided, offering insights for trade facilitation improvement and increased e-commerce trade volume.

1.4 Definitions

1. Trade Facilitation: In this study, trade facilitation can be operationally defined as comprehensive measures including but not limited to the following elements: lowering tariff barriers, reducing non-tariff barriers, simplifying customs procedures, improving logistics efficiency, and promoting cross-border e-commerce transactions.

2. This research categorizes the development of CBEC in ASEAN China into four dimensions: the number and scale of CBEC, the transaction volume of CBEC, the types of exported commodities in CBEC, the logistics efficiency of CBEC, and the policy environment of cross-border e-commerce.

3. The following are some of the factors that may have an impact on the development of CBEC in ASEAN:

1) Policies and regulations: Policies and regulations formulated by the government are crucial to the development of CBEC. These include tariff policies, trade facilitation policies, e-commerce regulations, intellectual property rights regulations, etc. The formulation and adjustment of these policies will have a direct impact on the operation and growth of CBEC.

2) Market Demand: The development of CBEC in China and ASEAN is driven by market demand. Consumer demand for various types of goods and services, especially cross-border goods, will influence the development direction and sales strategy of e-commerce platforms.

3)Technological Infrastructure: E-commerce relies on advanced technological infrastructure, including Internet coverage, payment systems, and logistics networks. The degree of sophistication of these infrastructures will affect the feasibility and efficiency of CBEC.

4) Payment and financial systems: CBEC requires payment and financial systems that support cross-border transactions. Specifically, this includes international payment methods, foreign exchange policies, cross-border capital flows, etc. These factors will affect the level of trust and convenience for businesses and consumers in CBEC.

5) Logistics and Supply Chain: Effective logistics and supply chain management are crucial for CBEC. Factors such as logistics cooperation, warehousing facilities, and transportation modes can affect the speed and cost of product delivery.

6) Branding and marketing: Brand awareness and marketing strategies are critical to the attractiveness of an e-commerce platform and sales. Establishing and maintaining a good brand image can attract more consumers and merchants to participate.

7) Competitive environment: The competitive landscape and competitors also have a significant impact on the development of CBEC. Competition in the marketplace affects pricing, product innovation, and service quality.

8) Culture and language: Cross-border e-commerce needs to take into account cultural and linguistic differences in different countries and regions. Adapting to local cultures and providing multilingual support is crucial to attract more international customers.

9) International trade relations: International trade relations and cooperation agreements between ASEAN countries can also affect the development of CBEC. Trade agreements, tariff preferences and the establishment of free trade zones can all contribute to e-commerce development.

10) Epidemics and global events: Global events such as epidemics and geopolitical events can have unpredictable impacts on the e-commerce industry, including disruptions in the supply chain and fluctuations in demand.

Taking these factors into account, the development of CBEC in China and ASEAN needs to fully consider a number of aspects, including the policy environment, market demand, technology and infrastructure, payment and finance, logistics and supply chain, in order to better address the challenges and capitalize on the opportunities.

2 Literature Review

Cross-border e-commerce is a new form of trade that can shorten the transaction process and improve the efficiency of transactions, while also having the advantages of openness and globalization. Therefore, it plays a very crucial role in China's opening-up strategy. A large amount of literature on cross-border e-commerce and trade facilitation is read with a view to

finding a research breakthrough in the level of development of cross-border e-commerce and its impact on export trade.

Relevant literature includes JohnS.Wilson, CatherineL.Mann, TsunehiroOtsuki(2003), Duan and Huang (2011), Shi and Wu. (2019), Chen. and Yang (2015), Guan (2016), Zhu (2020), Dong and Chen (2021), Berman, Hericourt (2010), Zhang (2018), Kong and Dong (2015), Chen (2014), Wilson, Mann and Otsuki (2003), Chai. And Dong (2019), Xie (2011), Chen. and Chen D.B (2018), Chen R.H, (2017).

2.1 Research related to the measurement of trade facilitation levels

In the establishment of trade facilitation evaluation system, different indicators are mainly selected for different countries or regions. Zhang (2018) took the BRICS countries as the object of research and selected four first-level indicators of port and logistics efficiency, customs environment, regulatory environment and e-commerce, as well as nineteen second-level indicators to measure the trade facilitation level of the BRICS countries. Kong and Dong. (2015) set port and logistics efficiency, customs and border management, regulatory environment, and finance and e-commerce as the first-level indicators to construct a trade facilitation evaluation system to measure the trade facilitation level of the "Belt and Road" countries.

Chen (2014) examined the facilitation level of the Shanghai FTZ from four aspects: market access, business environment, infrastructure, and government efficiency. Wilson, Mann and Otsuki (2003) were the first to propose a scheme for measuring the level of development of trade facilitation from the perspective of establishing comprehensive indicators, i.e., constructing a trade facilitation evaluation system based on four primary indicators and 12 secondary indicators, namely, port efficiency, regulatory environment, customs management and e-commerce.

Wilson, Mann and Otsuki(2003) selected four indicators, namely port infrastructure, port environment, regulatory environment and e-commerce infrastructure to measure the degree of trade facilitation, and then with the help of the gravity model to measure the relationship between these four indicators and the trade flow, and to analyze each trade facilitation influencing factors on the development of foreign trade. The impact of the improvement of the level on the development of foreign trade. The results show that improving port effectiveness has a significant positive impact on foreign trade flows. However, its improvement effect is not as good as the feedback effect brought by port optimization or regulation.

Duan and Huang (2011) studied and discussed the background, process and impact of the establishment of the China-ASEAN Free Trade Area. It is believed that the establishment of China and ASEAN will further strengthen the economic ties between China and ASEAN countries, promote the process of trade liberalization, and increase the volume of trade and investment between the two sides. At the same time, the establishment of the free trade area will also provide more market opportunities for Chinese enterprises and strengthen China's economic status and influence in the ASEAN region.

Shi and Wu (2019) studied and explored the changes in trade patterns, trade structural adjustment and industrial transfer after the completion of the China-ASEAN Free Trade Area. The paper argues that the establishment of the free trade area has deepened the economic ties between China and ASEAN countries, promoted trade liberalization and investment liberal-

ization, and boosted intra-regional trade and investment flows. In studying the relationship between trade facilitation indicators and cross-border e-commerce development, the indicator of financial services is added to explore the impact of finance on trade facilitation indicators.

