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Extraction of acid phosphatase from mung bean sprouts and determination of its enzymatic properties

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Abstract: To investigate the enzymatic properties of acid phosphatase from mung bean sprouts and explore the optimal reaction conditions for this enzyme. This study extracted phosphatase from fresh mung bean sprouts and determined its enzymatic properties. It was found that the activity of acid phosphatase in 1ml of mung bean sprout enzyme solution was 8.68, the optimal pH was 5.4, and the temperature at which the activity was highest was 50 degrees Celsius. This study not only determined the enzymatic properties of the enzyme and obtained the optimal reaction conditions, laying the foundation for related research, but also providing theoretical guidance for subsequent industrial applications.

Keywords: Acid Phosphatase, Enzymatic Properties, Optimum Condition, Mung Bean Sprouts, Enzyme activity

1. INTRODUCTION

Acid phosphatase (ACPase) is widely distributed in animals and plants and is an important enzyme in biological phosphorus metabolism[1]. In addition to participating in phospholipid metabolism, it also participates in important life activities such as metabolic regulation and energy conversion. ACPase is involved in plant phosphorus metabolism and plays an important role in cellular regulation.

These enzymes play important roles in various biological processes within the organism, such as cellular signaling, energy metabolism, and disease development. In recent years, significant progress has been made in the study of acid phosphatase, particularly in structural biology, enzyme activity regulation mechanisms, and disease correlation. In terms of structural biology, scientists have revealed the three-dimensional structure of various acid phosphatase enzymes through X-ray crystallography and nuclear magnetic resonance (NMR) techniques. These structural information are of great significance for understanding the catalytic mechanism of enzymes and designing inhibitors. For example, studies have found that the active sites of ACP typically contain iron ions, which are crucial for the catalytic activity of enzymes[2].In terms of enzyme activity regulation mechanisms, researchers have explored how factors such as pH, metal ions, and substrate specificity affect the activity of ACP. For example, pH has a significant impact on the activity of ACP, with enzymes exhibiting the highest activity in acidic environments. In addition, certain metal ions can act as cofactors to enhance the activity of ACP[3].In

terms of disease relevance, an increasing number of studies have shown that ACP is closely related to the development of various diseases, such as prostate cancer, osteoporosis, and neurodegenerative diseases. Therefore, ACP is considered a potential biomarker and therapeutic target. For example, prostate acid phosphatase (PAP) is an important biomarker in the diagnosis of prostate cancer[4-8].

The enzymatic activity of ACP in mung bean sprouts is essential for plant growth. It is involved in the hydrolysis of phosphate compounds, releasing phosphoric acid and organic molecules, which are important for energy conversion and utilization in plants. In addition, ACP is involved in signaling processes in plants, especially during the seed germination and seedling growth stages, and changes in ACP activity may be an important factor in regulating these physiological processes. By regulating the activity of ACP, the growth rate and acclimatization of the plant, and consequently its ability to adapt to the growing environment, can be influenced.The importance of ACP in plant growth and development, and understanding and determining its optimal response conditions are of practical importance for improving and controlling plant growth. By optimizing these conditions, the activity of ACP can be increased to promote the growth of mung bean sprouts or, in the case of agricultural production, to improve crop yield and quality by regulating these conditions.

This experiment used mung bean sprouts as the experimental material, isolated and purified ACPase, and studied its enzymatic properties, providing theoretical reference for the cultivation of mung bean sprouts[9][10].This study not only determined the enzymatic properties of the enzyme and obtained the optimal reaction conditions[11], laying the foundation for related research[12], but also providing theoretical guidance for subsequent industrial applications[13].

2. MATERIALS AND METHODS

2.1 Acid phosphatase extraction

Pinch off the roots and leaves of mung bean sprouts to obtain mung bean sprouts and stems, weigh 50g of mung bean sprouts and stems, thoroughly grind them in a mortar, let them stand at room temperature for 30 minutes[14], and squeeze and filter with double-layer gauze in a culture dish to obtain the filtrate. Transfer the filtrate to two centrifuge tubes, balance them, and place them in a centrifuge. Centrifuge at a speed of 12000 r/min for 8 minutes[15]. Transfer most of the supernatant from the centrifuge tube to a graduated cylinder, and filter a small portion of the supernatant close to the sediment through filter paper.

2.2 Determination of acid phosphatase activity

Disodium phenyl phosphate can be hydrolyzed by acid phosphatase to produce phenols and inorganic phosphorus. When there is a sufficient amount of substrate sodium diphenylphosphate present, the greater the activity of acid phosphatase, the more phenols and organic phosphorus produced. According to the definition of enzyme activity units, 1 is generated per minute under the optimal conditions of enzymatic reactions μ The enzyme required for the mol product is one activity unit, so the activity of acid phosphatase can be expressed by measuring the product phenol using the Folin phenol method or by measuring inorganic phosphorus using the fixed phosphorus method.

Six test tubes were taken for the production of standard curves, numbered from 00 to 05, with empty tubes numbered as 00. Reagents were added in sequence according to Table 1, and after adding the reagents, the absorbance test was performed after standing still for 35 minutes.

Table 1： Production of Standard Curve.

Reagent	Test tube number					
	00	01	02	03	04	05
0.4mmol/LPhenol standard solution	0	0.1	0.2	0.3	0.4	0.5
0.05mol/L pH5.0 citrate buffer	1	0.9	0.8	0.7	0.6	0.5
1mol/L sodium carbonate solution	5.0	5.0	5.0	5.0	5.0	5.0
Folin reagent	0.5	0.5	0.5	0.5	0.5	0.5

Using test tube 00 as a blank, read the optical density OD680nm of each tube at a wavelength of 680nm on a visible spectrophotometer. Use OD680nm as the x-axis and the volume (mL) of phenol standard solution as the y-axis to draw the standard curve using a first-order function fitting method.

Take 2 test tubes, number and operate according to Table 2, and measure the enzyme activity of acid phosphatase.

Table 2： Enzyme Activity Determination.

Procedure	Test tube number	
	01'	00'
Add 5mmol/L sodium benzoate solution	0.5 ml	0.5 ml
Preheat at 35 ℃ for 2 minutes		
Add enzyme solution preheated at 35 ℃	0.5 ml	0 ml
Accurate reaction for 10 minutes		
1mol/L sodium carbonate solution	5ml	5ml
Folin reagent	0.5ml	0.5ml
Add enzyme solution preheated at 35 ℃	0 ml	0.5 ml
Shake well, keep at 35 ℃ for 10 minutes to develop color		

Using test tube 00 'as a control, measure the OD680nm optical density value of test tube 01' at 680nm using a visible spectrophotometer. Calculate the volume (V) of the phenol standard solution corresponding to OD680nm based on the standard curve. Calculate the enzyme activity corresponding to 1ml of enzyme solution according to Equation 1[11].

$$\text{enzyme activity} = \frac{2 \times 0.4 \times V \times 1000}{10} \tag{1}$$

2.3 Determination of optimal temperature

Take 9 test tubes and number them from 20 to 28. The experimental design is shown in Table :3. Add 1.0mL of 1.2mmol/L NPP solution to test tubes 1-8 and keep at their corresponding temperatures for 2 minutes. After insulation, test tubes 1-8 were added to the enzyme solution in a constant temperature water bath at 10 ℃, 20 ℃, 30 ℃, 35 ℃, 40 ℃, 50 ℃, 60 ℃, and 70 ℃ for 2 minutes. After 15 minutes of precise reaction, add 3.0mL of 0.3mol/L NaOH solution to terminate the reaction. The reaction temperature of tube 20 is 50 ℃. First, 3.0mL of 0.3mol/L NaOH solution is added, and then enzyme solution is added. After each tube is terminated, OD405nm is measured sequentially using tube 10 as a control. The results are recorded according to different pH values.

Table 3： Enzyme Activity Determination Process.

Test tube number	20	21	22	23	24	25	26	27	28
Reaction temperature(℃)	50	10	20	30	35	40	50	60	70
1.2mmol/L NPP(ml)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Enzyme solution (ml)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
0.3mol/L NaOH(ml)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

3. CONCLUSION

Using OD680nm as the x-axis and the volume (mL) of the phenol standard solution as the y-axis, perform a first-order function fitting to obtain the standard curve, as shown in Figure 1.
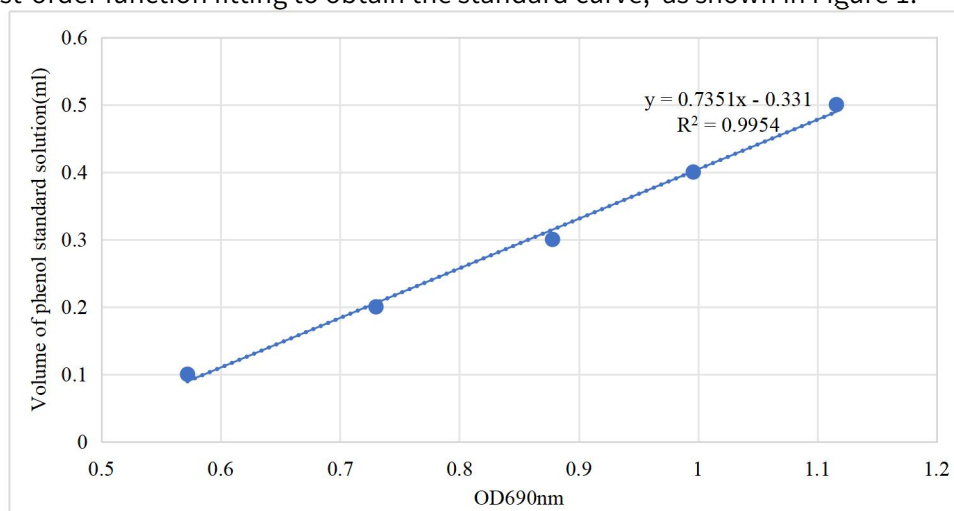
Figure 1. Standard curve

The volume corresponding relationship between OD680nm and phenol standard solution is shown in equation 2. The standard curve R^2=0.9954 after a single fitting in this experiment indicates that the curve is relatively accurate.

$$y = 0.7351x - 0.331$$
(2)

In the formula, x represents the optical density value at 680nm, and y represents the volume of phenol standard solution (ml)

Using a visible spectrophotometer as a control, the optical density value OD680nm=0.598 at 680nm in test tube 01 'was measured. According to the standard curve, the optical density value at 680nm was calculated to be equivalent to 0.1085ml of phenol standard solution. Then, according to equation 1, the activity of 1ml of enzyme solution was calculated to be 8.68.

The results of the enzyme optimal pH determination experiment are shown in Table 4. In 10 groups of experiments, the pH of the buffer with the highest acid phosphatase activity was 5.5, and OD405nm=1.371.

Table 4: Results of Enzyme Optimal pH Determination Experiment.

Test tube number	11	12	13	14	15	16	17	18	19	110
OD405nm	0.050	0.219	0.386	0.668	1.073	1.313	1.371	1.149	0.843	0.445

Based on this experimental data, curve fitting was performed using Excel. The results are shown in Figure 2, indicating that the optimal pH for acid phosphatase is 5.4, with OD405nm=1.382.
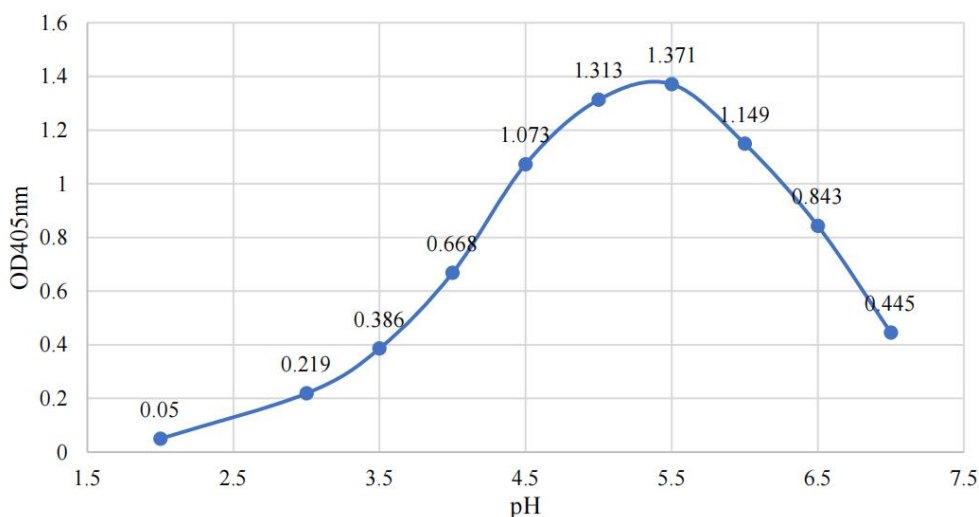
Figure 2： Fitting curve of enzyme optimal pH measurement experiment results

The results of the enzyme optimal temperature determination experiment are shown in Table 5. Among the 8 groups of experiments, the temperature at which acid phosphatase activity is highest is 50 degrees Celsius, at which OD405nm=1.371.

Table 5. Experimental Results of Enzyme Optimal Temperature Determination.

Test tube number	21	22	23	24	25	26	27	28
OD405nm	0.165	0.556	1.055	1.387	1.835	2.461	1.967	1.675

Based on this experimental data, curve fitting was performed using Excel. The results are shown in Figure 3, indicating that the optimal temperature for acid phosphatase is 50 degrees Celsius, at which OD405nm=1.371.
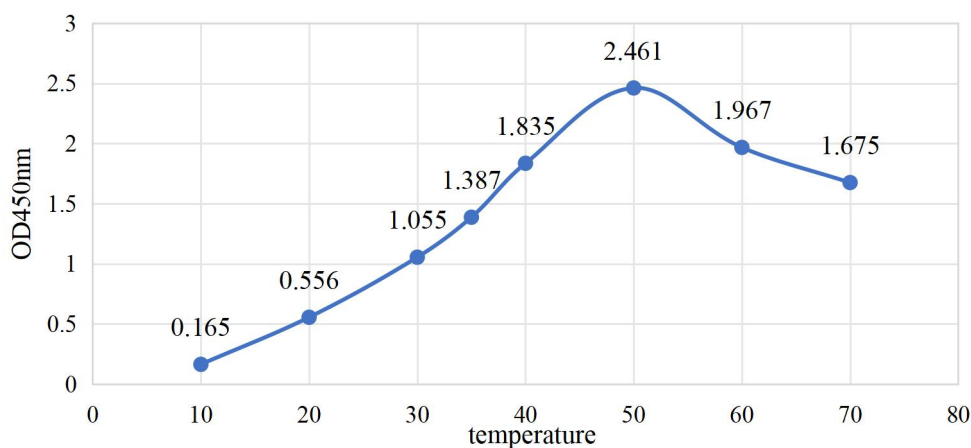
Figure 3： Fitting curve of enzyme optimal temperature measurement experiment results.

4. DISCUSSION

This study investigated the optimal temperature and pH of acid phosphatase (ACP) in mung bean sprouts, and calculated its optimal enzyme activity, providing important information for understanding the role of ACP in plant growth and development. Meanwhile, substrate concentration can affect enzyme saturation and reaction rate, so our team will determine its optimal concentration through experiments

in the future. In addition, the future will also explore the influence of certain metal ions as cofactors on ACP activity.

After completing the above tasks in the future, we will delve deeper into the following content.

Functional research: Further explore the specific biological functions of ACP in the growth and development of mung bean sprouts. For example, the effects of ACP on nutrient transport, energy metabolism, and plant hormone signaling pathways can be studied through gene silencing or overexpression techniques.

Genetic variation research: To study the genetic diversity of ACP genes in different mung bean varieties, and analyze how these variations affect enzyme activity and plant growth phenotype. This helps to screen out mung bean varieties with excellent agronomic traits.

Environmental adaptability research: examining the changes in ACP activity under different environmental conditions, such as temperature, light, soil nutrition, and moisture. This helps to understand how ACP helps plants adapt to environmental stress and may reveal new stress resistance genes or pathways.

Inhibitor/Activator Screening: Discover or design specific ACP inhibitors or activators, and study their effects on the growth and development of mung bean sprouts. This not only helps to gain a deeper understanding of the functions of ACP, but may also provide new growth regulators for agricultural production.

Biotechnology application: Using genetic engineering technology, genes with high ACP activity are introduced into other crops to study whether it can improve crop growth rate and yield, or enhance their adaptability to adverse soil conditions such as phosphorus deficiency.

Molecular mechanism research: At the molecular level, investigate how ACP is regulated by intracellular signaling pathways, including the effects of protein modification methods such as phosphorylation and ubiquitination on ACP activity.

Disease association research: As ACP may play a role in plant disease resistance, it is possible to investigate whether ACP affects the resistance of plant pathogens and whether it participates in systemic acquired disease resistance (SAR) in plants.

5. TASK DIVISION

Quan Zhou has completed the experimental design, data analysis and image drawing. At the same time, Quan Zhou wrote the Chinese version of the paper.

Lei Chen completed the specific experimental content and translated the Chinese version of the paper.

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Body Mass Index and Causal Relationships with Four Characteristic Female Cancers: A Two-Sample Mendelian Randomization Study

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Abstract: This study employs a two-sample Mendelian randomization (MR) approach to investigate the causal relationship between increased Body Mass Index (BMI) and four characteristic female cancers. BMI and data pertaining to the four characteristic female cancers were obtained from the GWAS database. Single nucleotide polymorphisms (SNPs) were selected as instrumental variables (IVs) based on assumptions. The PhenoScanner method was utilized to eliminate SNPs associated with confounding factors. Five Mendelian randomization analysis methods, including inverse variance-weighted (IVW), were employed for two-sample Mendelian randomization analysis. Cochran Q and Rücker Q heterogeneity tests were conducted using IVW and MR-Egger methods. Egger-intercept method was employed for pleiotropy testing, and stepwise exclusion testing for sensitivity analysis. F-values were calculated to assess the presence of weak IVs bias. Genetically predicted increase in BMI was causally associated with reduced risk of breast cancer (OR=0.648, 95% CI: 0.535-0.783, P=7.74e-06), and increased risk of endometrial cancer (OR=1.534, 95% CI: 1.195-1.970, P=7.84e-04). There was insufficient evidence to suggest a causal relationship between genetically determined BMI increase and other characteristic female cancers studied. Increased Body Mass Index may potentially decrease the risk of female breast cancer while increasing the risk of endometrial cancer. There is inadequate evidence to indicate a significant impact of increased BMI on the occurrence risk of other characteristic female cancers studied. Further research is warranted to elucidate these findings.

Key words: Mendelian Randomisation, Body Mass Index, breast cancer, endometrial cancer, ovarian cancer, cervical cancer

1.Background:

Cancer poses a significant threat to human health, exerting a critical influence on prognosis and quality of life. As female populations increasingly prioritize their health, preventing cancer occurrence becomes a pivotal measure for enhancing women's overall well-being[1]. Among all malignancies, female breast cancer, endometrial cancer, ovarian cancer, and cervical cancer are characteristic cancers specific to the

female population, constituting significant threats to women's health[2].

Body Mass Index (BMI) is an internationally recognized metric for evaluating individual obesity, calculated as body weight (kg) divided by the square of height (m) [3-5]. With improving living standards worldwide, dietary constraints have diminished, coupled with a lack of physical exercise in a majority of populations, resulting in a gradual increase in the global obese population. Data shows that since 1975, the global obesity count has nearly tripled, and research indicates higher mortality rates in countries with a larger proportion of obese individuals. Additionally, studies suggest an association between obesity and the incidence of certain cancers.

Increased BMI may elevate cholesterol, low-density lipoprotein, and very low-density lipoprotein levels in the blood. The carcinogenic effect of cholesterol may manifest through the Hedgehog pathway. In healthy individuals, this pathway is largely inactive, but cholesterol binding to the G-protein-coupled receptor Smoothened (Smo) can activate it[6]. Once activated, this pathway influences the survival, proliferation, and migration of tumor stem cells. Furthermore, some scholars suggest an inverse correlation between the use of statin drugs, which lower cholesterol and low-density lipoprotein, and cancer incidence. However, this conclusion is speculative and uncertain. Therefore, this study conducts a two-sample Mendelian randomization research to explore the causal relationship between increased BMI and the risk of characteristic female cancers.