2.2 Research related to the economic significance of trade facilitation

Chen and Yang (2015) comprehensively analyze the trade facilitation indicators of the countries along the Belt and Road, and find that by improving the level of trade facilitation, the countries along the Belt and Road can more easily carry out cross-border trade, and enhance their economic ties and cooperation.

2.3 Definition of cross-border e-commerce and related research on influencing factors

Guan (2016) pointed out that cross-border e-commerce refers to the cross-border trade activities in international trade, e-commerce service platform as a medium, connecting the main body of the transaction under different customs, product display, information exchange, order processing, payment and settlement, logistics and distribution and other activities on the platform, and ultimately to reach the purchase and sale of goods and the provision of services and other transactional behavior.

Zhu (2020) used a VAR model to explore the effects of TAR, POP, and per capita income on the development of cross-border e-commerce, and found that a reduction in tariff levels, an increase in population size, and an increase in per capita income would be favorable to cross-border e-commerce development . Dong and Chen (2021) collected data by distributing questionnaires and analyzed the collected data and found that the international environment will have a direct impact on cross-border platforms and cross-border logistics, i.e., changes in the international environment have an important impact on the development of cross-border e-commerce.

2.4 Research related to the development of cross-border e-commerce

Berman, Hericourt (2010) found that a well-developed infrastructure can effectively reduce the production costs of cross-border e-commerce, thus promoting its development. However, due to the complex customs clearance procedures and long logistics cycle, which are detrimental to the development of cross-border e-commerce as well as the consumer experience, it is important to standardize and improve.

2.5 Empirical research on trade facilitation on cross-border e-commerce development

In terms of proving the economic and trade effects of trade facilitation from an empirical point of view, numerous studies have shown that trade facilitation is conducive to the reduction of trade costs and has a significant role in promoting economic trade. Chai and Dong (2019) empirically analyze the impact of trade facilitation on China's cross-border e-commerce exports in countries along the "Belt and Road", and the results of the study show that the impact

of different trade facilitation measures on the exports of cross-border e-commerce has a differentiated effect.

Xie (2011) demonstrates through regression analysis that trade facilitation helps to promote China's exports based on data from 50 trading countries.

Chen and Chen.D.B (2018), taking the countries along the "Belt and Road" as the research object, simultaneously use two measures to prove that there is a positive promotion effect between the trade facilitation level and trade potential of the countries along the route, that is to say, improving the trade facilitation level of the countries along the route can increase the volume of China's trade with the countries along the route, and the impacts of different trade facilitation measures on different regions are also different.

Chen (2017) explored the development status and influencing factors of cross-border e-commerce from the perspective of "Belt and Road" countries. The study found that the inconvenience of trade is one of the main reasons that hinder the further development of cross-border e-commerce. Specifically, because cross-border e-commerce involves a variety of complex trade formalities and customs procedures, coupled with institutional and cultural differences between different countries, cross-border e-commerce faces greater difficulties and obstacles in customs inspection, cargo clearance, etc.

2.6 Summary of the literature review:

According to previous literature, scholars at home and abroad have conducted detailed studies on trade facilitation, cross-border e-commerce and the relationship between them, which provides some ideas for the analysis of this thesis, but the author finds that there are still research gaps. First, in terms of definition, indicator selection and measurement methods, Chinese and foreign scholars do not have the same understanding of trade facilitation, and there is a lack of common definitions, measurement indicators and modeling algorithms with international discourse power. Second, the analysis of the impact of trade facilitation on the development of CBEC is more case-based, and there are few empirical analyses based on mathematical models. Thirdly, most of the studies conducted by scholars took place before the epidemic era, and the impact of various indicators on in the wake of the pandemic, there has been a corresponding rise in trade facilitation.

2.7 Research Ideas and Methods

2.8 Conceptual Framework

The study's meat and potatoes are a set of modelling calculations and empirical assessments that reveal how changes in trade facilitation have affected the expansion of CBEC. Below picture 1 is the conceptual framework diagram:

1) First is the research background and overview of the paper. After that, we introduce the current research status of domestic and foreign scholars, systematically sort out relevant studies, summarizes the effects of trade facilitation on CBEC.On this basis, the innovations and shortcomings of the thesis are presented.At the end of the chapter, the research ideas and methods of the thesis are systematically organized.