Mendelian Randomization Study

Mendelian Randomization (MR) is a commonly employed epidemiological research method in recent years[7-11], primarily based on single nucleotide polymorphisms (SNPs) to infer causal relationships between exposure and disease outcomes through genetic variation. In MR studies, phenotype-associated genetic variations are utilized as instrumental variables for exposure, allowing for causal inferences of exposure-outcome associations. Genetic variations adhere to the rules of random segregation from parents to offspring and are determined by genetic variations at conception, thus making them less susceptible to population confounding factors in traditional observational studies. Currently, Mendelian randomization has been applied in various medical disciplines. For instance, in the field of nutrition, Paul Carter et al.'s Mendelian randomization study demonstrates a positive causal association between coffee consumption and the occurrence of certain cancers[12]. In epidemiology, Shili Xue et al. investigated the causal relationship between serum uric acid levels and 136 health outcomes, revealing that elevated serum uric acid levels were only confirmed exposure factors for gout and kidney stones. This demonstrates the crucial role of Mendelian randomization studies in exploring causal relationships between exposure and outcomes in medical research. Furthermore, a randomized clinical trial related to BMI and breast cancer suggests that compared to women of normal weight, overweight and obese women have an increased risk of invasive breast cancer. BMI $\geqslant 35.0$ kg/m^2 is an independent risk factor for estrogen receptor-positive and progesterone receptor-positive breast cancer, but is unrelated to estrogen receptor-negative breast cancer. It was also found that changes in weight during the follow-up period (increase or decrease) were unrelated to breast cancer[13]. Therefore, caution is needed in generalizing and extrapolating the impact of increased BMI on the occurrence of different

types of cancer.This study conducts a two-sample Mendelian randomization analysis to explore the causal relationship between increased BMI and four characteristic female cancers: breast cancer, endometrial cancer, ovarian cancer, and cervical cancer.

2.Methods

The data utilized in this study were sourced from previously published research or public databases, specifically the GWAS (Genome-Wide Association Studies) database. Consequently, ethical committee approval was not required.

2.1 Exposure and Outcome Measurement

The exposure variable was BMI increase, encoded as "ebi-a-GCST90095039" in the GWAS dataset, which encompassed a mixed population dataset comprising 330,793 samples. To minimize the impact of linkage disequilibrium (LD), we opted for single nucleotide polymorphisms (SNPs) meeting established genome-wide significance thresholds ($P<5 \times 10^{-8}$, $r2 \leqslant 0.001$, adhering to Hardy-Weinberg equilibrium (H-W), genetic distance <10000kb) as instrumental variables (IVs). The F-values of IVs were computed, ensuring that IVs with F>10 were incorporated into the study to mitigate biases stemming from weak instrumental variables. Instrumental variable selection criteria entailed that the instrumental variables exclusively exert influence on the outcome through the exposure variable BMI increase; instrumental variables do not influence the outcome through confounding factors; and instrumental variables do not directly impact the outcome, as depicted in Figure 1.
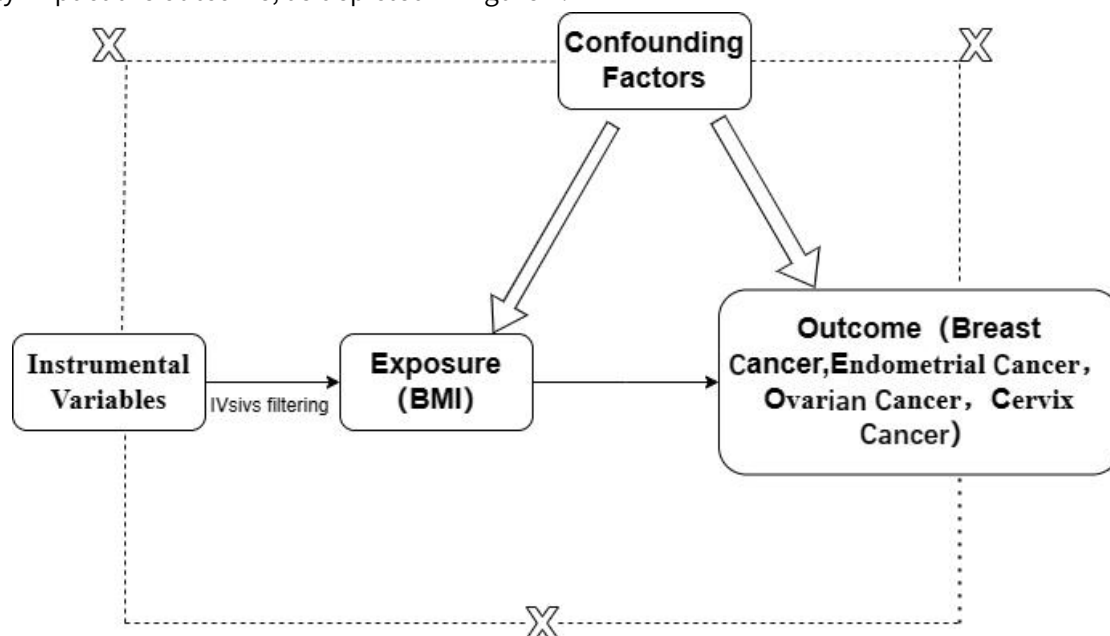
Figure 1: Instrumental Variables Selection Principle

The outcome factors comprise four distinct female-specific cancer types, namely breast cancer, endometrial cancer, ovarian cancer, and cervical cancer, with their respective GWAS data codes being "ieu-a-1131", "ebi-a-GCST90018838", "ebi-a-GCST90018888", and "ukb-b-918". All data have been

derived from a meta-analysis of GWAS studies. Detailed information regarding the data is provided in Table 1. Our study solely relies on published GWAS results and does not involve individual-level data. All summary data for exposures and outcomes were obtained from the publicly accessible Genome-Wide Association Studies (GWAS) database (https://gwas.mrcieu.ac.uk/).

Exposure	Outcome	Cases(n)	Controls(n)	Size(n)
BMI		-	-	330793
	Breast Cancer	14910	17588	32498
	Endometrial Cancer	2188	237839	240027
	Ovarian Cancer	1588	244932	246520
	Cervical Cancer	3175	459835	463010

Table 1: Exposure and Outcome Data Information

2.2 Mendelian Randomization

The MR analysis was conducted on the MR base online platform (https://app.mrbase.org/). This study explores causal relationships between exposure and outcome using a two-sample MR framework. Specifically, SNP exposures (Body Mass Index) and SNP outcomes (female-specific cancers: breast, endometrial, ovarian, and cervical) were incorporated to investigate the causal relationship between BMI and these four female-specific cancers. To eliminate SNPs associated with confounding factors, this study employed the PhenoScanner method. The Mendelian randomization analysis employed five MR analysis methods, with the Inverse Variance Weighting (IVW) method serving as the primary approach. Heterogeneity testing was performed using both the IVW and MR Egger methods. If Cochran's Q test yielded a P-value < 0.05, it indicated heterogeneity among single nucleotide polymorphisms. The final Mendelian randomization analysis was conducted using the random effects model of the IVW method. The MR-Egger-intercept method was used to test for horizontal pleiotropy.

3. Results

3.1 Heterogeneity Testing

Heterogeneity tests were performed using the Inverse Variance Weighting (IVW) method and the MR-Egger method, employing Cochran Q and Rücker Q tests. The results revealed significant heterogeneity among internal SNPs in the breast cancer and endometrial cancer groups (P < 0.05). Conversely, heterogeneity within internal SNPs in the ovarian cancer and cervical cancer groups was not substantial (P > 0.05). Consequently, the final Mendelian randomization analysis for the breast cancer and endometrial cancer groups employed the random effects model of the IVW method, while the ovarian cancer and cervical cancer groups utilized the fixed effects model of the IVW method. Refer to Table 2 for detailed results.

	IVW（P-value)	MR-Egger(P-value)

Breast Cancer	0.0008528	0.0008864
Endometrial Cancer	0.0287088	0.0269904
Ovarian Cancer	0.8860324	0.8826452
Cervical Cancer	0.0535872	0.0464912

Table 2: Heterogeneity Testing Results

3.2 Pleiotropy Analysis

The Egger-intercept method was employed to assess horizontal pleiotropy. The results indicated that there was no significant association between the causal relationship of the exposure and outcome factors for breast cancer, endometrial cancer, ovarian cancer, and cervical cancer, and horizontal pleiotropy. This implies that Mendelian randomization analysis can be conducted without concern for horizontal pleiotropy. Refer to Table 3 for the results of the horizontal pleiotropy test.

	Egger-intercept(P-value)
Breast Cancer	0.3308104
Endometrial Cancer	0.4706562
Ovarian Cancer	0.4070501
Cervical Cancer	0.9090576

Table 3: Horizontal Pleiotropy Test Results

3.3 Sensitivity Analysis

The funnel plots representing the causal association between BMI increase as the exposure factor and the outcome factors of the four female-specific cancers display a generally symmetrical distribution when using individual SNPs as instrumental variables. This suggests a low likelihood of potential bias in the causal association (see Figure 4). Sensitivity analysis using the leave-one-out method revealed that after sequentially excluding each SNP, the results of the IVW analysis for the remaining SNPs were similar to the analysis including all SNPs (see Figure 5). No SNPs were identified to have a significant impact on the exposure and outcome factors.

3.4 Mendelian Randomization Analysis Results

A two-sample Mendelian randomization study was conducted to investigate the causal relationship between BMI increase as the exposure factor and four female-specific cancers: breast cancer, endometrial cancer, ovarian cancer, and cervical cancer. Five MR analysis methods were employed, with the Inverse Variance Weighting (IVW) method serving as the primary approach. Odds ratios (OR), 95% confidence intervals, and P-values were calculated for each of the four groups. The results are presented in Table 4. A causal relationship was observed between BMI increase and breast cancer as well as endometrial cancer. The P-values for almost all five MR analysis methods were less than 0.05, indicating robustness and reliability in the study results. Refer to Figures 2, 3, 4, and 5 for visual representations of the results.

	OR(Odds Ratio)	95%CI	P-value
Breast Cancer	0.648	0.535-0.783	7.74e-06*
Endometrial Cancer	1.534	1.195-1.970	7.84e-04*
Ovarian Cancer	0.901	0.695-1.168	0.4296406
Cervical Cancer	1.000	0.999-1.002	0.7945332

Table 4: Mendelian Randomization Analysis Results using IVW Method(The table presents the results of Mendelian randomization analysis using the Inverse Variance Weighting (IVW) method. Statistically significant differences (P<0.05) are indicated with an asterisk (*). The results show the odds ratio (OR), 95% confidence interval, and P-value for each cancer type).
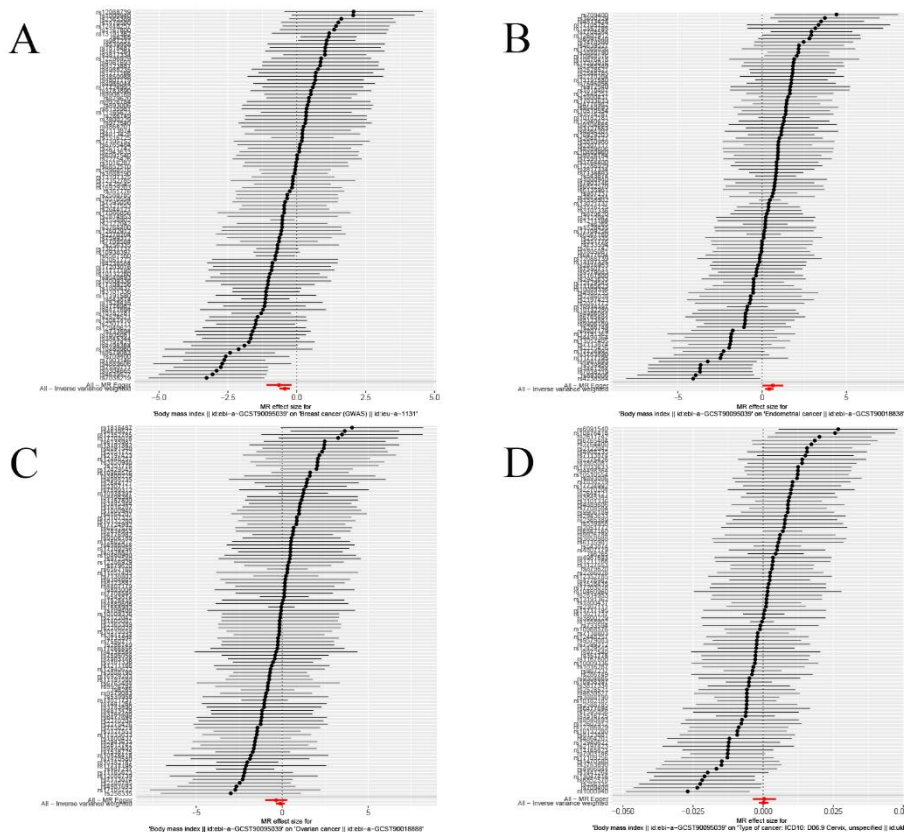
Figure 2: Forest Plots of Two-Sample Mendelian Randomization Results

A. Forest plot depicting the results for the group of female breast cancer as the outcome factor.

B. Forest plot displaying the results for the group of endometrial cancer as the outcome factor.

C. Forest plot illustrating the results for the group of ovarian cancer as the outcome factor.

D. Forest plot showing the results for the group of cervical cancer as the outcome factor.
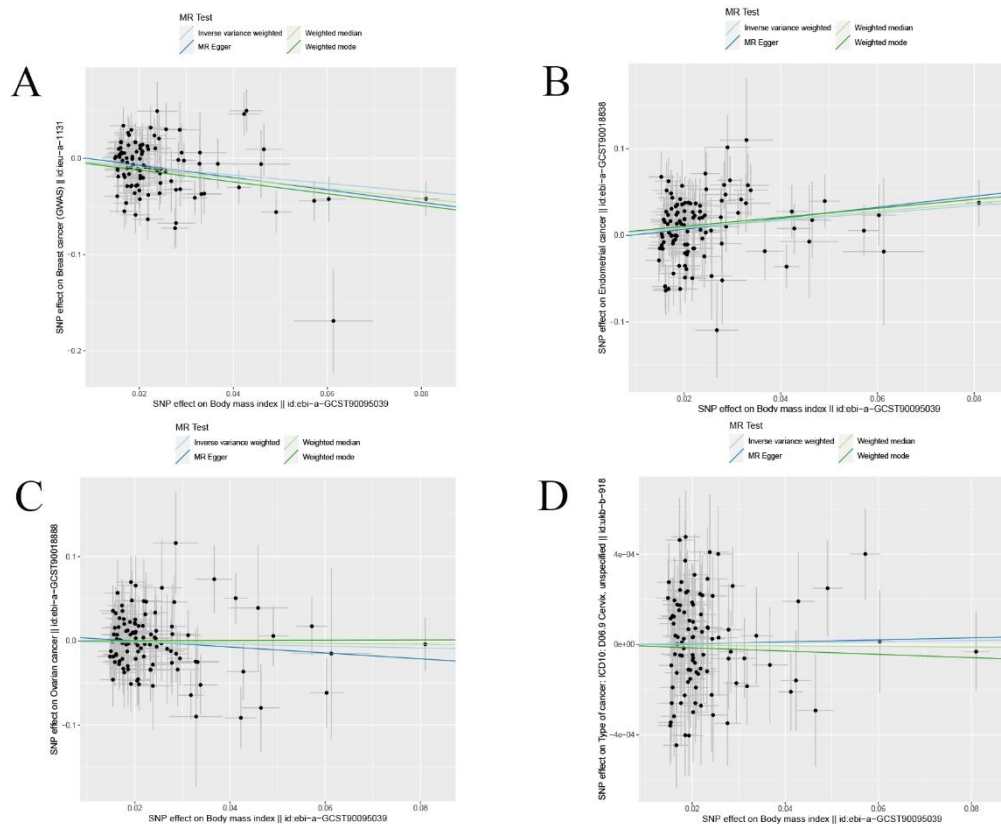
Figure 3: Scatter Plots of Two-Sample Mendelian Randomization Results
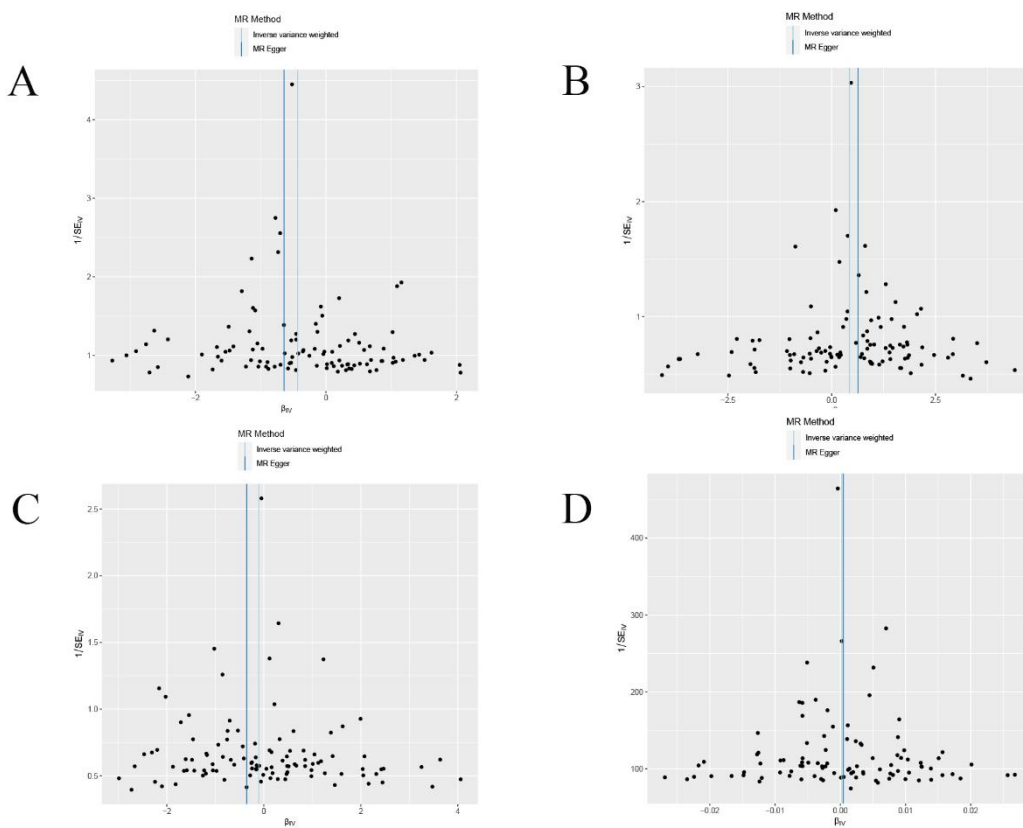
Figure 4: Funnel Plots of Two-Sample Mendelian Randomization Results
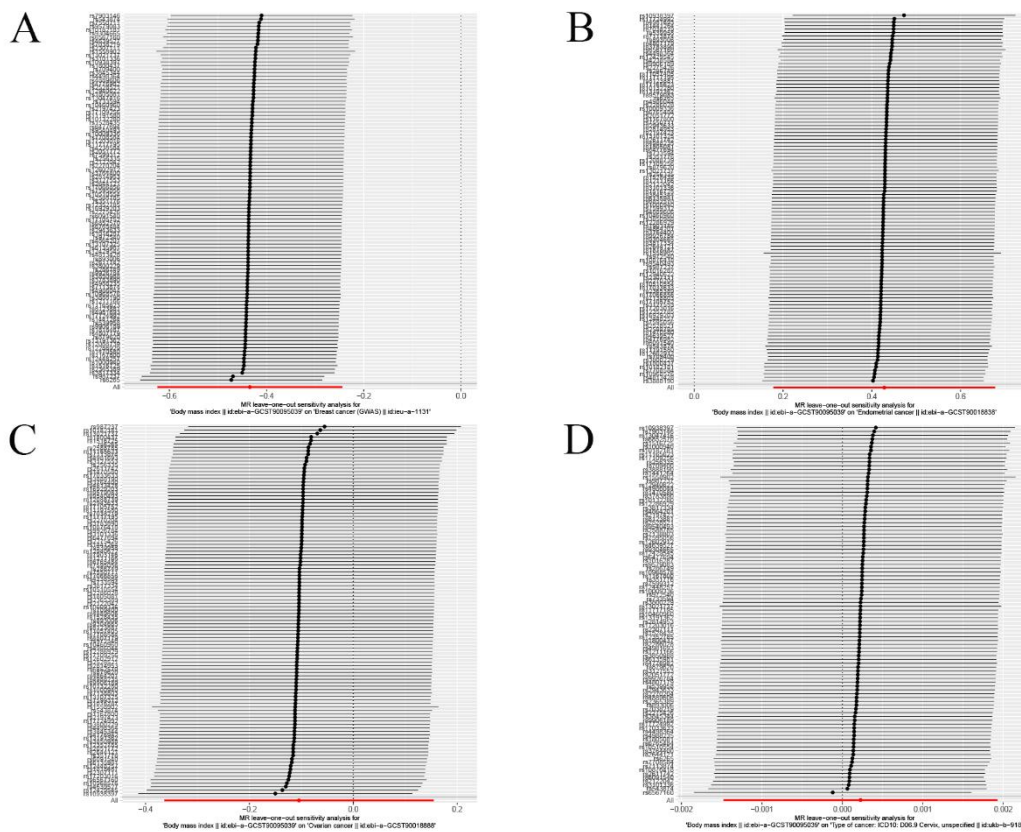
Figure 5: "Leave-One-Out" Plots

4.Discussion

This study utilized two-sample Mendelian randomization analysis to establish a negative causal association between BMI increase exposure and female breast cancer outcomes (OR=0.648, 95%CI: 0.535-0.783, P=7.74e-06). This suggests that the genetic variation associated with increased BMI may serve as a protective factor against breast cancer in females. However, this finding appears contradictory to the conclusion by Huang et al. that central obesity may elevate the risk of breast cancer in perimenopausal women. Additionally, the study's results indicate that the impact of central obesity on breast cancer risk may vary depending on the different estrogen receptors, progesterone receptors, and human epidermal growth factor receptor 2 statuses.