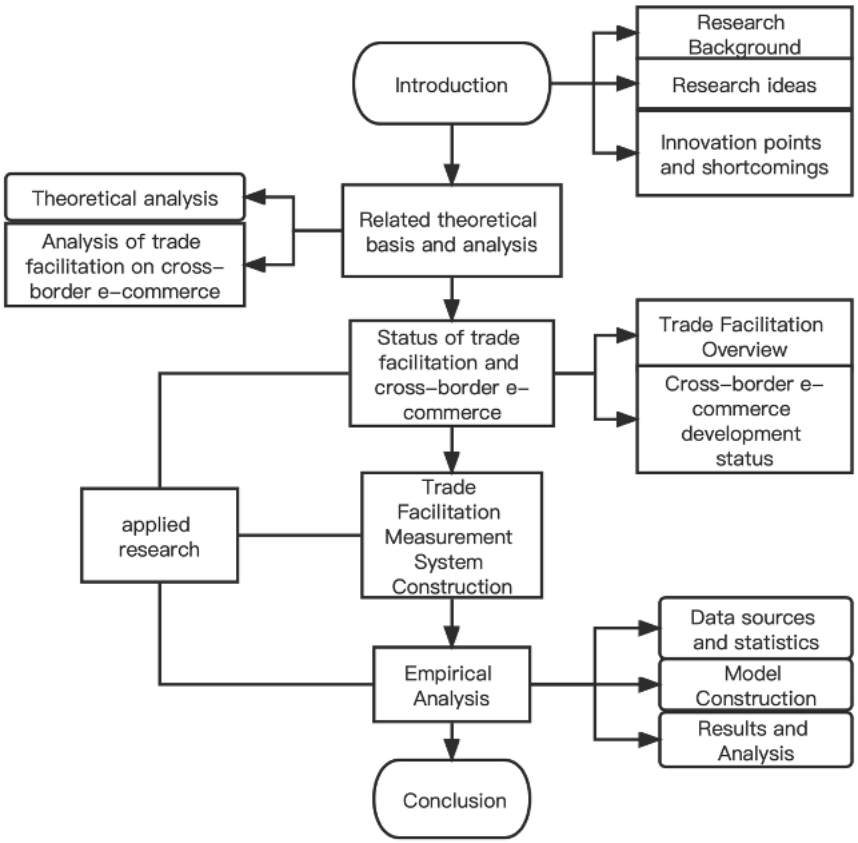

Figure 1: *Conceptual diagram of the research framework*

2) The second section initiates with foundational theory, serving as a foundation for investigating how trade facilitation influences CBEC. It subsequently delves into an extensive examination of the underlying mechanisms, building upon the theoretical framework.

3) The third section begins by presenting an overview of trade facilitation development in China. It proceeds to analyze the international and domestic development of cross-border e-commerce. Following that, it elaborates on the specific progress of CBEC within China. Lastly, it introduces China's development stage, level, and overall progress in the field.

4) The fourth part constructs the measurement system and related measurement. The data on China's CBEC trade is used to develop a measuring system for trade facilitation, with principal component analysis used to determine the importance of each indicator.

5) The fifth part is the empirical analysis. Using a Robust Regression model, the explanatory variables are China's exports to CBEC, with gross national product (PerGDP), trade facilitation level (TFI), tariff (TAR), population size (POP), exchange rate (FX), and foreign direct investment (FDI), for empirical regression.

6) The sixth part is the conclusion and recommendation. Based on the theoretical and empirical analysis, the conclusion of this paper is that CBEC has been developing rapidly with the improvement of trade facilitation. On this basis, the corresponding policy recommendations are given at both government and enterprise levels to encourage the robust and quick growth

Table 1: *Trade Facilitation Metrics Frame*

Primary indicators	Secondary indicators	Data source
Port Efficiency (PRO)	Quality of road infrastructure P1	Global Competitiveness Report (GCR)
	Quality of railroad infrastructure P2	
	Quality of port i nfrastructure P3	
	Quality of air transport infrastructure P4	
Customs environment (CUS)	Prevalence of Non-tariff Barriers C1	Global Competitiveness Report (GCR)
	Customs clearance efficiency C2	Logistics Performance Index Report (LPI)
Institutional Environment (INS)	Judicial Independence I1	Global Competitiveness Report (GCR)
	Burden of government regulation I2	
	Effectiveness of regulations I3	
	Policy Transparency I4	
E-commerce (ELE)	Availability of science and technology E1	Global Competitiveness Report (GCR)
	Technology absorption degree of enterprises E2	
	Buyer's maturity E3	
Financial Services (FIN)	Risk capital availability F1	Global Competitiveness Report (GCR)
	Bank stability F2	

of international e-commerce in China.

2.9 Measurement of trade facilitation levels

Building System and Data Sources The trade facilitation indicator evaluation system developed in this paper merges the assessment framework proposed by Wilson (2003) with the trade facilitation evaluation criteria found in the recent editions of the Global Competitiveness Report by IMD. The primary indicators chosen for evaluation include Port Efficiency, Financial Services,Customs environment and Institutional Environment,. Furthermore, the content of 15 secondary indicators under each primary sub-indicator has been refined and expanded.

The selection of these secondary indicators aligns with the criteria outlined in the IMD Global Competitiveness Report for the year 2022.

The specific composition of the trade facilitation indicator system is shown in the following Table 1.

The significance of the selection of each indicator is as follows:

1) Selection of port efficiency indicators

Port efficiency refers to the time and cost of customs clearance at customs ports for customs and other regulatory agencies, as well as the cargo The waiting time and processing time of goods at the port. Inefficient ports will lead to blockage of goods, long clearance time and increase trade costs, it will be detrimental to businesses engaged in electronic commerce across borders. Therefore, the growth of electronic commerce across borders is significantly influenced by the efficiency of ports.

2) Selection of Customs Environment Indicators

In CBEC, the customs environment serves as a gauge for assessing both the direct transaction costs stemming from customs procedures and the transparency of customs administration and immigration management. A favorable customs environment can significantly benefit enterprises by expediting customs clearance processes, enhancing the efficiency of goods clearance, lowering customs clearance expenses, improving the transparency of customs oversight, increasing the predictability and stability of customs procedures, and ultimately fostering the growth of CBEC.

3) Selection of institutional environment indicators

The independence of the judiciary means that the authorities must act in strict accordance with the law and carry out judicial activities independently and responsibly to safeguard the fairness and impartiality of market transactions, maintain the regular functioning of market economic activity, and advance justice and judicial efficiency.

4) Selection of e-commerce indicators

E-commerce usually refers to the activity of using the Internet, mobile devices and other digital technologies to conduct business transactions, covering areas such as online shopping, online payment, e-marketing, and electronic supply chain management. In e-commerce, enterprises and consumers can communicate, trade and cooperate through the Internet and digital technologies to achieve business goals. The popularity and development of utilizing e-commerce may increase businesses' competitiveness and market share while also giving customers additional options and convenience.

5) Selection of Financial Services Indicators Venture capital is the money invested by institutional venture capital funds in small start-ups with exceptional growth opportunities and potential, and the core criteria for investment selection are high returns in the foreseeable future. When venture capital is highly available, its contribution to the economy is greater.

2.10 Data source

The Global Competitiveness Report (GCR)and the Logistics Performance Index (LPI), both published studies on global competitiveness spanning the period from 2020 to 2022, provide the 15 secondary indicators used to calculate the Trade Facilitation Index in this research. Therefore, this study makes use of data from 2010 through 2020.

Data processing and testing Different indicators may use different units and scales, which makes them incomparable. In this paper, we adopt the Z-Score standardization method to convert the indicators of different scales into the same standard score, which makes them comparable and minimizes the influence of different scales on the analysis results, and facilitates the factor analysis. At the same time, the standardized data have a mean of 0 and a

variance of 1, which is convenient for subsequent data processing and analysis. The specific equation is as follows (1).

$$Z = (X_1 - X_2)/Y_1 \tag{1}$$

Note: The value of the variable is denoted by X1, the mean by X2, the mean variance by Y1, and the standardized value by Z.

At first, we used the results of the KMO (Kaiser-Meyer-Olkin) test with Bartlett's sphericity test to determine whether it was okay to use normalized data for PCA. Stronger variable correlations, as shown by a KMO value closer to 1, suggest more potential for component analysis. However, Bartlett's sphericity test looks at the significance of the correlations between the variables. The variables are strongly connected and appropriate for component analysis if the P-value is small. In general, the data's suitability for factor analysis is indicated by a KMO value over 0.7 and a P-value in Bartlett's test below 0.05.

2.11 Research Designs, Scope and Methods

The research design and scope are as follow:

Method of Statistical analysis We use Stata software for statistical analysis, through which we perform data processing, regression analysis and hypothesis testing. Using Stata, we can organize, transform and filter data and perform regression analysis. At the same time, we also use Excel software to perform data visualization and analysis. Through Excel's charting capabilities, we create line graphs, bar charts, and other visualizations to assist us in exploring data characteristics. Using a combination of Stata and Excel, we were able to obtain accurate and reliable statistical analysis results and present the data in an intuitive graphical format to support the answers to our research questions and inferences of our conclusions.

Methods of measurement In this paper, we will use Principal Component Analysis (PCA) to assess the level of trade facilitation. The level of trade facilitation can be assessed through the following steps:

1.Identify the research object: Identify the regions or countries to be compared and collect the relevant data.

2. Screening indicators: According to the purpose of the study, the indicators related to trade facilitation are screened out from the collected data.

3. Data standardization: Since the data units and scales of different indicators may be different, in order to facilitate comparison, the data need to be standardized so that all indicators have the same scale and standard deviation.

4.Calculate the correlation coefficient matrix: The standardized data will be analysed by correlation coefficient to get the correlation coefficient matrix among the indicators.

5.Extract principal components: Through principal component analysis, the correlation coefficient matrix is transformed into the principal component matrix, and the main dimensions and factors are extracted. 6.Explain the principal components: According to the extracted principal components, explain the influence of each factor on trade facilitation and the performance of each region or country on different factors.

7. Based on the results of the PCA, we will assess and compare the trade facilitation levels for each region or country. Subsequently, we will conduct empirical analyses to investigate the

influence of trade facilitation on the development of cross-border e-commerce. The empirical findings will be thoroughly examined to gain insights into how trade facilitation impacts international cross-border e-commerce growth.

Finally, we will provide a comprehensive review and discussion of strategies aimed at improving trade facilitation in China, as well as the effects of trade facilitation factors on the scale of cross-border export e-commerce transactions. For measurement and analysis, we will utilize Stata software.

2.12 Empirical analysis of the impact of trade facilitation on the development of CBEC.

Model Construction An intuitive understanding of the present state and development of cross-border e-commerce may be gained by using the amount of export trade in CBEC as an explanatory variable. This number is useful because it shows the scope and rate of expansion of international trade, especially in exports conducted through CBEC. However, no authoritative cross-border e-commerce export trade volume statistics exist in China yet, based on the research results of scholars in recent years, this paper will draw on the ideas of Ai Rui Consulting, and the specific expressions are as follows:

$$\text{EXP} = \text{Cross-border e-commerce export scale} * \frac{\text{Import trade volume to CHINA}}{\text{CHINA total export trade}}$$

Data source: The CBEC export scale information provided by China's Ministry of Commerce, Ariadne Consulting Statistical Report and Foresight Logistics Industry Research Institute Statistical Report, US Comtrade Database National Bureau of Statistics

Model Selection In this paper, one of the main problems we faced was the presence of heteroskedasticity in the regression model. Therefore, we used a robust regression model. This approach originated from the research of economist White (1980), who proposed this method of correcting OLS estimation results, namely OLS + robust standard errors, which aims at solving the common problem of heteroskedasticity in regression analysis.

Heteroskedasticity is a common problem in practice because the error variance sometimes changes as the independent variable changes. The traditional OLS approach only assumes that the error variance remains constant, but if the heteroskedasticity assumption is ignored, the OLS estimates will be biased and invalid, and the standard error estimates will be inaccurate. In this case, the OLS + robust standard error method is an appropriate choice. The method provides robust estimates of heteroskedasticity by nonparametric estimation of the variance-covariance matrix of the residuals. Robust standard errors correct the standard error estimates to make them more reliable and accurate.

Thus, using the OLS + robust standard error approach yields more accurate and reliable estimates of the regression coefficients and guarantees the validity of the statistical inference. By solving the heteroskedasticity problem, we are able to improve the reliability and robustness of regression analysis in empirical research, and thus conduct model analysis and conclusion inference with more confidence.

Meanwhile, we also introduced control variables such as GDP per capita, total population, exchange rate and tariff to further explore their impact on the scale of cross-border e-commerce

import and export transactions. These control variables can reflect the extent to which the country's overall economic strength, market openness, trade policy, and monetary policy affect cross-border e-commerce import and export transactions. Through the comprehensive study of these factors, we can better understand the formation mechanism of the scale of cross-border e-commerce import and export transactions and provide a reference basis for the formulation of relevant policies.

In order to avoid the covariance relationship between variables, we choose four control variables, which is because many indicators involving trade facilitation have been included in the previous paper. In order to better explain the relationship between the variables, we performed logarithmic transformation on some of them. Logarithmic transformation reduces the range of variation of the variables and brings the variance of each independent variable closer to each other. After the logarithmic transformation operation, we can use the conclusions of related studies to construct the model of this paper: (2):

$$\ln EXP_{ij} = \alpha_0 + \alpha_1 \ln PerGDP + \alpha_2 \ln TFI + \alpha_3 \ln POP + \alpha_4 \ln TAR + \alpha_5 \ln FX + \varepsilon_{ij} \quad (2)$$

Table 2: *Impact indicators of CBEC import and export transaction scale.*

Index	The secondary indicators	Data sources	Unit	Time
LNPerGDP	Per capita GDP	World Bank Database	USD	2010-2020
LNTAR	Tariffs	National Bureau of Statistics of China	Tax rate	2010-2020
LNFX	Exchange Rates	World Bank Database	Local currency/USD	2010-2020
LNPOP	Total population	World Bank Database	One billion people	2010-2020
LNTFI	Trade facilitation			

Explanation of variables and data sources EXP_i denotes country i's CBEC import trade to China

ε_{ij} denotes the random perturbation term.