Research conducted by Manuel Picon-Ruiz et al. supports a negative correlation between BMI increase and breast cancer risk in premenopausal women, which aligns with the results of this study. Furthermore, a meta-analysis incorporating nine studies suggests a negative correlation between premenopausal breast cancer risk and obesity (RR=0.98, 95%CI: 0.97-0.99). Another large-scale meta-analysis covering over 2.5 million women and 7930 cases of premenopausal breast cancer indicates that with every 5kg/m² increase in BMI, the risk of premenopausal breast cancer decreases by approximately 8% (RR=0.92, 95%CI: 0.88-0.97, P=0.001). Discrepancies in conclusions between different studies may be attributed to variations in hormone receptor statuses.Existing research results predominantly affirm a negative correlation between BMI increase and breast cancer incidence. However, for Asian women, there appears to be a positive correlation between BMI increase and breast

cancer incidence.

The study's Mendelian randomization analysis also demonstrated a positive causal association between BMI increase exposure and female endometrial cancer outcomes. The tumorigenic mechanisms associated with BMI increase might involve obesity-induced local and systemic pro-inflammatory cytokines, promoting tumor angiogenesis, and stimulating the most malignant cancer stem cell populations to drive cancer cell growth, invasion, and metastasis. Alternatively, BMI increase may lead to higher levels of cholesterol, low-density lipoprotein, and very-low-density lipoprotein in the blood. The pro-carcinogenic effect of cholesterol may manifest through the Hedgehog pathway, where the binding of cholesterol to the G protein-coupled Smoothened receptor (Smo) activates the pathway, subsequently leading to the survival, proliferation, and migration of tumor stem cells. Studies indicate that the impact of BMI increase on endometrial cancer risk surpasses that of any other cancer type[14]. A meta-analysis comprising 30 prospective studies demonstrates that for every 5kg/m² increase in BMI, the risk of endometrial cancer rises by 54% (95%CI: 47%-61%). This conclusion aligns with the findings of this study and is largely consistent with current research, with little academic dissent regarding the positive causal association between BMI increase and endometrial cancer.

Notably, BMI increase did not exhibit a causal association with ovarian and cervical cancer in this study. However, numerous other studies suggest positive associations between BMI increase and various cancers, as well as other disease outcomes[5,15-20]. Therefore, maintaining a healthy BMI through balanced nutrition holds significant importance in cancer and disease prevention. Given that this study is based on a two-sample Mendelian randomization analysis focused on female-specific cancers, there are limitations to the generalization of its conclusions. Therefore, large-scale, multicenter case-control studies and prospective cohort studies are crucial for verifying the causal relationship between BMI increase and female-specific cancers. This, in turn, would provide scientific recommendations for the prevention of female-specific cancers and weight management.

Conclusion:

In summary, genetically predicted BMI increase was found to have a clear negative causal association with female breast cancer, and a clear positive causal association with endometrial cancer. However, BMI increase did not show a causal association with ovarian or cervical cancer. The study is subject to limitations including potential confounders and biases, and further Mendelian randomization and clinical studies are needed to confirm the precise causal relationships between exposure and outcomes.

5. Conclusion

In summary, this study identified clear causal associations between genetically predicted BMI increase

and female breast cancer (negative) and endometrial cancer (positive) using two-sample Mendelian randomization analysis. However, there was no observed causal relationship between BMI increase and ovarian or cervical cancer. The study's results are subject to limitations, including potential confounders and biases, and further research is needed to confirm the causal relationships between exposure and outcomes.

Declarations：

Ethical Approval
The data for this study were obtained from the GWAS public database and the patients' personal information was anonymised, so it does not require ethical committee approval as it does not involve personal privacy or informed consent.

Consent for publication
Not applicable

Availability of data and materials
All data covered in this study were obtained from the GWAS public database.

Competing interests
The author(s) declare that they have no competing interests.

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Target enhancement interpretive processing techniques and their application in B area

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Abstract: The Ordovician reservoir in Area B is a carbonate fracture- controlled fractured-vuggy reservoir. The distribution of the reservoir is controlled by the slip fracture zones, with large differences in three-dimensional space and strong heterogeneity, which makes it difficult to identify the geological target body. Methods to improve the accuracy of fracture prediction through improved algorithms work well, but are difficult for ordinary interpreters. Therefore, a characteristic interpretive processing approach oriented to geological problems is proposed. In this paper, the geological target body in Area B is processed by the target-enhanced interpretive processing approach, and suitable key parameters are selected to highlight the geological target features. By these methods, improve the interpretation accuracy of the layers and fractures, and effectively support the later reservoir prediction.

Keywords: Carbonate reservoirs, fractured-vuggy reservoir, target enhancement, dip-steering filter, fracture characteristics

Introduction

Carbonate reservoirs occupy an extremely important position in oil and gas exploration. 47.5% of the world's remaining recoverable oil-gas reserves come from carbonate reservoirs[1-2]. The Ordovician reservoir in Area B is a carbonate fracture-controlled fractured-vuggy reservoir. In this area, the imaging effect of its 3D data on fractures and fractured-vuggy is poor, the imaging accuracy of seismic data on fractures and fractured-vuggy is low. Multiple waves are developed[3-4]. The in-event dislocation of small and medium-sized scale fractures is small and the breakpoints are not clear, which can't accurately portray the Ordovician fracture. On the one hand, the large difference in wave impedance between the Upper Ordovician and Middle Ordovician has a great shielding effect on the underlying target layer. On the other hand, it is difficult to identify the fractures by conventional methods because of the unclear imaging, which leads to the lack of understanding of fault property, scale, and tectonic evolution, and restricts the further development[5.]

Seismic fracture prediction techniques can be broadly divided into three categories[6]. The first method is

to use specific seismic attributes, such as curvature and stress field, to characterize fractures based on post stack seismic data. The second is based on pre-stack multi-directional seismic data, which uses anisotropic characteristics of longitudinal wave orientation to predict fracture orientation and density. The third is based on multi-component data using shear wave splitting, which is relatively limited due to the difficulty and high cost of obtaining high-quality shear wave data. The analysis techniques for coherence, curvature, and anisotropy are widely used [6-10].

Usually, people improve the accuracy of fracture prediction by improving algorithms. As many scholars continue to improve the third-generation coherence algorithm[3-4], their noise resistance and resolution are continuously improved. However, improving algorithms requires a high level of geophysical, mathematical, and computer programming skills, which is difficult for ordinary interpreters[11].

This proposes a characteristic interpretive processing technology method guided by geological problems, which improves the accuracy of fracture prediction through interpretive processing. Based on the characteristics of different fracture algorithms, interpreters use conventional processing and interpretation software to process the input data and output results separately before and after calculating fracture attributes, making the input data more in line with the needs of specific algorithms, further optimizing the output results, and achieving the goal of improving fracture prediction accuracy.

In this paper, the geological target features are highlighted through the target enhancement interpretive processing of the geological target body in Area B. The layer and fracture interpretation accuracy is improved, which lays foundation for reservoir meticulous depiction.

1. Main method

In order to highlight the target body in a targeted way, this paper makes use of high-resolution 3D seismic data to carry out research on target-enhanced processing techniques to improve the signal-to-noise ratio and resolution of the seismic data, so as to enhance the accuracy of seismic imaging of different types and scales of faults in B area. According to the characteristics of spectrum, amplitude and signal-to-noise ratio of the data, we will carry out comparative analysis of the key parameters of seismic data target-enhanced interpretive processing technology, determine the corresponding processing methods and parameters, and improve the seismic response characteristics, so as to establish an interpretive processing and imaging process suitable for the area, and highlight the fracture characteristics hidden in the seismic signals.

1.1 Strong reflection separation

The strong reflection separation technique adopts a match-tracking algorithm. It takes the input layer as the reference, matches the local optimal wavelet according to the best matching criterion, extracts the strong reflection features consistent with the optimal wavelet and realizes the adaptive decomposition

of the original seismic record. The method blurs the position information in the matching trace, which leads to the good continuity of the identified strong reflection events. The effective reflections in the reservoir is highlighted after the strong reflections are stripped.

There are obvious strong reflections of clastic and carbonate rocks in Area B. The problem of strong reflections shielding weak signals of the reservoir has brought great difficulties to fine reservoir prediction. Figure 1 is a comparison of the effect before and after the separation of T_7^4 by using the above separation method. We can see that the strong reflection layer of T_7^4 at the top of the Ordovician, which is made up of limestone, has a strong shielding effect on the underlying fractured-vuggy reservoirs before the separation, and the characteristics of the fractured-vuggy bodies in its vicinity and underneath are blurred. After the strong reflection separation, the strong reflection interface is well weakened, which is helpful for fine interpretation and attribute extraction in the later stage.

Before   After
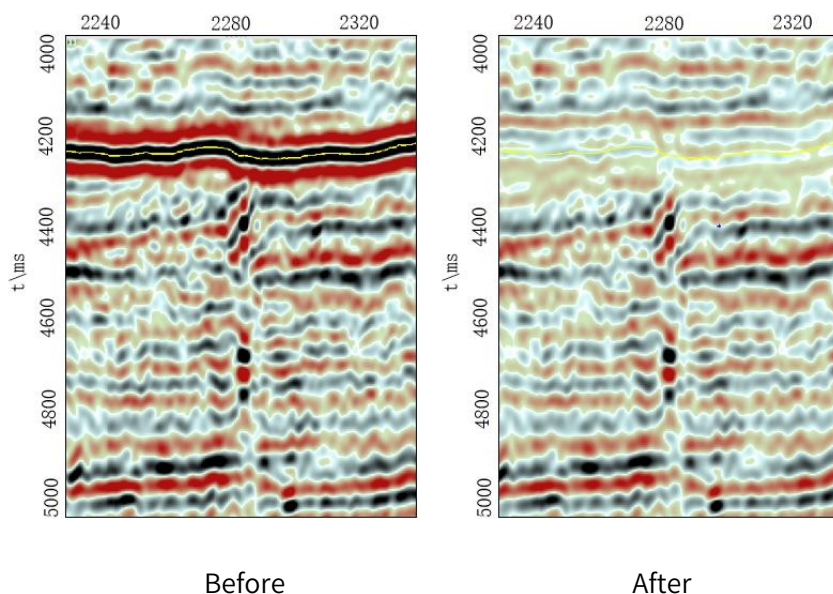
Fig. 1 Strong reflection separation effect diagram

1.2 Dip-steering filter

Dip-steering filter is a common method in interpretive processing flow. The application of dip-steering filter generally improves the signal-to-noise ratio of seismic data significantly. Dip-steering controlled enhancement technology uses the changes in inclination and azimuth to calculate the similarity of neighbouring channels, the results of which have significantly enhanced seismic lateral signal-to-noise ratio and the ability to delineate faults. This facilitates the subsequent study of faults and fractures.

The dip control enhancement can improve the quality of seismic data for better interpretation of stratum and fault . In calculation process, the dip change of each sampling point is fully considered. The comparison window is selected centered on the calculation sample points., and the corresponding calculation weights are defined for each sampling point involved in the calculation. Each correlation initial value is defined as 1 to ensure that all the results are positive. A perfect correlation will produce a

weight of 2. We calculate the amplitude and weight of each dip-controlled sample point first , then average the weighting process for the sample points of all the comparison windows.

In the denoising processing and the selection of key parameters for filter, it is not only necessary to effectively suppress the noise and improve the signal-to-noise ratio, but also to maximize the protection of target body information such as faults and fractured-vuggy bodies. Find the balance between the protection of the fault information and the noise attenuation, so as to achieve the purpose of effective enhancement of the target. The RTM results data were tested and analyzed for key parameters, and the test effects of different parameters were compared. It was found that the fracture convergence is better and the fracture characteristics are more obvious by using the dip-steering filter parameter of 3_3_5 (Fig. 2).
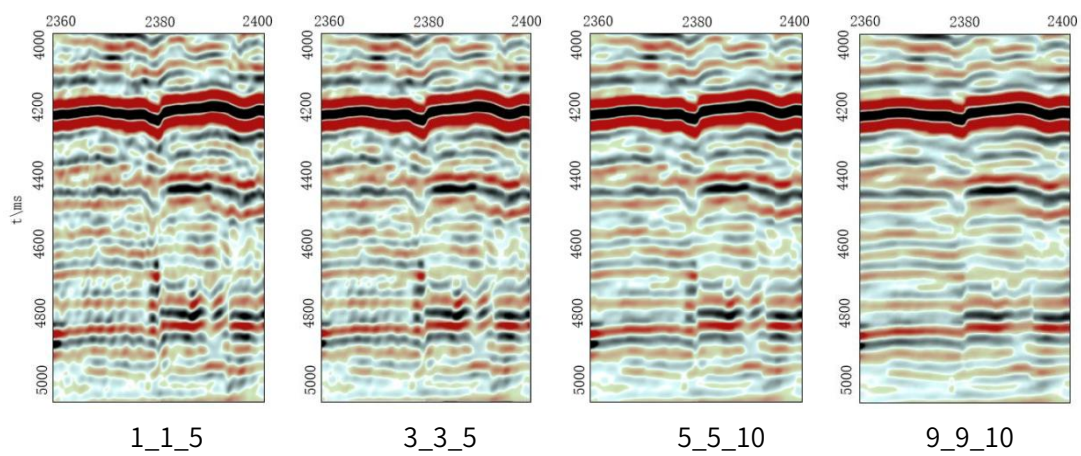
Fig. 2 Comparative analysis of dip-steering filter processing
test parameters

The characteristics of the seismic profiles after processing have been significantly improved, the noise has been suppressed, the strong amplitude characteristics of beads are maintained better, and the breakpoints of fractures are clear. Meanwhile, the amplitude spectrum of the data basically does not change. indicating that the processing follows the original amplitude and change rule, which has a high fidelity (Fig. 3).
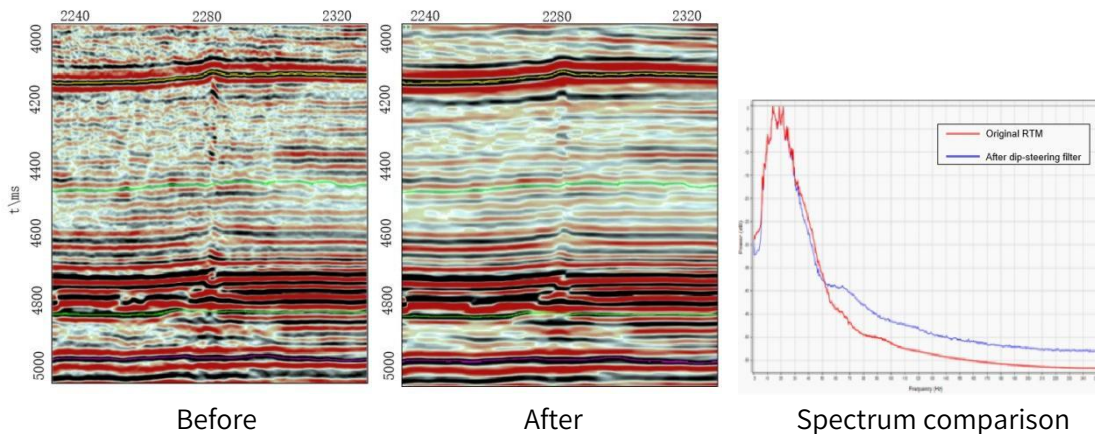
Fig. 3 Dip-steering filter processing effect diagram

1.3 Band-pass filter

Band-pass filter is a frequency-specific filtering method that preserves the frequency components in a certain frequency range while attenuates the frequency components in other ranges to a very low level. Band-pass filter is performed on the original data based on the DSG. Five filter ranges of 8-15Hz, 8-20Hz, 8-25Hz, 8-30Hz and 8-35Hz are selected to compare and analyze the filter effect. By comparison, we can see that after 8-30 Hz filter the signal-to-noise ratio of the Ordovician layer is moderate. The fracture convergence and bead imaging effect are better, and the fidelity is high(Fig. 4).

| 8-15Hz | 8-20Hz | 8-25Hz | 8-30Hz | 8-35Hz |
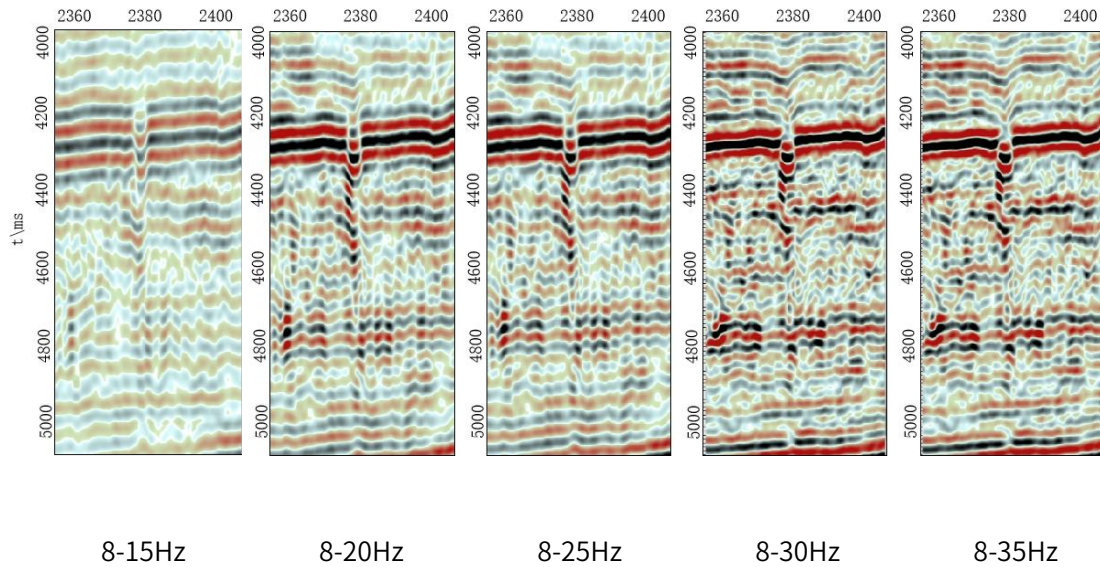
Fig. 4 Comparative analysis of band-pass filter test parameters