On the basis of the above constructed model indicators, we can put forward the following alternative hypotheses and null hypotheses:

Alternative hypothesis (H1): the increase of trade facilitation index will significantly promote the growth of China-ASEAN cross-border e-commerce export scale.

Null hypothesis (H0): the trade facilitation index has no significant effect on the scale of China-ASEAN cross-border e-commerce exports.

In order to test the above hypothesis, we will conduct a regression analysis and use the cross-border e-commerce export scale as an explanatory variable and the trade facilitation index as an explanatory variable. In addition, we will control for GDP per capita, exchange rate, tariff and population size.

Through empirical analysis and statistical significance tests, we will finally draw conclusions about the extent and direction of the impact of trade facilitation on the scale of China-ASEAN cross-border e-commerce exports.

Table 3: *Test results*

KMO test and Bartlett's test of sphericity		
KMO Indicators of Sampling Appropriateness		0.894
Bartlett's degree of sphericity test	Chi-square	2014.905
	Degree of freedom	105
	Sig	0.000

If the empirical results show that the increase in the trade facilitation index is significantly positively correlated with the scale of China-ASEAN cross-border e-commerce exports, we can conclude that with the increase in the level of trade facilitation, the scale of China-ASEAN cross-border e-commerce exports will also grow accordingly. This means that trade facilitation helps to promote the development of cross-border e-commerce and has a positive impact on the economic cooperation between China and the ASEAN region.

However, if the empirical results show that there is no significant association between the trade facilitation index and the scale of China-ASEAN cross-border e-commerce exports, we cannot support the alternative hypothesis (H1). This suggests that trade facilitation does not have a significant impact on the growth of China-ASEAN cross-border e-commerce export scale. In this case, we need to reconsider the impact of other factors on the development of cross-border e-commerce and find other ways to effectively promote economic cooperation between China and the ASEAN region.

3 Empirical Results

3.1 Data testing

First, the standardized data's suitability for principle component extraction is checked using the KMO test and the degree of sphericity test developed by Bartlett.

If the KMO score is high (closer to 1), then the variables are highly correlated and suitable for factor analysis. Bartlett's test of sphericity determines the importance of correlations between variables; a low P-value indicates weaker correlations and indicates that component analysis may be appropriate.

Table 3 below displays the assessment outcomes.

Bartlett's test of sphericity yields an estimated chi-square value of 2014.905 with a p-value of 0, while the KMO test suggests a KMO statistic value of 0.894 for the dataset. The data is typically suitable for factor analysis when the KMO value is more than 0.7 and the p-value from Bartlett's test is less than 0.05. In conclusion, these indicators meet the requirements and may be used in a factor analysis.

3.2 Results measurement and analysis of trade facilitation levels

The process of empirical analysis Factor scores and composite scores

Factor score coefficients were calculated using regression analysis to derive expressions for the relationships between the factors and the standardized variables. The coefficients of the factor scores are calculated in Table 4-2, and according to the coefficients in the table, we can

write the expression of the relationship between the factors and the standardized variables as follows.

Table 4: *Total Variance Explained*

Ingredients	The initial eigenvalue			Extract the sum of the squares of the loads			Rotational load sum of squares		
	Total amount	Variance %	Cumulative %	Total amount	Variance %	Cumulative %	Total	Variance %	Cumulative %
F1	12.118	80.784	80.784	12.118	80.784	80.784	8.256	55.039	55.039
F2	0.888	5.921	86.705	0.888	5.921	86.705	4.75	31.665	86.705
F3	0.588	3.917	90.622						
F4	0.407	2.717	93.338						
F5	0.289	1.928	95.266						
F6	0.233	1.555	96.821						
F7	0.152	1.013	97.833						
F8	0.101	0.673	98.507						
F9	0.077	0.513	99.02						
F10	0.046	0.307	99.326						
F11	0.037	0.246	99.573						
F12	0.028	0.185	99.758						
F13	0.018	0.123	99.88						
F14	0.01	0.068	99.949						
F15	0.008	0.051	100						

From the above table, it can be seen that the first two components F1 and F2 explain a total of 86.705% of the total variance, which is greater than 85%. So the first two components are selected for subsequent analysis.

$$\begin{aligned} F1 =& 0.777P1 + 0.927P2 + 0.832P3 + 0.781P4 + 0.679C1 + 0.704C2 + 0.826I1 \\ &+ 0.892I2 + 0.806313 + 0.84614 + 0.43E1 + 0.35E2 + 0.741E3 + 0.311F1 + 0.859F2 \end{aligned} \tag{3}$$

$$\begin{aligned} F2 =& 0.567P1 + 0.277P2 + 0.484P3 + 0.541P4 + 0.601CI + 0.507C2 + 0.48I1 \\ &+ 0.373I2 + 0.455I3 + 0.46814 + 0.834E1 + 0.756E2 + 0.533E3 + 0.875F1 + 0.308F2 \end{aligned} \tag{4}$$

Score in the overall evaluation of trade facilitation:

$$F = (55.039 * F1 + 31.665 * F2)/86.705 \tag{5}$$

On the basis of the comprehensive model mentioned above, the weights of each second-level indicator can be derived through calculation, and the weights of each first-level indicator can be accumulated to realize the comprehensive evaluation and ranking of the indicator system. Therefore, the weights occupied by all indicators are shown in Table 5:

Among the tier-1 indicators of trade facilitation, the most influential of the indicator factors is the institutional environment with 27.32 per cent, the second is port efficiency with a weight of 26.51 per cent, the third is the customs environment, which contributes 9.9 per cent of the impact factor, then e-commerce with 7.76 per cent, and lastly financial services with the smallest weight of 7.5 per cent. The quality of railroad infrastructure is the most weighted of the secondary indicators at 8.25%.

Table 5: *Weights of Trade Facilitation Indicators*

Main indicators	weight	Secondary Indicator	weight
Port Efficiency (POR)	0.2651	Quality of road infrastructure P1	0.0576
		Quality of railroad infrastructure P2	0.0825
		Quality of port infrastructure P3	0.0659
		Quality of air transport infrastructure P4	0.0591
Customs environment (CUS)	0.099	Prevalence of Non-tariff Barriers C1	0.0469
		Customs clearance efficiency C2	0.0521
Institutional Environment (INS)	0.2732	Judicial Independence I1	0.0656
		Burden of government regulation I2	0.0757
		Effectiveness of regulations I3	0.0643
		Policy Transparency I4	0.0676
E-commerce (ELE)	0.0776	Availability of science and technology E1	0.014
		Technology absorption degree of enterprises E2	0.0086
		Buyer's maturity E3	0.055
Financial Services (FIN)	0.075	Risk capital availability F1	0.0003
		Bank stability F2	0.0747

Analysis of measurement results China's trade facilitation score has shown improvement over the years, increasing from 0.601 in 2010 to 0.691 in 2020. This signifies a continuous enhancement of China's trade environment in recent times. However, it's worth noting that despite these improvements over the past decade, there is still a gap when compared to developed countries. China plays a pivotal role in international commerce as the world's biggest trading nation and the country with the second largest GDP. Therefore, it is essential for China to reinforce the implementation of trade facilitation measures to bolster its international competitiveness and appeal.

Examining ASEAN member states' trade facilitation efforts Based on these metrics, Singapore is clearly the leader in trade facilitation. Significantly outperforming other ASEAN nations. This observation aligns with Singapore's reputation for having the most favorable trade environment in Asia. The data highlights variations among ASEAN countries in their progress towards trade facilitation. While Singapore, Malaysia, and Thailand have made notable advancements, other countries are progressing at a slower pace. This underscores the need for China and ASEAN countries to adopt tailored strategies based on the specific circumstances of each nation when promoting cross-border e-commerce development. Targeted implementation of trade facilitation measures is essential to accommodate these differences effectively.

3.3 Analysis of trade facilitation's effect on CBEC's growth based on empirical data.

Descriptive Statistics In order to provide the framework and foundation for the ensuing empirical analysis, statistical analysis refers to the process of summarizing and characterizing

Figure 2: *Chart of changes in China's trade facilitation level score from 2010 to 2020*

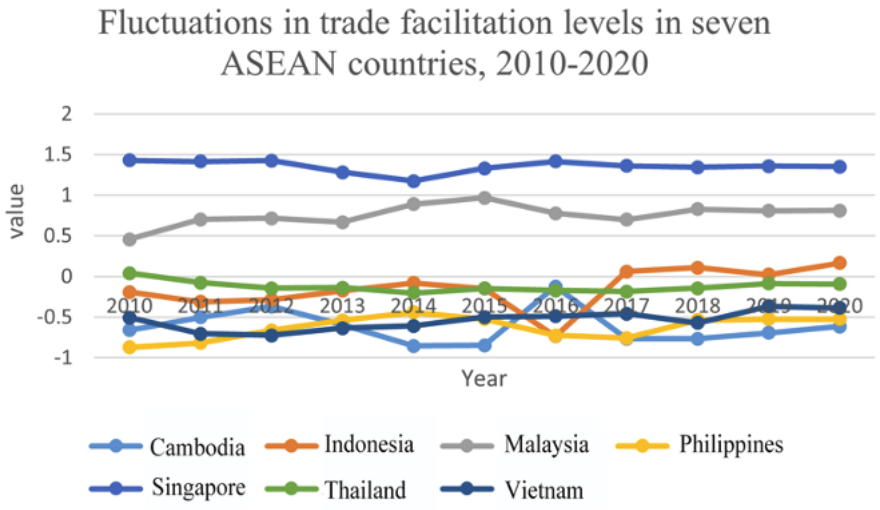

Figure 3: *Changes in the degree of trade easement among ASEAN nations*

the data as a whole. This includes determining the center position, degree of dispersion, distribution pattern, and other fundamental aspects of the data.

Table 6: *Concise Statistics*

VarName	Obs	Mean	SD	Min	Median	Max
EXP	77	2876.59	5617.354	0.259134	473.201	23156.1
LNEXP	66	8.16	3.111	0.9521735	9.044012	12.3526
TFI	77	0.01	0.729	-0.869	-0.173	1.4311
PerGDP	77	12141.13	19202.491	782.6992	3613.796	66836.33
POP	77	0.82	0.806	0.050767	0.702944	2.71858
LNPOP	77	-0.77	1.214	-2.980509	-0.352478	1.00011
Tar	66	0.02	0.031	0	0.0131205	0.108414
FX	77	5391.72	7873.789	1.24968	45.5028	23208.4

Note: Logarithmic treatment of level-valued variables to minimize unit-measurement gaps between data and subsequent regression calculations.

According to Table 6, we can observe that there are significant differences between ASEAN countries in the following areas:

1. the scale of cross-border e-commerce exports: there are large differences in the total amount of exports between the countries, which is reflected in the different levels of cross-border e-commerce development.

2. economic level: large differences in GDP per capita, reflecting the countries' differences in economic development, industrial structure and resource utilization.

3. trade facilitation: there are differences in the trade facilitation index, which may be constrained by factors such as trade policy, financing environment, logistics efficiency and border management.

4. Population: Population size varies considerably across countries, reflecting differences in population size.

5. Exchange rates: There are also differences in currency exchange rates, which may be subject to countries' economic policies and foreign exchange markets.

that these differences may have important implications for trade cooperation and cross-border economic activities among ASEAN countries.

3.4 Correlation test

Next we need to perform a correlation test, which ensures that there is a correlation between the dependent and independent variables is a key step in constructing a regression model. The purpose of testing for correlation is to further analyze the regression relationship and create an appropriate model to explain and predict changes in the dependent variable.

Table 7 shows these data demonstrate the results of correlation coefficient calculations between the above variables. These correlation coefficients can be used to assess the degree of correlation between the variables and further guide the regression modeling and analysis.