1.4 Median filter

Median filter is a nonlinear smoothing technique. It is able to protect the edges of the signal from blurring while filtering out noise, whose excellent characteristics are not available in linear filtering methods. In addition, the algorithm of median filter is relatively simple and easy to implement in hardware. Median filter is performed on the original data based on the DSG. The parameters of filter length are selected as 11, 13, 15, 17 and 21 to compare and analyze the filter effect. Comparison shows that the fracture characteristics are gradually clear, and the focus of the cavern is improved with the increase of filter length 11, 13, 15. With the increase of filter length 15, 17, 21, the continuity of the layer is slightly better, but the effect of the fracture carving and the bead imaging is getting worse gradually (Fig. 5). It is believed that the median filter is effective in the fracture convergence and the part of layers tracking, while the parameters of filter length should not be too large. 13 is more suitable for this area.
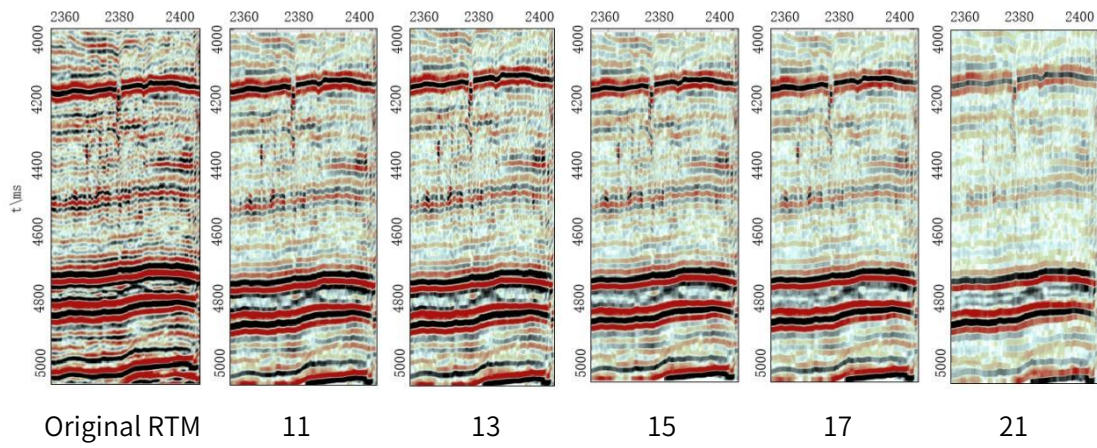
Fig. 5 Comparative analysis of median filter test parameters

1.5 Butterworth filter

Butterworth filter is performed on the original data based on the DSG. It is necessary to analyze the filter gradient and range parameters, which are selected as 8-10-15-18, 8-10-20-24, 8-10-30-36, 8-10-40-48, and 8-10-50-60. The result shows that that the signal-to-noise ratio of the layer after 8-10-30-36 filter is higher, the continuity is better, and the effect of fracture carving and bead imaging is relatively better, too (Fig. 6). Butterworth filter is effective in tracing the continuity of the fracture and part of the layer, and the 8-10-30-36 filter parameters are more appropriate for this area.
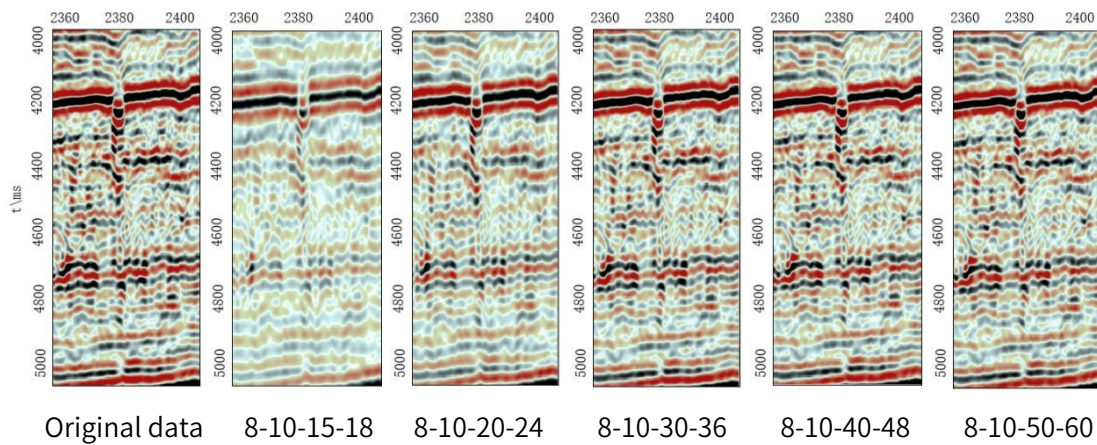
Fig. 6 Comparative analysis of butterworth filter test parameters

3 Application effect

In summary, the filter parameter test and analysis are carried out around dip-steering, band-pass, median and butterworth after strong reflection separation. The signal-to-noise ratio of dip-steering filter data has been greatly improved, the main fracture breakpoints and sections are clear, and the bead response is prominent, followed by band-pass filter and butterworth filter (Fig. 7). This could provide reliable interpretive processing resultant data for the later fine interpretation.

RTM   Dip-steering filter   Band-pass filter   Median filter   Butterworth filter
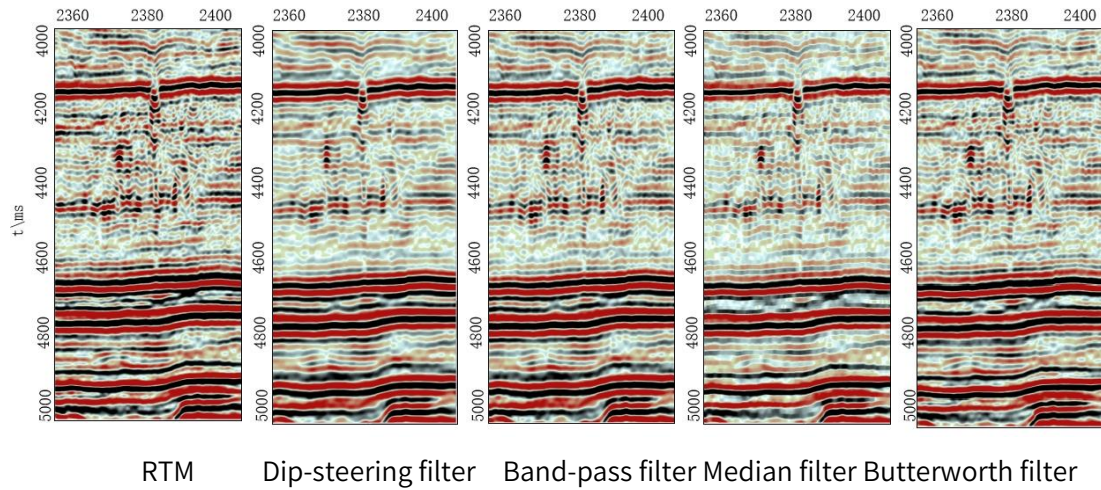
Fig. 7 Comparison of interpretive processing effect

The comparative analysis of the extracted AFE attributes before and after the interpretive processing also shows that there is a significant improvement in the clarity of the faults and fractures after the interpretive processing (Fig. 8).

Before interpretive processing   After interpretive processing
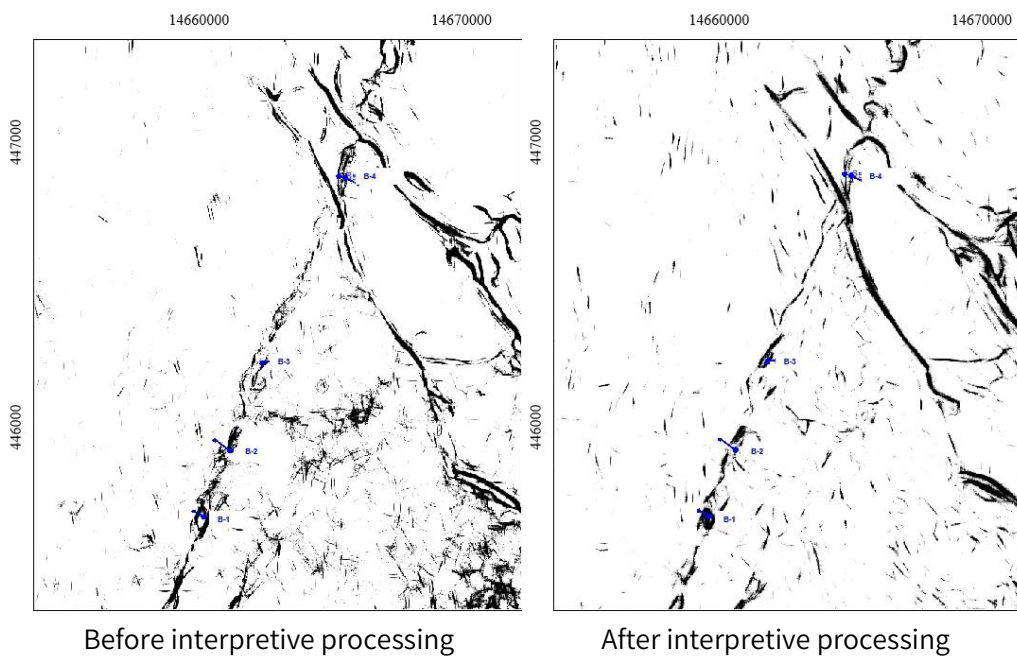
Fig. 8 Comparison of the AFE attributes of the main destination layer

4 Conclusion

The target enhancement processing using a combination of strong reflection separation, dip-steering filter, and bandpass filter with different frequency bands can significantly improve the interpretation accuracy of the layers and fractures in this region. It would effectively improve the subsequent seismic imaging effect of fractures at different levels and fractured-vuggy in the target layer, and lay a solid foundation for the fine engraving of the reservoir.

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Precision Calibration of Industrial 3D Scanners: An AI-Enhanced Approach for Improved Measurement Accuracy

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Abstract: With the rapid development of intelligent manufacturing, there are important and challenging tasks in many aspects, especially in the calibration of 3D scanners. In order to improve the calibration accuracy, this paper proposes an innovative method that utilizes artificial intelligence (AI) for calibration. As we all know, precision 3D scanning is very important in many industrial applications. However, in complex environments, traditional calibration methods are often unable to meet the required accuracy requirements. To overcome the above limitations, we propose an innovative approach that combines advanced AI algorithms with traditional calibration processes. Through comprehensive and profound research, we use artificial intelligence enhanced technology to improve measurement accuracy. This reduces both time and resource costs. This research not only introduces a new calibration method for the field of industrial metrology, but also promotes the application of artificial intelligence in the field of precision engineering.

Keywords: Artificial Intelligence, Industrial 3D Scanners, Precision Calibration, Measurement Accuracy, Machine Learning Algorithms, Sensor Fusion, Data Analytics

Introduction

The introduction of 3D scanning technology has revolutionized the field of manufacturing and quality control. However, the performance of these scanners is primarily determined by their calibration accuracy. Although traditional calibration methods are still relatively reliable, they often fail to meet the accuracy requirements of today's complex industrial environments. This study highlights the need to improve innovative approaches to closing the capability gap. Select the field of artificial intelligence to demonstrate its great potential. This can improve various technical processes. This paper aims to investigate the use of artificial intelligence to optimize the calibration of industrial 3D scanners.

Firstly, the core of 3D scanning technology is studied in detail, and its importance in precision measurement is clarified. In addition, we explore the current challenges facing the calibration industry, laying the foundation for our proposed solutions. In this academic field, artificial intelligence has great potential, but it is not fully exploited, which is a unique development opportunity tailored for us. Our

goal is to develop and rigorously test an AI-based calibration method that exceeds current accuracy standards.

Currently, 3D scanner calibration faces a number of challenges. These challenges involve dealing with environmental factors, such as changes in lighting and temperature, as well as inherent limitations of the scanner itself, such as sensor noise and resolution. These challenges are compounded especially in industrial Settings, where precision requirements are high and conditions are often less than ideal.

Our research is based on the latest developments in artificial intelligence and machine learning, with a focus on their applicability in the field of industrial metrology. We aim to combine these advanced AI techniques with traditional calibration methods to propose an innovative and practical approach. However, the implementation of such integration is not easy, as the complexity of AI algorithms and the adaptability to small differences in 3D scanning technology pose major challenges.

The purpose of this research is not only to improve the accuracy of calibration, but more importantly to explore the interrelationship between artificial intelligence and industrial metrology. We believe this discovery will make an important contribution to the field and lay the foundation for future research.

1.Industrial 3D Scanners and Calibration

1.1 Basics of 3D Scanning Technology

3D scanning technology is the basis of modern industrial processes, and it provides a way to obtain the dimensions of objects, using lasers or light to capture them. [1]Scanners use principles such as time-of-flight or structured light to convert physical data into digital models. [2,3]For example, a scanner that uses structured light projects a pattern onto an object and measures its size by calculating the pattern's deformation.Mathematical Expression of Scanning Process:[4]

Let's say the scanner projects a sinusoidal pattern. The deformation of this pattern, captured by the scanner, can be mathematically modeled. If (P(x, y)) represents the pattern and (D(x, y)) the deformation, the captured data (C(x, y)) can be expressed as:

(C(x, y) = P(x, y) *D(x, y))

where x, y are coordinates on the object's surface.

1.2 Importance of Calibration in Measurement Accuracy

For these scanners, a critical step in ensuring data accuracy is calibration.[5,6,7] Calibration refers to adjusting the scanner's parameters to known standards to achieve consistency. [8,9] If not calibrated correctly, it can cause the captured data to deviate significantly from expectations, affecting the accuracy of the final product.[10]

A simple bar graph can be used to display the calibration error. [11]Suppose we have obtained a set of dimensions and obtained the corresponding values from an uncalibrated scanner measurement. Differences in these values can reflect calibration errors.[12]

Known Dimensions vs. Measured Dimensions
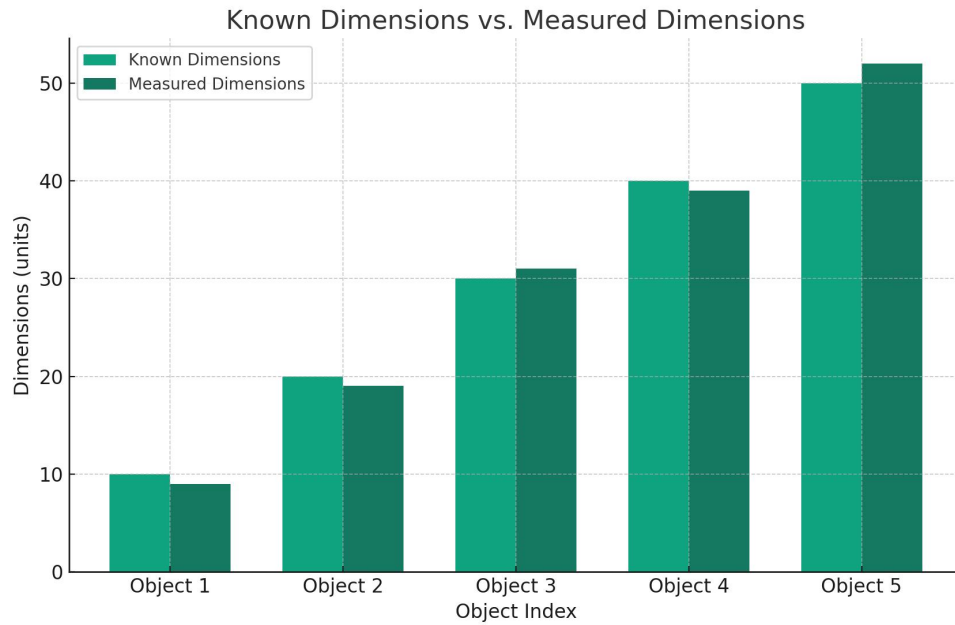
1.3 Review of Conventional Calibration Methods

Common calibration methods generally involve using a known reference object and comparing its scan data with the actual size. However, this method takes a long time and is less applicable in different industrial environments.[13]

Consider a matrix representing the efficiency of traditional calibration methods across different scenarios:

Scenario	Time Taken	Accuracy
Simple Objects	Low	High
Complex Environments	High	Medium

1.4 The Need for Advanced Calibration

As the level of manufacturing continues to evolve, the need for more advanced calibration methods to adapt to complex shapes and environments continues to rise.[14,15] This is where important advances are being made in AI-enhanced methods, which are able to learn and adjust in real time.[16]

2.AI in Industrial Metrology

2.1 Introduction to AI and Machine Learning

Artificial intelligence (AI) is a field that imitates human cognition and has become an important part of modern technology. [17]In particular, the application of machine learning (ML) to industrial metrology presents unprecedented opportunities. With machine learning algorithms, we can process large-scale data and learn patterns in it that are often imperceptible to humans.

We can draw a line graph to describe the learning process of the AI model. As the amount of data increases, the accuracy of the model improves significantly. This diagram shows the power of artificial

intelligence in processing complex data sets.

AI Learning Curve
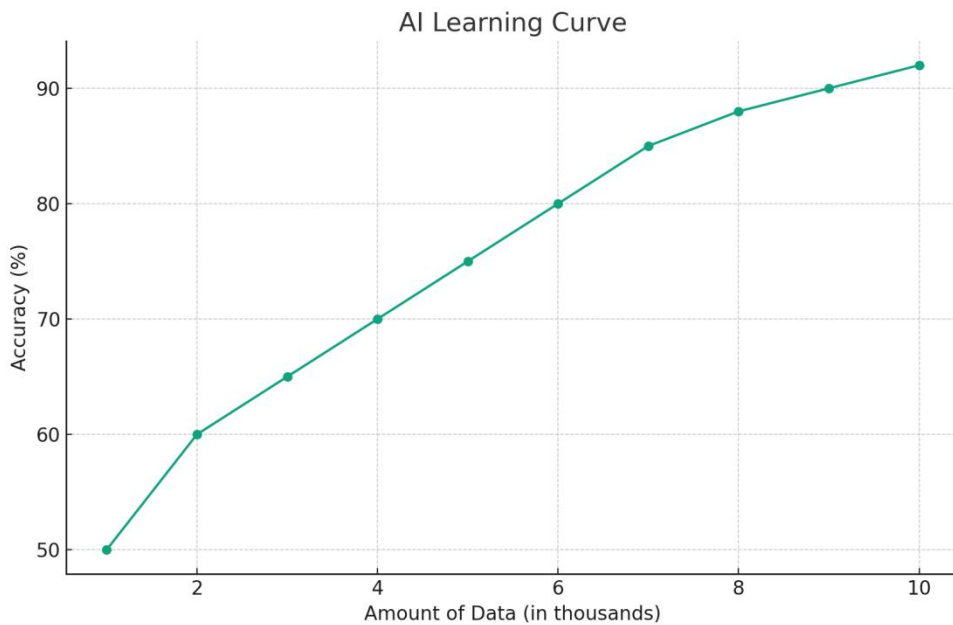
2.2 Role of AI in Precision Measurement and Calibration

The convergence of artificial intelligence and the field of metrology is changing the way measurement and interpretation are done.[18] Through the use of algorithms, data can be processed in real time, improving accuracy and efficiency. [19]In addition, AI has demonstrated adaptability to different industrial environments and flexibility in the calibration process.

We studied the scenario of using artificial intelligence to calibrate 3D scanners. By leveraging artificial intelligence systems, we analyze past calibration data and employ advanced regression techniques to deduce optimal calibration configurations. This method greatly reduces manual operations and time consumption.

Mathematical Representation of Regression Analysis:

If Y represents the calibration accuracy and X1, X2, ..., Xn are different calibration parameters, a multivariate regression can be represented as:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \varepsilon$

where β_i are coefficients and ε is the error term.

2.3 Overview of Relevant AI Techniques

Industrial metrology can apply various AI techniques, such as neural networks, deep learning, and reinforcement learning. Each technique has unique advantages and is selected according to the specific requirements of the calibration process.

A table comparing different AI techniques based on criteria like adaptability, complexity, and data requirements can be insightful.

AI Technique	Adaptability	Complexity	Data Requirement

AI Technique	Adaptability	Complexity	Data Requirement
Neural Networks	High	Moderate	High
Deep Learning	Very High	High	Very High
Reinforcement Learning	Moderate	High	Moderate

3: Developing the AI-Enhanced Calibration Method

3.1 Algorithm Design and Selection

At the heart of our AI-enhanced calibration approach lies the careful selection and design of suitable algorithms. [20]There are many algorithms to choose from in the field of artificial intelligence, each with its own unique advantages. To achieve our goal, we focus on supervised learning models, especially those regression algorithms that can accurately predict calibration parameters.

Data analysis is the first step in algorithm selection, followed by algorithm selection, testing, and final selection. It would be helpful to attach a detailed flow chart of the algorithm selection process.

Data Analysis   Algorithm Shortlisting   Testing   Final Selection
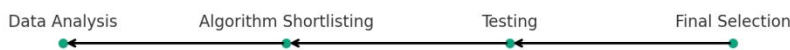
3.2 Integration of AI with 3D Scanning Technology

In order to integrate AI into a 3D scanning system, careful engineering is required. We took machine learning (ML) models and trained them using datasets containing historical calibration data, environmental factors, and scanner performance metrics. This training enables the model to predict the best calibration Settings under different conditions.

Data Processing Code Snippet:

To prepare the data for the ML model, we use code to clean and structure the data. For instance, in Python, we might use pandas DataFrame to organize the data and scikit-learn for preprocessing.

```
import pandas as pd
from sklearn.preprocessing import StandardScaler
# Load data
data = pd.read_csv('calibration_data.csv')
# Preprocess data
scaler = StandardScaler()
processed_data = scaler.fit_transform(data)
```
```

## 3.3 Methodology for Testing and Validation

After the development phase, rigorous testing and validation is extremely important. We use cross-validation techniques to ensure the stability and accuracy of the model. We evaluate improvements by comparing the performance of the AI model with conventional tuning methods.

This can be illustrated by comparing the performance of AI models with traditional methods in terms of accuracy, time efficiency, and adaptability.[21]

| Method | Accuracy | Time Efficiency | Adaptability |
|---|---|---|---|
| Traditional | Moderate | Low | Low |
| AI-Enhanced | High | High | High |

## 4: Experimental Setup and Methodology

### 4.1 Description of the Industrial Environment

We conducted experimental Settings in a real industrial environment. This setup includes a range of 3D scanners and objects of various known sizes for calibration. The complexity of the real environment, as well as changing light and temperature conditions. This provides a good test bed for our AI-enhanced calibration approach.

To quantify environmental conditions, we created a table that recorded factors such as temperature, humidity, and lighting levels. This data is important for AI models to learn to adapt to these changes.

| Factor | Range |
|---|---|
| Temperature (°C) | 15-30 |
| Humidity (%) | 40-60 |
| Lighting (Lux) | 200-1000 |

### 4.2 Implementation of the Calibration Technique

The implementation phase involved setting up the AI model within the 3D scanning system. The model received real-time data from the scanners and adjusted calibration settings dynamically.

Pseudo-code for Calibration Adjustment:
```python
if scanner_accuracy < desired_threshold:
    adjust_calibration(scanner_data)
else:
    maintain_current_settings()
```

4.3 Methodology for Testing and Validation

The testing phase is particularly important when evaluating the effectiveness of AI-enhanced calibration

methods. We used objects of precisely known size by comparing 3D scan accuracy before and after applying the AI method.[22]

We will use linear graphs to demonstrate the improved accuracy of our AI approach in multiple experiments to demonstrate its effectiveness.
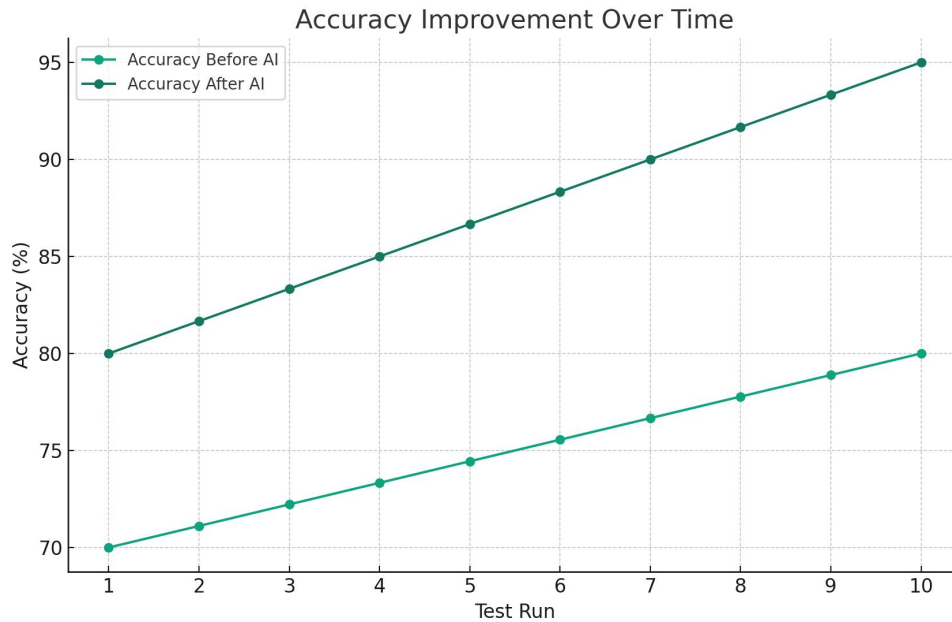
4.4 Data Collection and Analysis

When data was collected, we documented the performance of both traditional and AI-enhanced calibration methods. To analyze the data, we used statistical tools and focused on metrics such as improved accuracy and time efficiency.

Statistical Analysis Code Example:

```
import numpy as np
# Arrays of accuracy measurements
traditional_accuracy = np.array([...])
ai_enhanced_accuracy = np.array([...])
# Calculating mean improvement
mean_improvement = np.mean(ai_enhanced_accuracy - traditional_accuracy)
```

5: Results and Discussion

5.1 Accuracy Improvements Achieved

The AI-enhanced calibration method we implemented greatly improves accuracy. The experimental results show that the measurement accuracy of various industrial objects has been significantly improved.

We compared the accuracy of traditional calibration methods with artificial intelligence enhanced

methods. The following table shows the results of this comparison:

Object Type	Traditional Accuracy (%)	AI-Enhanced Accuracy (%)
Simple Geometric	85	92
Complex Assemblies	75	88
Irregular Shapes	70	85

5.2 Comparative Analysis with Traditional Methods

Compared to traditional methods, AI-enhanced technology not only provides higher accuracy, but also shows significant adaptability under different environmental conditions.

Considering the environmental change and the complexity of the target and other factors, we can use the quantitative calibration method to adapt to these conditions. Mathematically, this can be expressed as:

$$\text{Adaptability Index} = \text{Number of Factors} \, \Sigma \, (\text{Accuracy}_{AI} - \text{Accuracy}_{Traditional})$$

5.3 Discussion on the Findings

The results show that AI has great potential in the industrial metrology revolution. In particular, by improving the accuracy and adaptability of AI-enhanced methods, errors in the manufacturing process are significantly reduced.

The chart shows the significant reduction in error rates before and after the application of AI methods, a change that intuitively clearly demonstrates its impact.
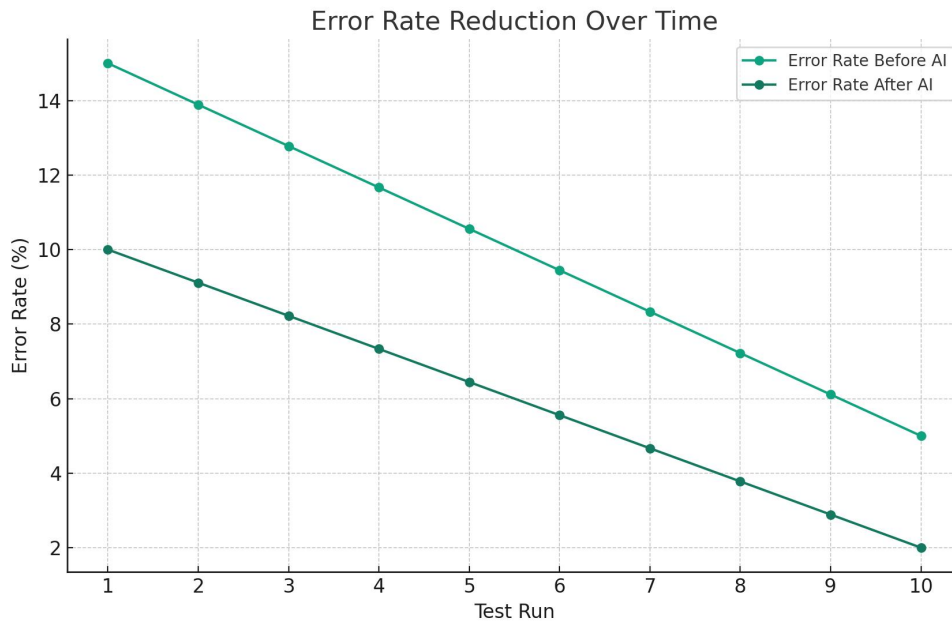
5.4 Future Implications and Recommendations

The success of this approach provides new directions for subsequent research, especially in the area of integrating AI with other measurement tools. We recommend further research into the application of artificial intelligence technology in automated quality control systems.

Conclusions

Our in-depth research on improving the calibration of industrial 3D scanners has yielded exciting results and shows great potential for development. Our research not only validates significant improvements in calibration accuracy, but also highlights the broad applicability of AI in various industrial sectors.

Compared with traditional calibration techniques, we use advanced artificial intelligence algorithms to improve the accuracy of the display. In practical applications such as automotive and aerospace, our approach continuously reduces error rates and improves overall manufacturing quality.

The combination of industrial metrology and artificial intelligence has brought about important changes, making the manufacturing process more intelligent, efficient, and enhancing its adaptability. In this field, AI's ability to learn and adapt to complex environments has also been significantly improved.

In the future, the application potential of artificial intelligence in the industrial field is wide. Further research could combine AI with other measurement tools to adapt to changing environments and delve into its role in automated quality control systems.

This study reaffirms the revolutionary impact of AI on industrial processes, both improving accuracy and introducing adaptability and efficiency that were previously unattainable. As the industry continues to develop, it is expected that the importance of artificial intelligence in the field of intelligent manufacturing and quality control will be further significant. By applying AI technology, we are able to achieve innovation and high-quality development in the manufacturing industry.

Acknowledgements

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Design of YJ17 Cigarette Machine Stem and Thread Separation Triple Air Separation Device

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Abstract: In response to the problem of incomplete separation of tobacco stems during the secondary air separation of the YJ17 type coiling machine, which caused tobacco to fall into the tobacco stem box along with the tobacco stem during collision, resulting in waste, a self-designed set of three air separation devices for tobacco stems effectively reduced tobacco consumption. Each machine per shift can save about 2.5 kilograms of tobacco, creating benefits for the enterprise.

Keywords: YJ17 cigarette maker, stem tobacco, tobacco, tertiary air separation device

Ⅰ. Introduction

The concept of lean production management aims to eliminate various wastes, optimize resource allocation, and improve efficiency and benefits. It extends the concept and methods of lean improvement by constructing a long-term mechanism for lean management work, applying continuous improvement methods of lean management, and achieving maximum value creation with minimal investment. When cigarette production enterprises promote lean management production management activities, they compare key indicators, identify waste in the production process, and use lean tools to carry out improvement activities[1]. In practical improvement, eliminate waste, reduce costs, provide efficiency, and achieve the true connotation development of the enterprise.

The research status of stem stick separation at home and abroad is that there are many types of cigarette equipment at home and abroad. Although each cigarette unit itself comes with a device for separating stem sticks and tobacco, the separation effect is really poor, and there are a large number of mistakenly removed tobacco, which needs to be recycled. At the same time, separating too many or too few stem sticks can have a huge impact on the quality of cigarettes and also cause excessive waste of enterprise costs[2]. The so-called stem stick separation is the use of a method to remove the stem sticks from the original machine and further remove and separate them from the tobacco. At present, there are many methods for separating two different substances, most of which rely on the different properties of the two substances themselves.

The YJ17 cigarette maker comes with a secondary air separation device for tobacco stems and cut tobacco, which completes the separation of tobacco stems and cut tobacco through two air selections.

The secondary sorting device for stem tobacco mainly consists of a feeding hopper, a wind deflector, adjusting screws, inclined blocks, and a secondary sorting wheel installed in the feeding port. The separated tobacco is directly adsorbed onto the suction belt of the air chamber body. In order to reduce tobacco waste, a new type of stem separation device is studied using the method of separation during movement, which will recycle the recycled tobacco; By increasing the vertical lifting distance between tobacco stems and tobacco, the separation of tobacco stems can be achieved[3]. However, there is little research on the use of positive pressure blowing to separate tobacco stems and cut tobacco again. Therefore, by designing a set of stem separation devices, the suspension time of the stem in the air is increased, so that the dispersed tobacco is sucked into the air chamber again, achieving the third separation of the stem.

The research and development of the YJ17 cigarette unit (hereinafter referred to as the cigarette machine) third stem separation device project is based on the requirements of lean production management activities in the tobacco industry, and is a special improvement project carried out by cigarette production enterprises themselves around the annual goals proposed by the tobacco industry. It focuses on the characteristics of the tobacco stem separation mechanism in cigarette machines and tackles the phenomenon of high silk content indicators in 10000 cigarette stems in current cigarette production[4]. It was found that the stem separation system of the cigarette machine is designed to control the silk content in the stem by changing the negative pressure airflow size of the stem channel through the airflow adjustment plate below the stem channel. However, in production, the airflow control valve of the stem cannot meet the lean target of the production enterprise for the silk content in ten thousand cigarette stems within its adjustment range. The original design of the equipment is insufficient and lacks foresight, which restricts the reduction of production costs, affects equipment production efficiency, and increases employee labor intensity.

In summary, there are many separation methods for two or more substances (including two), and the selection of separation methods for stem sticks, stem blocks, and tobacco must consider the quality of the separated tobacco and the entire tobacco. From the current cigarette manufacturing process, reducing the number of stem sticks in cigarettes is mainly controlled through the stem stick removal device provided by the tobacco supply device of the cigarette machine and the MIDAS for detecting tobacco segments. Although many domestic and foreign enterprises and scholars have conducted varying degrees of research on stem stick separation, some conclusions have also been obtained from experiments, which have played an important role in the development of stem stick separation devices. However, there are still certain shortcomings:

(1) There are many types of cigarette units, and the technical workers of major cigarette factories only study and improve the stem stick separation system under specific units in their own factories. When applied to other units, the effect is not obvious, which can easily cause problems such as blockage of the air selection channel, severe tobacco breakage, higher content of stem stick removed tobacco, and significant differences in separation effects. Therefore, specific methods should be required for each unit.

(2) Although major cigarette factories have applied for many patents, they have not been applied in practice, and most of the existing stem stick separation devices are independent. They only separate the usable tobacco from the stem sticks through the separation system for recycling[5]. They have not been

able to directly introduce the separated tobacco into the supply system and directly carry out cigarette production. At the same time, the separation device has a large appearance, complex structure, and high cost Additional maintenance and upkeep work are required, as well as a longer wind selection path, which can easily cause moisture loss and breakage of recycled tobacco, affecting the intrinsic quality of the cigarettes. (3) At present, research is only focused on the stem separation device of the original tobacco supply machine in the cigarette unit. By changing some of the structures and process parameters of the first and second stage stem separation devices, the separation effect can be improved. Although some results can be obtained, most of them are obtained through years of experience and observation of the worker master, and the requirements for the worker's ability are relatively strict, Although some structural adjustments can ensure a decrease in the stem stick rate in cigarettes, sometimes it cannot guarantee the silk content in the separated stem sticks. At the same time, the cigarette unit is a complex and interrelated system, and changing the structure of the original unit itself is difficult, and it will have a certain impact on the performance of the entire cigarette unit. Installation and maintenance are inconvenient, expensive, and affect the overall aesthetics. (4) The separation of stem tags is mostly achieved through wind separation, and there is little research on the flow field inside the wind separation device. The changes in the internal flow field of the air separation device directly affect the separation effect. Identify the changes in the internal airflow field and optimize the structure reasonably. When conducting further flow field analysis, the internal flow field also includes stem sticks and tobacco particles. Although there have been calculations for gas-solid two-phase flow modeling, most of them consider the material as spherical particles, ignoring the collision between particles and the collision between particles and the wall, which will cause deviation in analyzing the gas-solid separation effect inside the separator. Meanwhile, in the entire separation system, most devices are connected through pipelines, which are also important for energy loss, particle flow patterns, and changes in flow fields inside the pipelines. Reasonably designing the connecting pipelines ensures the quality of tobacco and tobacco.

II. Problem Analysis

Based on the original two air separation system functions of the YJ17 cigarette machine and the personnel arrangement of the cigarette production enterprise, personnel were not arranged to separate the waste stems in the subsequent process of removing them from the cigarette machine. All waste stems removed by the cigarette machine, including the tobacco cut in the stems, will be directly treated as waste. According to statistics, the average silk content in the current stem of a certain brand of cigarettes produced by a cigarette manufacturing enterprise is 1.06 1g/10000 cigarettes, compared to the historical best indicator of 0.93g/10000 cigarettes. The cigarette machine has a production capacity of 3.4 million cigarettes per shift, with 2 shifts per day and 260 days per year. A total of 10 cigarette machines waste approximately 1876 kg of tobacco annually. The waste caused by removing tobacco from waste stems in the production of YJ17 cigarette machines is very obvious, which restricts the reduction of production costs and the improvement of equipment efficiency for enterprises. The negative pressure air of the YJ17 cigarette machine's secondary air selection stem separation device is provided by the air chamber body of the suction molding system. After the tobacco is suspended and lifted, it is taken away by the suction ribbon, and the debris from the tobacco stems falls into the

tobacco stem box. The problems include the following two aspects:

One reason is that the stem baffle is difficult to control the primary sorting of stem fibers. After a wind separation, the tobacco enters the suction channel under the drive of the high-speed rotating throwing roller. During this process, if the adjustment position of the stem baffle is too high, a large amount of stem will be sucked into the air chamber, causing many quality defects in the produced cigarettes that have been punctured by the stem. If the position of the stem baffle is adjusted too low, a large amount of tobacco will be thrown into the spiral stem return mechanism and transported to the feeding port of the secondary sorting device. In the case of incomplete stem separation, it will increase production costs and cause waste. The second reason is that the cut tobacco that falls into the tobacco stem box is relatively heavy. The secondary air separation of the YJ17 type coiling machine is only partially completed on the right side of the rear body, with a vertical suction duct width of only 110mm. There are many collisions between the stem and tobacco, and the air separation effect is poor, resulting in incomplete stem separation. Many tobacco leaves fall into the stem box along with the stem during the collision. It was found on site that a large proportion of tobacco leaves are contained in the stem box.

III. Improvement Methods

The development of the third stem and silk separation device for YJ17 cigarette maker utilizes the difference in suspension speed between stems and silk, and uses airflow separation. Assuming the airflow velocity is v, the force of the airflow on the particles is R, and the particle gravity Q=mg, according to Newton's formula R=K （ γ/ g) F (C- v) 2=K ρ F (C- v) 2: γ Is the air density, Kg/m3; ρ Is the air density Kg ''s2/m4; C is the absolute velocity of particles, m/s; F is the windward area, m2; K is the resistance coefficient. Due to the different external dimensions of tobacco and tobacco stems, i.e. F, and the different gravity Q, the critical suspension velocities of the two are different. Therefore, as long as the separation airflow velocity v satisfies v0<v<vO stems, tobacco and tobacco stems can be effectively separated.

After clarifying the separation theoretical basis used for the third stem and silk separation device, a vertical airflow simulation blow test method was used to test the stem and silk content of a certain brand produced by 10 # cigarette maker. After a vertical airflow simulation blow test, under the premise of qualified cigarette quality, 50% of the simulated data was less than the improvement target value set by the cigarette enterprise of 0.663g/10000 cigarettes. It can be inferred that it is indeed feasible to install the YJ type cigarette machine's third stem separation device to produce high silk content in the stems of ten thousand cigarettes.

The three-stage separation device for stem and silk is mainly composed of four parts: middle note device, quick connector of blowing device and air duct. Its working principle is that the positive pressure air enters from the air inlet, regulates the air pressure through the pressure regulating valve, and then the positive pressure air comes out from the air inlet. The common pressure is measured by the pressure gauge, and then comes out from the air outlet to enter the blowing device. The three-level separation device for tobacco stems is installed on the lower right side of the straight channel. Through uniform positive pressure air, the most dense and rapidly moving tobacco stems in the channel are blown away[6]. This not only maximizes the dispersion of high-density tobacco clusters, but also blows the scattered tobacco after collision upwards, blowing the tobacco that is about to fall into the tobacco stem box up

for a distance. The tobacco is sucked into the air chamber under the action of negative pressure air. However, the truly heavy tobacco stems still cannot be sucked into the air chamber and fall into the stem box, ultimately achieving the third separation of stem fibers. The stem content can be easily controlled through a pressure regulating valve according to production process requirements. A small air chamber with an inner diameter of 6.8mm is designed inside the blowing device, and six uniform holes with an aperture of 1mm are designed outside the shaft. Positive pressure air enters the small air chamber and blows out from the six uniform holes to form a positive pressure airflow, achieving the purpose of loosening and dispersing tobacco clusters. As shown in Figure 1.

Figure 1. Schematic diagram of structure

IV. Conclusions

After the processing and installation of the third stem separation device parts, the maintenance worker verified the effectiveness of the YJ17 cigarette machine's third stem separation device. After the third use of the stem separation device, the silk content in the stem was 0.583g/10000 wen. Tracking tests were conducted on the stem content in the tobacco produced by the YJ17 cigarette maker. The conclusion was that there was not much change in stem label removal before and after the activity, and the stem content in the tobacco was 0, which meets the production process standards of cigarette enterprises. This improvement is indeed effective.

By using a three-level stem separation device, the tobacco content in the stem box of the YJ17 cigarette maker is significantly reduced. After calculation, one machine producing two shifts a day can save about 2.5 kilograms of tobacco, reduce consumption, and save production costs for the enterprise. At the same time, it also reduces the labor intensity of workers, improves the effective operation rate of equipment, reduces the risk of product quality hazards, and protects consumer rights and interests

The whole stem-label separation system is divided into three levels, and each level is very important. Because the movement of the separated stems and cut tobacco in the separation device is affected by many factors. The influence of air flow field on cut tobacco and stem labels, the impact of collision between cut tobacco and stem labels, the layout of connecting pipes and the influence of transportation process all make the separation process of each stage of stem labels a complex gas-solid two-phase flow movement process. Therefore, there are many problems in the theoretical analysis of the movement of cut tobacco and stalks in the separation device. According to the actual operation requirements of enterprises, the stalk separation system can be further explored and analyzed in the following aspects to make up for the shortcomings of this paper. The main results are as follows:

(1) Although the stalk-label separation device is small, its structure has a great influence on the separation process because the cut tobacco and the stalk-label are too small. This paper only selects the

main structural factors to analyze and study it, and the arrangement and spacing between the guide blocks in the diversion area may affect the separation effect, so it can be considered to be studied in the later stage.

(2) In the simulation, due to the irregularity of cut tobacco and stems, several groups of quantitative particle models can be added in the later stage to improve the model, so that there is more than one shape of cut tobacco and stems, and the physical parameters are closer to the actual situation of the enterprise, which improves the accuracy of numerical simulation results and truly conforms to the experimental results.

(3) During the experiment, only the separation efficiency of cut tobacco and the final rolling quality of cigarettes were statistically analyzed. It is difficult to measure the movement law of cut tobacco and cut tobacco directly and accurately in the whole three-stage separation system. Later, we can explore new experimental methods to measure the movement law of cut tobacco and cut tobacco during separation, which will lay a certain foundation for theoretical research on gas-solid two-phase flow in tobacco industry and verify the accuracy of numerical simulation results.

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Construction of Cross Border E-commerce Cooperation Alliance based on Cloud Platform and Interest Game

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Abstract: The development of cross-border e-commerce is crucial in establishing the new pattern of domestic and international double circulation. Currently, the issue of 'information islands' within the cross-border e-commerce supply chain and the problem of conflicting interests are hindering the further development of cross-border e-commerce. This paper describes the establishment of a horizontal alliance between cross-border e-commerce manufacturers and platforms through the construction of a cloud platform. Subsequently, a vertical alliance was formed with cross-border e-commerce platforms, domestic logistics service providers, international carriers, and foreign logistics service providers as the main components. To ensure effective information coordination and benefit sharing among cross-border e-commerce partners, the traditional single benefit distribution model has been replaced. The benefits of horizontal and vertical alliances in cross-border e-commerce are now distributed using Stackelberg game theory and an improved Raiffa model, resulting in a more equitable distribution among alliance members.

Keywords: cross border e-commerce alliance, Stackelberg game, Raiffa model

1   Introduction

Cross-border e-commerce imports and exports facilitate the global flow of commodity factors, which is closely related to the formation of a new development pattern of domestic and international double circulation. According to the E-commerce Research Center, China's cross-border e-commerce transaction scale reached 15.7 trillion yuan in 2022, representing a year-on-year growth of 11.81%. Cross-border e-commerce is expected to continue its rapid development trend in the future, playing a crucial role in both domestic and international double cycle systems.

Cross-border e-commerce involves the crossing of national boundaries, and the links from supply to final consumer can be complex and scattered. In addition, consumers' expectations for products and logistics services are constantly increasing, making it challenging for a single enterprise to efficiently complete the entire cross-border e-commerce transaction. To address this, enterprises have explored new development modes and built various forms of cross-border e-commerce cooperation alliances. Martin

Christopher proposed that in the 21st century, competition is no longer between enterprises, but between supply chains. The future of cross-border e-commerce will also move towards a resource-intensive and integrated development model. However, the information standards of different countries and enterprises are inconsistent, making it difficult to share and transfer information in real-time. The issue of information islands and the problem of conflicting interests between them is a significant obstacle to the efficiency of cross-border e-commerce. Therefore, it is essential to establish a cross-border e-commerce alliance that involves multiple parties, industries, and regions, and promotes information coordination and benefit sharing[1] (Du & Gong, 2018).

Regarding cooperative alliances,information sharing through cloud computing, cloud platforms, and other technologies can effectively enhance the management performance of cooperative alliances[2](Chan et al,2017). With respect to the distribution of alliance benefits, the importance of establishing a reasonable distribution and coordination mechanism to maintain a stable alliance relationship[3-4](He et al,2012; Nikkhoo & Bozorgi,2018). Based on previous studies, this paper presents a comprehensive design for a cross-border e-commerce alliance, focusing on two key aspects: the organizational model and the benefit distribution model. The aim is to address the significant issues of 'information islands' and conflicting interests.

2   Construction of cross border e-commerce cooperation alliance based on cloud platform

Cross-border e-commerce involves multiple subjects and complex links, including supply, transportation, customs clearance, distribution, and final consumers. To enhance the efficiency of cross-border e-commerce and integrate all resources, a cross-border logistics alliance led by major cross-border e-commerce platforms (such as Alibaba and Dunhuang) has emerged. The company has integrated domestic and foreign logistics service providers, international carriers, and other intermediaries to optimize the entire cross-border logistics process. The existing cross-border e-commerce platform not only sells its own products but also provides a sales platform and logistics services for other manufacturers. However, the mutual substitution and competition between cross-border e-commerce platforms and manufacturers' products affect the prices of goods and logistics services, making it challenging to increase the total revenue of cross-border e-commerce. Scholars have discussed the relationship between e-commerce platforms and manufacturers. They propose that manufacturers can become product suppliers of cross-border e-commerce platforms through alliances with them to improve their earnings[5] (Wang et al,2017). This paper presents a model for a cross-border e-commerce cooperation alliance based on a cloud platform, with the cross-border e-commerce platform at its core. The model involves manufacturers, domestic logistics service providers, international carriers, and foreign logistics service provider, as shown in Fig.1.