According to the results of descriptive statistics in Tables 7, there is a correlation between the size of cross-border e-commerce exports of ASEAN countries and other indicators. These

Table 7: *Correlation test results for exports*

Variable	LNEXP	TFI	LNGDP	TAR	LNFDI	LNFX
LNEXP	1					
TFI	0.775***	1				
FX	-0.286**	-0.322***	1			
PerGDP	0.632***	0.673***	-0.335***	1		
TAR	-0.375***	-0.680***	-0.136	-0.421***	1	
LNPOP	-0.105	-0.402***	0.474***	-0.721***	0.373***	1

indicators include log Trade Facilitation Index (log TFI), exchange rate (FX), gross domestic product per capita (PerGDP), tariff rate (TR) and total population (POP).

The correlation coefficients show the following trends:

1. the logarithm of TFI shows a significant positive correlation with the scale of cross-border e-commerce exports, indicating the importance of trade facilitation for the development of cross-border e-commerce.

2. FX shows a weak negative correlation with the size of cross-border e-commerce exports, indicating that the size of cross-border e-commerce exports may be affected by the exchange rates of different countries' currencies.

3. PerGDP shows a significant positive correlation with the scale of cross-border e-commerce exports, indicating that the improvement of economic level will promote the growth of cross-border e-commerce exports.

4. TR and the scale of cross-border e-commerce exports show a significant negative correlation, suggesting that lower tariff rates may help promote the growth of cross-border e-commerce exports.

5. the correlation between POP and the size of cross-border e-commerce exports is weak, although the correlation between the two is small, the size of the population in a large country may still have some influence on the size of cross-border e-commerce exports.

These correlation results provide important clues to understand the development of cross-border e-commerce among ASEAN countries and can inform policymakers in formulating effective trade policies and economic development strategies.

Regression test 1. Multiple covariance test

When there is multicollinearity between independent variables, it will lead to the instability of regression coefficients, increase in standard error, decrease in the level of statistical significance and other problems, thus affecting the reliability and validity of the model. In regression analysis, multicollinearity can lead to problems such as inaccurate parameter estimation, regression coefficients with signs opposite to those expected, increase in standard error, and decrease in the level of statistical significance.

The main tests are Tolerance and VIF. the most commonly used one is VIF, which is calculated by the formula:

$$\mathrm{VIF} = \frac{1}{(1 - R_i)^2} \tag{6}$$

The indicators for multicollinearity test include VIF (Variance Inflation Factor) and tolerance.

The VIF values were found to be correlated with the degree of multicollinearity in a positive manner, whereas the tolerance was found to be correlated negatively with the extent of multicollinearity. Generally, when the VIF value is greater than 10 or the tolerance is less than 0.1, it indicates that there is a serious multicollinearity problem.

The results obtained after the test are shown in Table 4-6, from which it can be seen that the problem does not exist between the variables.

Table 8: *Results of Variance Expansion Coefficient Tests*

Variable	variance inflation factor (VIF)	1/VIF
TFI	3.80	0.263042
FX	3.78	0.264460
PerGDP	3.70	0.270380
TAR	3.06	0.326819
LNPOP	2.12	0.471828
Mean VIF	3.29	

2. Heteroskedasticity test

The BP test was used in this study to assess the heteroskedasticity in the model. This may increase the accuracy and dependability of study findings and further enhance our interpretation and understanding of the experimental results. And we should also take note of data analysis and result interpretation from the perspective of heteroskedasticity problem to ensure the scientific and credibility of the study.

Table 9: *Breusch-Pagan Inspection results*

Statistical indicators	Statistical value
chi2(1)	4.05
Prob >chi2	0.0442
chi2(5)	19.16
Prob >chi2	0.0018

Based on the results of table 9 the Breusch-Pagan/Cook-Weisberg heteroskedasticity test, it can be concluded that based on the assumption that the error terms are independent and identically distributed, the fitted values of the explanatory variables and all the independent variables show heteroskedasticity, i.e., their variance is not constant.

Regression model selection This research employed the OLS (Ordinary Least Squares) estimate technique in conjunction with the robust standard errors approach to handle the issue of heteroskedasticity in the data and guarantee accurate and dependable regression analysis findings.

In statistical analysis, heteroskedasticity can lead to inaccuracies in OLS estimation because OLS methods usually assume that the error term has constant variance. To overcome this problem, we employ robust standard errors to deal with heteroskedasticity. The main purpose of robust standard errors is to correct for heteroskedasticity in order to more accurately estimate the standard errors and confidence intervals of the regression coefficients and to generate more reliable hypothesis tests.

Table 10: *Results of export regression*

Variable	LNEXP
LNTFI	1.237***
	(3.93)
LNFX	-0.000345***
	(-8.99)
Tar	-22.93**
	(-3.22)
Pergdp	0.000130***
	(9.96)
LnPop	2.353***
	(9.78)
Constant	10.19***
	(39.76)
Observations	66
R-squared	0.9668
F(5, 60)	349.01

Empirical results and analysis I. Overall regression results

1. The Influence of the Level of Trade Facilitation on CBEC in China

From the above table, the coefficient relationship between the variables is:

$$\ln EXP = 1.237 * \ln TFI + 0.00013 * \ln PerGDP - 22.93 \ln TAR + 2.353 \ln POP - 0.000345 \ln FX + 10.19 \quad (7)$$

From the results of the regression equation (7):

About the Trade Facilitation Index:

The logarithmic coefficient of the trade facilitation index is 1.237, showing that the scale of cross-border e-commerce exports from ASEAN countries is expected to increase by 2.457 times, or about 145.7%, when the trade facilitation index increases by one unit. In the current globalized economic context, trade facilitation is considered an important factor in promoting international trade and economic growth. The implementation and promotion of trade facilitation policies have made trade processes in ASEAN countries more streamlined and efficient, reducing trade costs and providing a better environment for enterprises to carry out cross-border e-commerce activities.

1.Trade facilitation policies have improved trade processes in ASEAN countries, including the simplification of customs clearance procedures, the standardization of customs clearance procedures and the digitization of trade documents, thereby shortening the delivery time of goods from the exporting country to the target market and making it easier for enterprises to complete trade transactions.