To establish an effective organizational mode, it is recommended to form a horizontal alliance between cross-border e-commerce platform enterprises and manufacturers. Manufacturers, as the suppliers of the cross-border e-commerce platform, should provide products at a lower price and ensure timely delivery. Meanwhile, cross-border e-commerce platform enterprises should provide manufacturers with a sales platform, cross-border payment, after-sales service, market information, logistics, and other necessary support services. The cross-border e-commerce platform sells products from various

manufacturers in a unified manner, eliminating the previous situation where manufacturers independently sold their products on the platform. This approach ensures that the prices of goods and services are unified, thereby avoiding market chaos. Additionally, the platform can monitor commodity inventory in real-time, shorten procurement lead times, and further improve cross-border e-commerce efficiency. Based on the horizontal alliance, a vertical alliance is established among cross-border e-commerce platforms, domestic logistics service providers, international transport carriers, and foreign logistics service providers. Domestic logistics service providers are responsible for procuring, transporting, warehousing, and managing inventory of domestic commodities. International transport carriers are responsible for completing customs clearance and cross-border transport business. Foreign logistics service providers are responsible for the transportation, warehousing, and distribution of overseas goods. The cross-border e-commerce cooperation alliance mode of horizontal and vertical integration is established based on the mode of 'manufacturer + cross-border e-commerce platform enterprise + logistics service provider' to achieve the division of labour.

To address the issue of information asymmetry and 'information islands' among alliance members, a cloud platform for cross-border e-commerce alliances has been developed. This platform integrates the information systems of each member, creating an alliance database that records supply, business, market, financial, and logistics information. All members of the alliance can access the alliance database through the cloud platform, ensuring coordination of information across all links of cross-border e-commerce. This facilitates collaboration between logistics, information flow, capital flow, and business flow generated by all links in the operation process of cross-border logistics alliance members, forming a 'four-flow integration' mode.

However, the alliance is likely to involve the issue of interest distribution. To ensure stability within the cross-border e-commerce alliance, it is essential to establish a fair and reasonable profit distribution mechanism that considers the interests of all members. This paper uses Stackelberg game theory and an improved Raiffa model to explore the problem of benefit distribution in cross-border e-commerce horizontal and vertical alliances. The research presented here aims to provide decision-making support for the establishment of a profit distribution mechanism for cross-border e-commerce alliances.

3   Benefit distribution model of cross border e-commerce horizontal alliance

3.1   Model construction and hypothesis

(1)The cross-border e-commerce horizontal alliance comprises manufacturers and cross-border e-commerce platforms. The platform, being the dominant player, integrates resources from all links of cross-border e-commerce and provides technical and service support for the sale of cross-border commodities. The manufacturers, as followers, provide products to the platform. Both parties are rational economic actors. Both parties aim to maximise their own interests through cooperation. The variable w represents the wholesale price of the product, while c represents the unit production costs for manufacturers. The variable p represents the product prices on the cross-border electric platform, and K represents the maintenance costs of the cross-border electric business platform, where w > c and p > w.

(2)Demand Function D: Assume that the demand of market is determined by the price of the product level and the logistics service level. Market demand is negatively correlated with product price and positively correlated with logistics service level, and demand is a linear function of commodity price and logistics service[6-7] (Chen et al,2013; Lejarza et al,2022). Demand of the market is: $D = \beta - b_1 p + b_2 s$, among them, the β as market size, s as logistics service level, b1 as the sensitive of consumer to commodity prices and b_2 respectively the sensitive of consumer to logistics services, and $b_i \geq 0$. It can be seen that in order to obtain the largest market share, manufacturers and cross border e-commerce platform enterprises need to make joint decisions to determine the optimal commodity price and logistics service level.

(3)The logistics service cost C(s) is assumed to be a quadratic function of the logistics service level, with $C(s) = \gamma_1 s^2/2$, where γ_1 is the coefficient for logistics service costs[8](Zhao et al,2022). There is an inherent conflict between logistics service cost and logistics service level. In order to reduce logistics costs, logistics service providers tend to maintain logistics service levels at a medium to low level, which can negatively impact consumers' experience. Therefore, it is essential to establish a horizontal alliance for cross-border e-commerce to unify the level of logistics services and improve the efficiency of cross-border logistics.
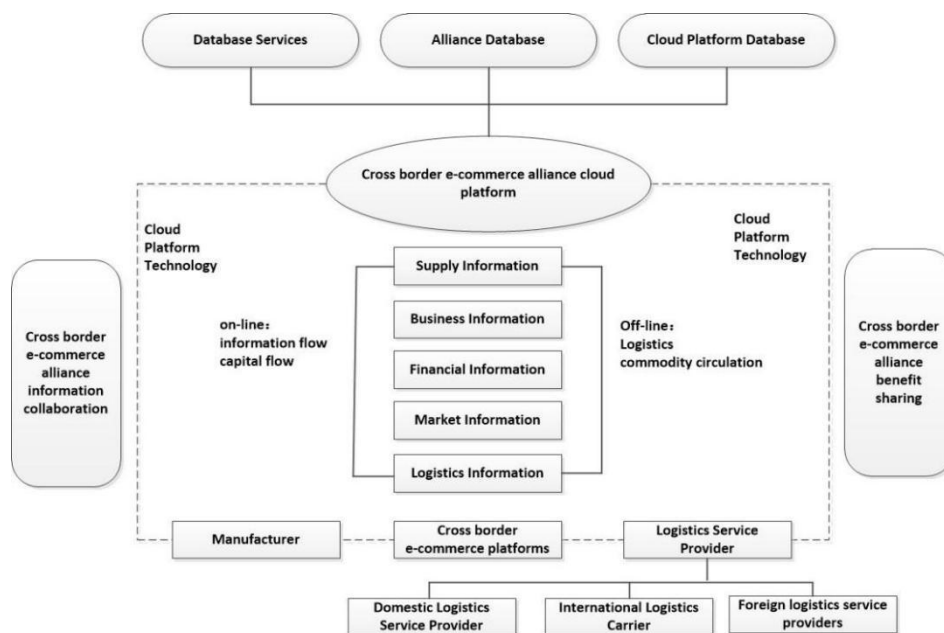
Fig. 1. Cross border e-commerce cooperation alliance model based on cloud platform

3.2 Stackelberg game model dominated by cross border e-commerce platform

In a market dominated by cross-border e-commerce platforms, the price of goods p and logistics service level s are determined by the platforms. Manufacturers, as followers, then determine the wholesale price of their products w based on the decisions made by the cross-border e-commerce platforms. This constitutes a Stackelberg game model[9-10] (Wen et ali,2019; Li et al,2022). In asymmetric competition, strong leaders make decisions to maximize their own profits, while weak followers choose strategies based on the leader's decisions. This results in a decentralized decision-making process. It is important to note that this is a technical text and therefore, technical terms such as 'asymmetric competition' and

'decentralized decision-making process' have been retained. The cross-border e-commerce platform and the manufacturer's profit functions are denoted as π_1 and π_2, respectively.

$$\pi_1 = (p - \omega)(\beta - b_1 p + b_2 s) - \frac{1}{2}\gamma_1 s^2 - K \tag{1}$$

$$\pi_2 = (\omega - c)(\beta - b_1 p + b_2 s) \tag{2}$$

Proposition 1: when $2\gamma_1 b_1 - b_3{}^2 > 0$, cross border e-commerce platform of the profit function is about commodity prices p and logistics service level s joint concave function. The manufacturer's profit function is about the wholesale price of w strictly concave function.

Proof: In equation (1), respectively count π_1 about p and s second order mixed partial derivative of the Hessian matrix:

$$H(p, s) = \begin{bmatrix} -2b_1 & b_2 \\ b_2 & -\gamma_1 \end{bmatrix} \tag{3}$$

If the Hessian matrix is negative qualitative, its corresponding function is concave. Owing to $|H_1| = \frac{\partial^2 \pi_1}{\partial p^2} = -2b_1 < 0$, to make the profit function of the cross border e-commerce platform as p and s joint concave function, need to satisfy $|H(p,s)| = \frac{\partial^2 \pi_1}{\partial p^2} * \frac{\partial^2 \pi_1}{\partial s^2} - \left(\frac{\partial^2 \pi_1}{\partial p \partial s}\right)^2 = 2\gamma_1 b_1 - b_3{}^2 > 0$. And then, according to $\pi_2 = (\omega - c)(\beta - b_1 p + b_2 s)$, assume $p = \omega + x$, among them, x as mark-up for cross border e-commerce platform, the manufacturer's profit function can be turned into equation (4):

$$\pi_2 = (\omega - c)(\beta - b_1 \omega - b_1 x + b_2 s) \tag{4}$$

In equation (4), calculating the second derivative of π_2 with respect to ω, result as $\frac{\partial^2 \pi_2}{\partial \omega^2} = -2b_1 < 0$. Therefore, the manufacturer's profit function π_2 is strictly concave function about the wholesale price w. Proof completed.

In conclusion, the cross border e-commerce platform of the profit function π_1 and the manufacturer's profit function π_2 have the maximum, which both sides can make optimal decisions, make to maximize their own profits.

Proposition 2: According to Proposition 1, cross border e-commerce platform can develop the optimal commodity prices p and logistics service level s. On the basis of cross border e-commerce platform decision-making, the manufacturer can determine the optimal wholesale price w.

Proof: In equation (4), according to the Stackelberg game model, using backward induction, calculate the first order partial derivative of manufacturers profit function π_2 with respect to w, result as $\frac{\partial \pi_2}{\partial \omega} = -2b_1 \omega + \beta + b_2 s + b_1 c - b_1 x$, make $\frac{\partial \pi_2}{\partial \omega} = 0$ and x=p-ω, result as equation (5):

$$\omega = \frac{\beta + b_2 s}{b_1} + c - p \tag{5}$$

Substitute equation (5) into equation (1), and calculate the first order partial derivative with respect to p and s, result as $p^{1*} = \frac{3(\beta + b_2 s)}{4b_1} + \frac{c}{4}$, $s^{1*} = \frac{(3p-c)b_1 b_2 - 2b_2 \beta}{b_1 \gamma_1 + 2b_2{}^2}$. And then, substitute p^{1*} and s^{1*} into equation (5), result as the manufacturer's optimal wholesale price $\omega^{1*} = \frac{\beta + b_2 s^{1*}}{b_1} + c - p^{1*}$. Proof completed. And then, substitute p^{1*} and s^{1*} into equation (1) and equation (2), result as $\pi_1{}^*$ and $\pi_2{}^*$, respectively representing the maximum profit of cross border e-commerce platform and manufacturer.

3.3 Profit distribution model of cross border e-commerce horizontal alliance under centralized decision-making

In the case of centralized decision-making, the cross border e-commerce platform and the manufacturer reach an alliance in the true sense. Instead of maximizing their own interests, they are committed to maximizing the overall interests of the cross border e-commerce alliance. According to the above model assumption, cross border e-commerce alliance union overall profit function π as follows:

$$\pi = \pi_1 + \pi_2 = (p - c)(\beta - b_1 p + b_2 s) - \frac{1}{2}\gamma_1 s^2 - K \tag{6}$$

In equation (6), calculate respectively the first order partial derivative of overall profit function π with respect to p and s, then make it zero. Joining $\frac{\partial\pi}{\partial p} = 0$ and $\frac{\partial\pi}{\partial s} = 0$, calculate the best price and optimal logistics service level as p^{2*} and s^{2*}, so as to maximize the overall benefit of the cross border e-commerce alliance, among them $p^{2*} = \frac{\beta\gamma_1 + b_1\gamma_1 c - c b_2^2}{2b_1\gamma_1 - b_2^2}$, $s^{2*} = \frac{b_2}{\gamma_1}(\frac{\beta\gamma_1 + b_1\gamma_1 c - c b_2^2}{2b_1\gamma_1 - b_2^2} - c)$. And then substituting p^{2*} and s^{2*} into equation (6) can obtain the overall maximum profit of cross border e-commerce alliance as π^*.

3.4 Profit distribution of cross border e-commerce horizontal alliance based on revenue sharing model

In order to promote the centralized decision-making of cross border e-commerce platform and manufacturers, improve the efficiency of cross border e-commerce and increase their respective profits, refer to [11], this paper uses the contract model of revenue sharing to coordinate the behaviors and interests of both parties. The cross border e-commerce platform determines the optimal commodity price and logistics service level from the perspective of the overall profit maximization of cross border e-commerce, while manufacturers provide products for the cross border e-commerce platform at a lower wholesale price. Cross border e-commerce platform share revenue from the sale of goods with manufacturers, among them, the cross border e-commerce platform accounted for the proportion of sales revenue for λ, the proportion of manufacturers as $1 - \lambda$. Under a revenue sharing, cross border e-commerce platform of the profit function is $\pi_1(\lambda)$.

$$\pi_1(\lambda) = \lambda p(\beta - b_1 p + b_2 s) - \omega(\beta - b_1 p + b_2 s) - \frac{1}{2}\gamma_1 s^2 - K \tag{7}$$

In equation (6), calculate respectively the first order partial derivative of $\pi_1(\lambda)$ with respect to p and s. Joining $\frac{\partial\pi_1(\lambda)}{\partial p} = 0$ and $\frac{\partial\pi_1(\lambda)}{\partial s} = 0$, the following results can be obtained.

$$p^*(\lambda) = \frac{\lambda b_2^2\omega - \lambda\gamma_1\beta - b_1\gamma_1\omega}{\lambda^2 b_2^2 - 2\lambda b_1\gamma_1} \tag{8}$$

$$s^*(\lambda) = \frac{(\lambda p^*(\lambda) - \omega)b_2}{\gamma_1} \tag{9}$$

Under a revenue sharing, in order to achieve the effect of centralized decision-making, set $p^*(\lambda) = p^{2*}$, the following results can be obtained.

$$\omega^*(\lambda) = \frac{(\beta\gamma_1 + b_1\gamma_1 c - c b_2^2)(b_2^2\lambda^2 - 2\lambda b_1\gamma_1)}{(2b_1\gamma_1 - b_2^2)(\lambda b_2^2 - b_1\gamma_1)} + \frac{\lambda\gamma_1\beta}{\lambda b_2^2 - b_1\gamma_1} \tag{10}$$

Substitute $\omega^*(\lambda)$ into equation (7), profit function $\pi_1(\lambda)$ of cross border e-commerce platform under revenue sharing can be calculated. In this case, the profit function of the manufacturer is $\pi_2(\lambda) = \pi - \pi_1(\lambda) = (1 - \lambda)\pi$. Under the assumption of revenue sharing, the profits of both cross border e-commerce platform and manufacturer are higher than those of decentralized decision-making, and the profits of cross border e-commerce platform as the leader are higher than manufacturer. That is $\pi_1(\lambda) > \pi_{1^*}$, $\pi_2(\lambda) > \pi_{2^*}$, and $\pi_1(\lambda) > \pi_2(\lambda)$.

4   Profit distribution model of cross border e-commerce vertical alliance

Domestic and foreign logistics service providers, as well as international transport providers, play a crucial role in cross-border e-commerce by connecting enterprises and consumers. The logistics service level of these providers directly affects consumer demand. To maximize their own interests in cooperation, logistics service providers act as rational economic agents. However, it is important to note that high logistics service levels may result in higher logistics costs. To reduce these costs, logistics service providers may naturally maintain logistics services at a medium or low level. This, unfortunately, contradicts the logistics service level expected by cross-border e-commerce platforms and consumers. To enhance the efficiency of logistics and service levels in cross-border e-commerce, a vertical alliance has been established. This alliance is led by a cross-border e-commerce platform and includes domestic logistics service providers, international transport providers, and foreign logistics service providers. The cross-border e-commerce platform shares the total revenue from the horizontal alliance with the logistics service providers. The logistics service provider will adhere to the optimal logistics service level $s^*(\lambda)$ as formulated by the cross-border e-commerce platform to provide logistics services.

Most studies use the Shapley model to distribute benefits to cooperative members. However, the calculation amount of the Shapley model increases exponentially with the number of members, limiting its practical application[11-12] (Yang et al,2020; Hu et al,2023). On the other hand, the Raiffa model considers the upper and lower limits of profit distribution. On the other hand, it is easy to operate and avoids the difficult problem of collecting information data. It is also more suitable for distributing profits among multiple members. In summary, it effectively compensates for the shortcomings of the Shapley model. To ensure a fair and reasonable distribution of alliance benefits, this paper uses the improved Raiffa model to distribute the benefits of the cross-border e-commerce vertical supply chain alliance[13] (Yang et al,2023).

4.1   Raiffa profit distribution model

The set of cross-border e-commerce vertical alliances for the enterprise is N={1,2…… N}, where n=4. V(N) represents the total revenue of the cross-border e-commerce vertical alliance. This paper sets V(N) as the total revenue of cross-border e-commerce under optimal decision-making. In other words, V(N) is the total revenue obtained under the revenue-sharing contract between the cross-border e-commerce platform, V(N) = $\pi_1(\lambda)$. x_i represents the profit gained by member i from V(N), and $\sum_{i=1}^{n} x_i = V(N)$. When the remaining number of n-1 enterprises establish a cooperative alliance, their profits is V(N/i) = μ_i, where $i = 1,2……n$.

First of all, according to profit which created by number of $n-1$ alliance enterprises, we can calculate $\underline{x_i}$, where $\underline{x_i}$ is the lower limit of distribution for the interests of all parties benefit.

$$\left\{ \begin{array}{c} \sum_{i=1}^{n} x_i - x_1 = \mu_i \\ \\ \sum_{i=1}^{n} x_i - x_n = \mu_n \end{array} \right. \tag{11}$$

According to equation (11), we can calculate $x_i = \frac{1}{n-1}\sum_{i=1}^{n}\mu_i - \mu_i$. Revenue will increase when the enterprise j establish an alliance with the number of $n-1$ alliance enterprises. We treat the increase in revenue as the ideal upper limit of profit distribution, where $\overline{x_j} = B - \mu_i$. $\overline{x_j}$ is divided equally by member party j and n-1, and they distribute profits based on $\underline{x_i}$. The following results can be calculated.

$$x_j = \frac{\overline{x_j}}{2}, \ x_i = \underline{x_i} + \frac{\overline{x_j}}{2(n-1)}, \ i = 1,2...n, \ i \neq j \tag{12}$$

Finally, j takes 1,2... n. we repeat the above average, then substitute $\overline{x}$ and $\underline{x}$ into equation (12). Profit distribution of the vertical alliance of cross border e-commerce can be calculated. The results is as follow:

$$x_i = \frac{V(N)}{n} + \frac{2n-3}{2(n-1)}\left[\frac{1}{n}\sum_{i=1}^{n}\mu_i - \mu_i\right] \tag{13}$$

4.2 Raiffa benefit allocation model modification based on services undertaken by alliance members

The Raiffa model presented above is considered ideal. However, for it to be applicable, the services provided by members of cross-border e-commerce vertical alliances must be consistent, namely $F = \frac{1}{n}$ [14](He et al,2018). In reality, the service content undertaken by the vertical alliance members of cross-border e-commerce differs, as do their contributions to the business. As a result, there is some discrepancy between the ideal model and the actual profit distribution. The cross-border e-commerce platform, as the leading party, is responsible for integrating and coordinating all resources involved in cross-border e-commerce and providing a range of supporting services. Domestic logistics service providers are responsible not only for transferring commodities to international carriers but also for commodity procurement, warehousing, transportation, and inventory management. International carriers are responsible for transporting goods across borders, while foreign logistics service providers are responsible for the warehousing and distribution of overseas goods. This paper revises the Raiffa model based on the services undertaken by alliance members.

It is assumed that the services undertaken by the vertical alliance members of cross border e-commerce are reflected in three aspects. On the one hand, costs φ_i incurred by alliance members for providing corresponding services. On the other hand, the service level s_i provided by the alliance members. And in addition, the business level θ_i provided by enterprise alliance. M_i is corresponding weights of three the above three. Therefore, the services F_i undertaken by alliance member i is as follow.

$$F_i = M_1 \frac{\varphi_i}{\sum \varphi_i} + M_2 \frac{s_i}{\sum s_i} + M_3 \frac{\theta_i}{\sum \theta_i} \tag{14}$$

It can be seen that the difference between the actual service undertaken by each alliance member and the original assumed model is $\Delta F_i = F_i - \frac{1}{n}, wh\ ere \sum \Delta F_i = 0$. At this point, given the interests of the members actual correction as $\Delta x_{i^*} = \Delta F_i V(N)$. As a result, according to improved Raiffa model, the actual distribution of benefits among alliance members i is as follow:

$$x_i^* = x_i + \Delta x_{i^*} = \frac{V(N)}{n} + \frac{2n-3}{2(n-1)}\left[\frac{1}{n}\sum_{i=1}^{n}\mu_i - \mu_i\right] + (F_i - \frac{1}{n}) * V(N) \tag{15}$$

5 Numerical simulation

To verify the correctness and scientificity of the proposed benefit distribution method, this paper conducts numerical simulations on the benefit distribution of alliance members. The simulations are carried out under three different situations: decentralized decision making, centralized decision making, and revenue sharing. This analysis aims to identify the optimal revenue sharing coefficient and decision-making process among alliance members by examining the changes in benefit distribution and decision-making under different coefficients.

5.1 Profit distribution of cross border e-commerce horizontal alliance

The benefit distribution model for cross-border e-commerce horizontal alliance members assumes specific values for each parameter: $K = 10, \gamma_1 = 1, c = 10, \beta = 200, b_1 = 2, b_2 = 1$. By substituting each parameter into the equations for p^{1*}, s^{1*} and ω^{1*}, the best commodity prices and logistics services for alliance members can be calculated in the context of decentralized decision-making. By substituting each parameter into the equations for p^{1*}, s^{1*} and ω^{1*}, the best commodity prices and logistics services for alliance members can be calculated in the context of decentralized decision-making. Specifically, the calculated values are $p^{1*} = 87.14$, $\omega^{1*} = 35.71$, $s^{1*} = 25.71$. Therefore, cross-border e-commerce platforms and manufacturers can maximise the benefits of decentralised decisions, namely $\pi_{1^*} = 2304.54$, $\pi_{2^*} = 1322.27$. Under centralised decision-making, the overall profit of cross-border e-commerce is 5390, namely π = 5390. By implementing revenue sharing, an ideal income sharing coefficient can be obtained when $\pi_1(\lambda) > \pi_{1^*}$, $\pi_2(\lambda) > \pi_{2^*}$ and $\pi_1(\lambda) > \pi_2(\lambda)$, with a range of $0.71 \leqslant \lambda \leqslant 0.88$. If the revenue sharing coefficient λ is below 0.71 or above 0.89, cross-border e-commerce platforms and manufacturers will not adopt the profit distribution mode of sharing under centralized control in order to ensure their maximum interests. When the benefit sharing coefficient λ takes different values, decision parameters and profit changes of cross-border e-commerce horizontal alliances can be calculated with a step change of 0.02. Refer to Table 1 for details.

Table 1. λ impact on cross border e-commerce horizontal alliance members

λ	$p^*(\lambda)$	$\omega(\lambda)$	$s^*(\lambda)$	$\pi_1(\lambda)$	$\pi_2(\lambda)$	π^*
0.71	70	16.68	33.02	2516.66	2509.46	5026.12
0.73	70	16.61	34.49	2654.01	2410.56	5064.57
0.75	70	16.50	36.00	2798.00	2304.00	5102.00
0.77	70	16.34	37.56	2949.07	2189.17	5138.24

0.79	70	16.13	39.17	3107.70	2065.43	5173.13
0.81	70	15.86	40.84	3274.39	1932.07	5206.46
0.83	70	15.54	42.56	3449.70	1788.30	5238.00
0.85	70	15.15	44.35	3634.23	1633.27	5267.5
0.87	70	14.71	46.19	3828.66	1466.05	5294.71
0.88	70	14.46	47.14	3929.80	1377.55	5307.35

5.2　Profit distribution of cross border e-commerce vertical alliance

The benefit distribution model for cross-border e-commerce vertical alliances includes four members: the cross-border e-commerce platform, domestic logistics service provider, international transport provider, and foreign logistics service provider (N={1,2,3,4}). To achieve the desired logistics service level, the cross-border e-commerce platform must form an alliance with a logistics service provider and share their total revenue. The revenue-sharing model for the cross-border e-commerce vertical alliance is based on the optimal decision of the cross-border e-commerce platform, denoted as V(N)=π_1 (λ), where the total revenue is calculated. This article assumes the following: V(1∪2∪3)=2200, V(1∪2∪4)=2300, V(1∪3∪4)=2000, and V(2∪3∪4)=1600. The logistics service provider should offer logistics services $s^*(\lambda)$ based on the optimal decision-making logistics service level in the horizontal alliance model. The model assumes that the service level provided by cross-border e-commerce platforms is consistent with that provided by logistics service providers. It only discusses the cost of investment φ_i and service level θ_i by alliance members. The cost of investment and service level by alliance members for the service are as follows: $\varphi = [\varphi_1, \varphi_2, \varphi_3, \varphi_4] = [20,15,8,12]$, $\theta = [\theta_1, \theta_2, \theta_3, \theta_4] = [0.7,0.5,0.4,0.6]$. The weight of cost investment φ and service level θ are 0.7 and 0.3 respectively. Formula (15) can be used to calculate the profit distribution of the cross-border e-commerce platform, domestic logistics service provider, cross-border transport provider, and foreign logistics service provider, represented by $\{x_1^*, x_2^*, x_3^*, x_4^*\}$.

Table 2 shows the profit changes of the cross-border e-commerce vertical alliance when the benefit-sharing coefficient λ takes different values, with step changes of 0.01. In the horizontal alliance benefit distribution model of cross-border e-commerce platforms under decentralized decision-making, the total income is 2304.5, denoted as V(N). According to the modified Raiffa model, the profit distribution among members of the cross-border e-commerce vertical alliance is as follows: $x_1 = 1056.59$，$x_2 = 680.42$, $x_3 = 110.35$，$x_4 = 457.19$. Table 2 shows that when λ=0.71, the benefits distributed by domestic and foreign logistics service providers are lower than those of decentralized decision-making. Therefore, it is necessary to consider the best interests of both horizontal and vertical parties in cross-border e-commerce alliances. The revenue sharing coefficient λ should be between 0.72 and 0.88.

Table 2. λ impact on cross border e-commerce vertical alliance members

λ	V(N)	x_1^*	x_2^*	x_3^*	x_4^*
0.71	2516.66	1235.00	672.88	164.35	444.44
0.72	2584.53	1258.75	690.46	174.96	460.36
0.74	2725.15	1307.97	726.89	196.95	493.34

0.76	2872.62	1359.58	765.10	220.01	527.93
0.78	3027.41	1413.76	805.21	244.21	564.23
0.80	3190.00	1470.67	847.33	269.63	602.37
0.82	3360.93	1530.49	891.62	296.36	642.46
0.84	3540.77	1593.44	938.22	324.48	684.64
0.86	3730.17	1659.72	987.29	354.10	729.06
0.88	3929.80	1729.60	1039.01	385.31	775.88

5.3 Comparative analysis of profit distribution of cross border e-commerce alliances under different decisions

To observe changes in interest distribution among members of cross-border e-commerce alliances under different decisions, we draw function images based on the model functions described above.
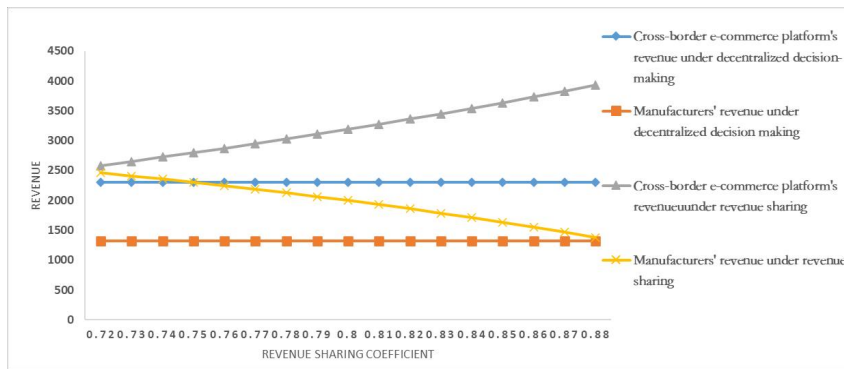
Fig. 2. benefit distribution of cross border e-commerce horizontal alliance members under different decisions

5.3.1 Comparative analysis on profit distribution of cross border e-commerce alliance.

Figures 2 and 3 illustrate the distribution of benefits in a cross-border e-commerce alliance under decentralized decision-making and revenue sharing. It is evident from the figures that centralized decision-making and revenue sharing result in higher profits for all alliance members compared to decentralized decision-making. Moreover, the revenue of cross-border e-commerce alliances has shown an increasing trend compared to the decentralized decision-making situation. This is in line with Pareto improvement and validates the rationality of the benefit allocation model mentioned above. However, if the revenue sharing coefficient exceeds 0.88, the manufacturer's revenue will be lower than that of decentralized decision making, and they may terminate the revenue sharing contract of centralized decision making. Additionally, the study found that cross-border e-commerce platforms generate the highest revenue in the case of revenue sharing. This is due to their significant contribution as the leading party. In terms of revenue, domestic logistics service providers rank first among all logistics service providers, followed by foreign logistics service providers in second place, and national logistics service providers in third place. This ranking is consistent with the current industry landscape.