2.Trade facilitation policies have reduced trade costs, including lowering tariffs and non-tariff barriers, reducing trade handling fees and logistics costs, and easing the economic burden on enterprises engaging in cross-border e-commerce.

3.Trade facilitation policies have boosted the digital economy in ASEAN countries, contributed to the prosperity of e-commerce platforms and the building of user trust, and further contributed to the growth in the scale of cross-border e-commerce exports from ASEAN countries.

On exchange rate indices:

The logarithmic coefficient of the exchange rate is -0.000345 and the results indicate that when the exchange rate increases by one unit, the size of cross-border e-commerce exports of ASEAN countries is expected to decrease to 0.710 times (about 71.0%) of the original size. The exchange rate has a significant impact on the size of cross-border e-commerce exports of ASEAN countries.

When the exchange rate appreciates, the prices of ASEAN countries' export commodities rise relatively, thus reducing their competitiveness in the international market. This phenomenon can be explained in two ways:

1.Exchange rate appreciation leads to the appreciation of the national currency, which makes the price of the country's products rise in the foreign currency market, thus reducing the competitiveness of the exported goods. The products of cross-border e-commerce exporters become more expensive, which may lead to a decrease in demand, which in turn affects the reduction of export size.

2. Exchange rate appreciation may also lead to higher production costs in ASEAN countries. While the price of imported raw materials and equipment has declined, a rise in the price of exported products could offset this advantage, making production costs relatively higher. This is particularly unfavorable for cross-border e-commerce firms that rely on imported raw materials and equipment, and high costs may limit their expansion and competitiveness, thus affecting the reduction in the scale of cross-border e-commerce exports. Thus, exchange rate appreciation has adversely affected cross-border e-commerce exports from ASEAN countries.

On the tariff index:

The coefficient of the tariff rate is -22.93, indicating that when the tariff rate increases by one unit, the size of cross-border e-commerce exports from ASEAN countries is expected to decrease by 22.93 units. This suggests that an increase in tariff rates may hinder the development of cross-border e-commerce exports in ASEAN countries. First, the increase in tariffs will increase the cost of imported goods, thus weakening the competitiveness of ASEAN countries in the international market. This may lead to a reduction in demand and have a compressive effect on the scale of cross-border e-commerce exports. In addition, increased tariffs can trigger retaliatory tariff measures in importing countries, creating further trade barriers and creating uncertainty and impediments to companies' overseas sales. At the same time, rising tariffs may also have a negative impact on supply chain stability.

On the per capita GDP index:

The coefficient of GDP per capita is 0.00013, indicating that when GDP per capita increases by 1 unit, the scale of cross-border e-commerce exports from ASEAN countries is expected to increase by 0.013%. There is a close correlation between the increase in GDP per capita and the increase in the scale of cross-border e-commerce exports in ASEAN countries.

An increase in GDP per capita means that the overall economic strength of ASEAN countries increases, providing more resources and opportunities for domestic businesses. Economic development enables enterprises to better invest in technological innovation and

marketing strategies to improve product quality and competitiveness, thus driving the growth of cross-border e-commerce export scale.

About the population index:

The coefficient of population size is 2.353 ($p < 0.001$), indicating that the size of cross-border e-commerce exports from ASEAN countries is expected to increase by 2.353 units when the logarithm of population in billions increases by 1 unit. This indicates that the increase in population size has a positive impact on the size of cross-border e-commerce exports. The increase in population size in ASEAN countries has a positive effect on the growth of cross-border e-commerce export size.

II. Robustness check

Table 11: *Robustness test regression results*

Variable	LNEXP
LnTFI	1.083**
	(3.46)
FX	-0.000348***
	(-9.77)
Tar	-23.88***
	(-3.54)
Pergdp	0.000132***
	(10.42)
LnPop	2.448***
	(10.28)
Constant	10.34***
	(41.91)
Observations	60
F(5, 54)	159.31
R-squared	0.9230

Note: Statistical value of T in parentheses, * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

The table displays the test findings, which indicate that the L.TFI regression coefficient is 1.083. The results are robust and significant at the 5% level of significance.

4 Conclusion

(1) First, after applying the trade facilitation assessment indicators updated by IMD in recent years and applying the relevant data from 2010 to 2020, it is found that from 2010 to 2020, our country's trade facilitation level shows a gradual upward trend, but the increase is not enough because it is at an intermediate to high level compared to ASEAN trading partner countries. Our country is a global economic powerhouse, so from this dimension, our country's trade facilitation development is relatively backward.

(2) Second, The Regression analysis in this article uses Robust Regression model, the explanatory variables are China's total CBEC import transactions and CBEC export transactions

to ASEAN countries, such as Singapore, Thailand, the Philippines and Vietnam, and the explanatory variables are:TFI, GDP, FDI, FX, and TAR, in which the TFI serves as the main explanatory variable, and the others are uncontrolled variables. The result is obtained: the improvement of TFI will lead to Expansion of the size of the Chinese economy by CBEC exports, which will lead to the development of CBEC in the two trading countries.

(3) Thirdly, in breaking down the degree of impact that each indicator has on trade facilitation, it is found that there are differences in the degree of impact of different indicators. Based on the currently captured data and evaluation criteria, the institutional environment has the largest impact.

(4) suggestion for policy Along with the Informa ionization of globalization and the continuous development of the Internet, the mode of foreign trade between countries is also changing. As a new industry, cross-border e-commerce is playing an increasingly important role in foreign trade. How to promote the development of cross-border e-commerce is one of the important economic development challenges facing the world in the future. Through the above analysis, this paper will give relative suggestions from the perspectives based on government and enterprises to enhance our trade facilitation and promote the development of cross-border e-commerce comprehensively.

1.At the governmental level

1) Improve infrastructure construction and enhance port efficiency.
2) Emphasize scientific and technological inputs and improve financial services.
3) Improving the customs environment and developing e-commerce
4) Strengthening the system and following up on the effects of implementation

2.At the enterprise level

1) Strengthening information technology to enhance the core competitiveness of enterprises.
2) Emphasis on cultivating and attracting talented people.
3) Developing international strategic thinking

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