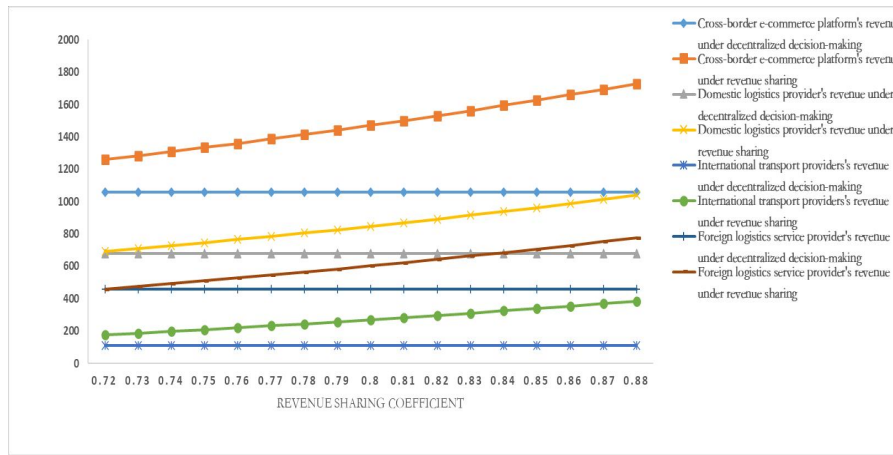
Fig. 3. benefit distribution among members of cross border e-commerce vertical alliance under different decisions

5.3.2Change analysis of decision parameters and demand under different circumstances.

Figure 4 shows the changes in logistics service level and market demand under different circumstances. The logistics service level is much higher under centralized decision-making than under decentralized decision-making. Additionally, as the revenue sharing coefficient λ improves, the level of logistics service also improves accordingly. Logistics service providers gain more income from profit distribution and take relevant measures to improve their logistics service level, such as introducing advanced management, logistics technology, and logistics talent. Revenue sharing contracts can effectively improve the logistics efficiency of cross-border e-commerce. It has been found that the price of goods is lower under revenue sharing than under decentralized decision-making, while the level of logistics is higher. As a result, market demand is expected to be higher under revenue sharing than under decentralized decision-making. Revenue sharing contracts can effectively address the issues of low efficiency in cross-border e-commerce and the severity game between alliance members. This will strengthen the alliance relationship between cross-border e-commerce members and promote the development of cross-border e-commerce.
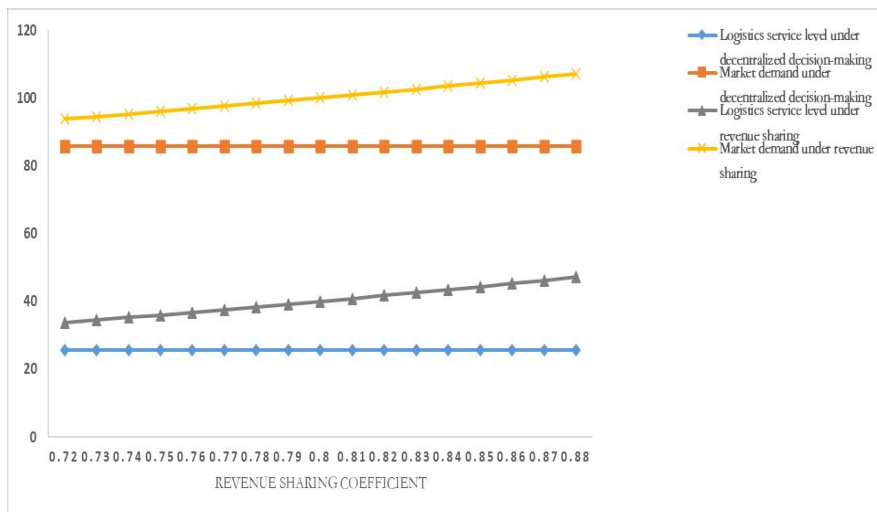
Fig. 4. Changes in logistics service level and market demand under different circumstances

6   Conclusion

This paper presents the design of a cross-border e-commerce alliance from the perspectives of organizational and interest distribution modes. The alliance is centered around a cross-border e-commerce platform and aims to address the issues of 'information islands' and conflicting interests among members of the cross-border e-commerce supply chain. To address the issue of 'information islands', the cross-border e-commerce alliance has developed a cloud platform that integrates logistics, information flow, capital flow, and business flow. Additionally, to tackle the issue of conflicting interests, the alliance has established Stackelberg game models, centralized decision models, and revenue sharing contract models for its horizontal members. The revised Raffia model is introduced to solve the benefit distribution problem of cross-border e-commerce vertical alliances. Numerical simulations are used to analyze the logistics service level, commodity price, market demand, and benefit distribution of alliance members under different decisions. The results demonstrate that: Under the revenue-sharing contract, the overall revenue of cross-border e-commerce and the benefit distribution of alliance members are higher than that of decentralized decision-making, which is in line with the Pareto improvement. Additionally, it is important to maintain the value range of the revenue sharing coefficient between 0.72 and 0.88 to ensure that all parties can reach an agreement. Thirdly, revenue sharing leads to lower prices for goods compared to decentralized decision-making, while also increasing the logistics level, thereby expanding market demand. In real life, there are numerous instances of cooperation breakdown between logistics service providers due to the unfair distribution of benefits. This paper's research holds significant reference value for addressing the issue of unfair benefit distribution.

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Study on the Dilemma and Development Strategy of Chinese Beauty brand: Based on the Analysis of Consumption Characteristics and Influencing Factors of Purchasing Willingness of College Student Groups

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Abstract: In order to fully explore the dilemmas behind the development of Chinese beauty brands, analyze the main factors affecting college students' purchasing of national beauty brands, and thus put forward a possible path for national beauty brands to retain traffic, this paper takes typical Chinese beauty brands and college students' groups as the objects of research, applies the factor analysis method to analyze the three factors that college students' groups are most concerned about Chinese beauty brands, and combines them with the existing data to find out the dilemmas and reasons that Chinese beauty , so as to put forward the paths and relevant countermeasures for Chinese beauty brands to retain traffic. The study shows that the brand awareness of Chinese beauty brands, the product R&D level of Chinese beauty brands, and the relative lack of product power of Chinese beauty brands are the three major dilemmas faced by Chinese beauty brands. Meanwhile, countermeasures such as optimizing brand layout by focusing on segmented categories, inviting celebrity endorsement and strengthening brand image are proposed.

Keywords: Chinese Beauty brand, Purchase intention, factor analysis, University student population

1.Introduction

With the continuous development of domestic science and technology level as well as economic level, Chinese national brand gradually enter our vision, and at the same time become the main products purchased by consumers, competing fiercely with foreign brand[1]. With the development of economy, people's living standard is improving, people's consumption demand has changed from the necessary consumption to meet the basic material needs to meet the higher level of spiritual needs of non-necessary consumption[2]. Coupled with the elevation of women's status, women's awareness of the awakening of the "her economy" has become a force to be reckoned with in the consumer market. Therefore, China's domestic cosmetics market has a broad blueprint. National identity, national self-confidence awakening makes consumers, especially young consumers are no longer superstitious about international brand, China's national cosmetics won a good opportunity to thrive[3]. The

advantages of China's national beauty brand lie in a better understanding of local consumer needs, faster adaptation to change, more flexible operation mode, and extensive use of digital platforms to interact with consumers[4]. Utilizing the new advantages of the digital economy to empower the transformation and upgrading of China's national cosmetics industry has brought an opportunity for Chinese national beauty brand, which started late and have a relatively weak foundation, to bend the road and overtake[5].

2.Research methodology

2.1 Questionnaire

This part adopts consumer questionnaire analysis, uses factor analysis to find the main problems affecting consumption motivation, and combines the actual market data to find out the dilemmas facing the current development of Chinese national brand and the reasons for facing dilemmas.

2.1.1 Sample Selection

According to the current consumption characteristics of national goods consumers, the mainstream group of e-commerce shopping and offline shopping is the college student group, so the research sample is set as the college student group in Sichuan province and the college student group in the first-tier, new first-tier and second-tier cities outside Sichuan province. The questionnaire was distributed by questionnaire star, with a balanced ratio of men and women, 320 copies of this research were distributed, 310 copies of questionnaires were recovered, of which 300 were valid questionnaires, and it lasted for one week from the end of October 2023 to the first half of November(*Table 1*).

Table 1 Basic information on investigators

name	option	Frequency	percentage (%)	Cumulative percentage (%)
Gender	woman	150	50	50
	man	150	50	100
Age	Under 18	3	1	1
	18-22 years	141	47	48
	22-26 years	93	31	79
	46-55 years	63	21	100
Grade level	first-year university student	49	16.33	16.33
	second-year university student	92	30.67	47
host city	third-year university student	57	19	66

name	option	Frequency	percentage (%)	Cumulative percentage (%)
	fourth-year university student	51	17	83
	Chengdu	80	26.67	26.67
	Other Cities in Sichuan Province	74	24.67	51.34
	First-tier cities outside Sichuan	50	16.67	68.01
	second-tier city	49	16.33	84.34
	others	47	15.67	100
add up the total		300	100.000	100.000

2.1.2 Reliability and Validity Tests

Table 2 Reliability test table

	Cronbach's Alpha	item count (of a consignment etc)
The questionnaire as a whole	0.932	9
Product Value Factor	0.862	3
Product Efficacy Factors	0.837	3
Marketing Factor	0.816	3

The data were imported into SPSS22.0 software to calculate the Cronbach's reliability coefficients of all levels were greater than 0.8, and the overall scale reliability was 0.932, which shows the scientific and reasonable design of the questionnaire structure and question items(*Table 2*).

Table 3 Validity test table

The Kaiser-Meyer-Olkin metric for sampling adequacy		.944
Bartlett's test of sphericity	approximate chi-square (math.)	1823.336
	df	36
	Sig.	.000

We analyzed the overall outcome validity of the questionnaire using factor analysis and calculated a KMO coefficient of 0.944 with a p-value of 0.000<0.05 using SPSS 22.0, which indicates that the questionnaire has good construct validity(*Table 3*).

2.1.3 Factor extraction

A total of nine consumer purchase motivation factors were designed in this questionnaire, and factor analysis was applied to extract the main factors. As shown in *Table 4*, the sum of the initial eigenvalues of the first three main factors in the total variance interpretation accounted for has reached 77.750%, close to 80%, so the first three factors can be extracted as the main factors.

Table 4 Total Variance Interpretation Table

comp onent	Initial eigenvalue			Extract the sum of squares to load			Rotate the sum of squares to load		
	total	% of variance	Cumulativ e %	total	% of variance	Cumulati ve %	total	% of variance	Cumulati ve %
1	5.854	65.049	65.049	5.854	65.049	65.049	2.635	29.283	29.283
2	.622	6.916	71.964	.622	6.916	71.964	2.597	28.854	58.137
3	.521	5.786	77.750	.521	5.786	77.750	1.765	19.613	77.750

Extraction method: Principal Component Analysis

2.1.4 Principal Component Analysis

①Using X1-X9 to denote 9 factors respectively, the rotated factor analysis model is established as shown in model (1), which is calculated that the first common factor is mainly determined by X1, X2 and X3, the second common factor is mainly determined by X4, X5 and X6, and the third common factor is mainly determined by X7, X8 and X9.

$$(1) \quad X_i = a_i F_1 + a_i F_2 + a_i F_3$$

②Identify the common factors. The first common factor has larger factor loading on the efficacy of Chinese national brand compared with foreign products, the effect that Chinese national brand can achieve, and the opinion of people around us on the effect of Chinese national brand, so the first common factor is categorized as the efficacy factor of Chinese national brand. The second common factor has larger factor loading on the degree of popularity of Chinese national brand, price range and product safety, so the second common factor is categorized as the value factor of Chinese national brand. The third factor has larger factor loading on celebrity artist publicity, e-commerce anchor recommendation, and friends and family recommendation, so the third factor is categorized as the Chinese national brand marketing factor.

Table 5 Component matrix after rotation

questionnaire topic	Compone nt 1	Compo nent 2	Componen t 3	Correspondence factor
How important is the degree of product explosion to your purchase of Chinese national brand	0.570	0.550	0.447	National Product Value Factor
How important is the price range of the product for you to buy Chinese national brand	0.245	0.829	0.249	National Product Value Factor
How important is the safety of the	0.377	0.742	0.239	National Product

				Value Factor
The efficacy of Chinese national brand is more prominent than foreign products.	0.804	0.246	0.256	National Product Efficacy Factor
I am satisfied with the results I can achieve with the Chinese national brand.	0.694	0.382	0.294	National Product Efficacy Factor
People around me are very satisfied with the efficacy of Chinese national brand	0.793	0.319	0.205	National Product Efficacy Factor
The importance of celebrity artists' representation and publicity for purchasing Chinese national brand	0.278	0.246	0.866	National Product Promotion Factor
The importance of key e-commerce representatives opinion leaders for your purchase of Chinese national brand	0.321	0.486	0.630	National Product Promotion Factor
The importance of recommendations from friends and family for your purchase ofChinese national brand	0.413	0.672	0.324	National Product Promotion Factor

Extraction method: Principal components.

a.Rotation method:Orthogonal rotation with Kaiser normalization.

2.1.5 Computing the eigenvector matrix

As shown in *Table 5*, the main factors influencing consumers to buy Chinese national brand are Chinese national brand efficacy,Chinese national brand value and Chinese national brand promotion, and the factor eigenvector matrix is calculated to provide certain reference and reference for Chinese national brand.Y1, Y2 and Y3 represent the three main factors of Chinese national brand efficacy,Chinese national brand value and Chinese national brand promotion, respectively.

$Y1=0.106*X1-0.308*X2-0.116*X3+0.603*X4+0.394*X5+0.572*X6-0.209*X7-0.198*X-0.075*X9$

$Y2=0.070*X1+0.695*X2+0.524*X3-0.307*X4-0.108*X5-0.186*X6-0.368*X7+0.027*X8+0.372*X9$

$Y3=0.096*X1+-0.220*X2-0.240*X3-0.106*X4-0.083*X5-0.219*X6+1.010*X7+0.506*X8-0.089*X9$

$Y=$（$Y1*2.635+Y2*2.597+Y3*1.765$）/（$2.635+2.597+1.765$）

2.2 Problem analysis

Through the factor analysis of the questionnaire, it can be seen that the target consumer groups are more concerned about the three factors of marketing, product efficacy and product value, and their component coefficients are as high as 0.694-0.804, 0.550-0.829, 0.630-0.866 respectively.According to the factor analysis, the coefficient of the component scores ranges from 0.4 or above can be considered that the variables are related to the components, and the closer the coefficient is to 1, the more relevant the coefficient is. 1 the stronger the correlation. Based on the above three factors, we will trace the current dilemmas faced by national brand and the related reasons from the three aspects of consumers' awareness of the brand, the level of product R&D of Chinese national brand companies and the product power of Chinese national brand.

2.2.1 There is still some room for improvement in the brand recognition of Chinese national brand

In the Chinese national brand industry, there are many brand and products to choose from, and the product iteration and update fast, and consumers generally have the attribute of tasting the new, so the brand loyalty is relatively low. But even so, brand strength is still one of the primary factors affecting consumer decision-making. From the point of view of the promotion factor of Chinese national brand, the popularity of national brand determines the quality and effect of marketing. According to the questionnaire survey data for consumer groups in terms of brand awareness, international brand accounted for 58%, domestic brand accounted for only 42%[6]. At the same time, the number of fans of domestic and foreign product brand platforms also reflects their brand awareness, which supports the promotion of product brand power. As of August 9, 2022, according to the public data of Tmall flagship store, the total number of fans of the four brand under the famous Chinese national brand company is 37.363 million, while the total number of fans of the 11 skincare brand under the famous foreign brand company is 103.036 million, which is 2.76 times of the total number of fans of the famous Chinese national brand company [7]. It can be seen that the international big brand in the Chinese market has accumulated a large number of traffic resources, has a strong brand effect, and the domestic brand has also accumulated a certain degree of brand influence, but its marketing positioning precision brand power gradually grow, but brand awareness still has room for improvement.

2.2.2Chinese national brand R&D level still needs to be improved

From the point of view of the efficacy factor of Chinese national brand, the efficacy of the product mainly depends on the level of research and development. R&D is the core driving force of an enterprise, and to measure the level of R&D and innovation of an enterprise, the number of patents and the R&D expenditure rate are important reference indicators. As of 2021, the two leading domestic beauty companies have 374 and 201 patents respectively after years of brand accumulation, which is far ahead of the national brand. Throughout the international big brand, in 2021, the number of patent applications in the global skin care industry TOP10 applicant technology is mainly laid out in the A61K8 (cosmetic or similar grooming with configurations) segment, of which the global skin care patent applications of the first beauty care company in the field of patent applications amounted to 2,030[8], and none of the domestic beauty brand on the list. International cosmetic brand in product development started early, large volume, but still did not relax the continuous investment in research and development.

Compared to the high marketing expenses of domestic beauty brand, its R&D expenses are relatively small. Public data show that its R&D expenses between 2018 and 2020 were 2.641 million yuan, 0.23 billion yuan and 0.67 billion yuan, accounting for 0.4%, 0.8% and 1.28% of total revenue respectively. The foreign high-end brand are obviously higher in R&D costs. L'Oreal's R&D expense ratio in 2020 is about 3.48%, and the R&D expenses in the first half of 2020 alone amounted to 3.783 billion yuan, an increase of 7.1 percentage points over the same period last year[9].

2.2.3 Relative lack of product power of Chinese national brand

In terms of product value factors, product power is the decisive factor. Product power is the attractiveness of the product to the target consumers, mainly reflected in the product quality, price and innovation to reflect the level. From the questionnaire survey data can be seen, the product explosion,

acceptable price and product safety for the focus of consumer attention. In the "flower West" behind the incident revealed not only the problem of e-commerce anchors, but also more of the national brand continue to increase prices, according to public information: the current domestic skincare products prices generally increased between 3% -15%.

At the same time, public information shows that the domestic beauty company also exists in the brand construction is not perfect, the aging of the product shows; new product quality is not stable enough, the exclusive market is limited, raise the price of the growth rate is fast. And foreign beauty under the middle and high-end skincare brand although the function is complete, product stability, but pricing is higher, consumer circle obvious. Therefore, national beauty brand want to enter the high-end market, in the research and development of efficacy differentiated products, do across the life cycle of the product, improve product safety and other product power still need to work [10].

2.2.4 Summary

To summarize, the biggest problem of the current national brand is that some of the Chinese national brand are not clearly positioned, resulting in brand dilution. At the same time,Chinese national brand do not pay attention to product research and development, resulting in a lack of research and development capabilities, the lack of high-end product lines, can only improve the marketing costs to sell products, however, because of foreign brand continue to eat online marketing leads to its only to increase their own prices, resulting in the reduction of its product power.

3.Brand Strategy and Recommendations

According to the above existing gaps and deficiencies, this paper from the position of the actual starting point, put forward the following Chinese national beauty brand strategy recommendations.

(1)Focusing on niche categories and optimizing brand layout.

Behind the national tide culture lies the consumption preference of different groups of people, constituting a diversified and prosperous national tide era. Under the background of national trend, enterprises should position their target market in the groups that are favorable to their development and have outstanding advantages. For example, after market research, Brand A chooses cool girls of Generation Z as its target market, and produces differentiated beauty products according to the characteristics of target consumers who "love beauty, want to taste freshness, and are not financially well-off" as well as the differentiated preferences of target consumers for beauty products, which satisfy consumers' needs and give value to the brand. Skillfully avoid the advantages of international brands, choose the development of immature, yet to be tapped lip glaze as a product entry point, occupy the product segmentation category, create air lip glaze this empty space, and continue to deepen the plowing, launched a series of explosive lip glaze, lip glaze to create a unique label for the brand. From the experience of L'Oreal, Procter & Gamble and other international brands, in multiple market segments to create explosive products, the use of differentiated product characteristics to attract different needs of consumer groups, to occupy more segments of the market, even if the loss of a product market, will not affect the overall layout and development of the brand.A brand as a domestic emerging brand, on the basis of ensuring product quality, and not confined to the lip glaze lipstick category, successive launch of the A brand as a new brand in China, on the basis of ensuring product quality, is not limited to lip glaze lipstick category, successive launch of foundation, loose powder,

eyebrow pencil and other categories of products, and constantly broaden their product mix, and then optimize the brand layout for the brand's subsequent long-term development of laying a deep foundation[11].

(2) Invite celebrity endorsement to strengthen brand image

In the era of "traffic is king", brands are gradually realizing that they can use the star effect to prompt fans to consume, seize the fans' psychology of following and loving stars, and attract more young consumers. When choosing a star to endorse a product, there are two main bases: one is the star's topic degree, with the topic of the star can bring heat and flow for the brand, increase product exposure and attract more consumer groups; the second is the star's persona, the star's persona needs to match the brand's concept, the better the fit, the more unified the content and brand perception is, the more persuasive the endorsement is.B brand through the online and offline double dimension to put endorsement ads, reach more target groups, perfectly enhance the brand premium ability, from the explosive national products upgraded to the national brand representatives. B brand has also repeatedly used Liu Baxin, Bi Wenjun, Wang ZiYi from the popularity of popularity from the popularity of variety shows, netroots talent show from popularity of idols, through the official announcement of the brand and other hot events, the use of the fan economic dividend to create a hotspot attention through the fans pry the economy. B brand marketing gives full play to the value of its spokespersons, transforming star traffic into brand energy and sales, transferring fans' and consumers' personal impressions of the stars to the brand image, and obtaining a win-win situation in terms of emotion and effect by empowering artists and fan groups[12].

(3) The people planting grass + live broadcasting, help the brand to break the circle.

Grasping the changes in consumer habits, Brand C chose Xiaohongshu as its main camp, where young women are the user group, and where the content aggregation, user quality, and tone are all in line with the brand, and vigorously launched soft advertisements by cooperating with expert.Brand C chose expert in the head waist (with more than 500,000 followers) and tail (with less than 1,000 followers) on Jieyin, Shutterhands, and other platforms, where the content is mainly about beauty, personal care and fashion, to work with. Brand C cooperates with head (500,000+ followers) and tail (1,000 followers or less) expert, utilizing head expert to attract followers, increase brand influence and consolidate the brand's tone. Through the cost-effective tail expert, we can spread the brand widely, build up a good reputation and further occupy consumers' mind. As for the live broadcast, we mainly choose the head of the Darren, and adopt the decentralized strategy of binding different products with different KOL, so as to ensure that each of the main products can get the exposure and support.

(4)Creating co-branded IP and shaping brand connotations.

Consumers are gradually changing their mindset, focusing on the meaning behind the product instead of the single function. Taking advantage of the national trend, D brand added two colors of "Flower Yellow" and "Red Makeup" to its eyeshadow palettes, which corresponds to the poem of Mulan, "When the house is in the red make-up" and "When the mirror is pasted with flower yellow". "Putting on flowers in the mirror" in Mulan's poem. Different from traditional IP cooperation, D-brand's IP cooperation will deeply explore the spirit and connotation of both brands. Hua Mulan is a loyal and courageous soldier on behalf of her father, and Brand D utilizes "Hua Mulan", a classic IP of traditional Chinese culture, to

convey the brand connotation of "I hope that every maverick cool girl can burn the world with a loyal, courageous, and true fervor, and become cool and beautiful". D brand also cross-border co-branding with national intangible cultural heritage "Qiang embroidery", launching "Beyond Qiang limited edition gift box", interpreting Chinese culture from the perspective of the new generation, perfectly integrating the traditional culture with modern spirit, and publicizing the national trend of the new generation, explaining the brand's "cool and beautiful". It is a perfect fusion of traditional culture and modern spirit to publicize the national trend and interpret the brand's cultural connotation of "Dare to be different"[13].

(5) Establishing private domain traffic to empower brand development.

Private traffic marketing is not a cut-and-dried single-channel marketing, enterprises should focus on the linkage between public and private traffic while focusing on the digital private traffic track. brand E adopts a comprehensive development strategy of online + offline in the private traffic field. As of June 2021, the number of E brand offline stores has exceeded 30, and it has strongly entered 1,528 Watsons stores. E brand stores are sweet, cool, simple and personalized, which is in line with the brand's tone, and the staffs in the stores provide attentive services according to the needs of the consumers to give them a better product experience. The staff will also guide and invite consumers to add the official public number and join the brand community to attract traffic to the online private area. Online private marketing is the key to brand marketing, the public domain traffic acquisition cost is getting higher and higher, the private domain traffic acquisition and maintenance is particularly important. In addition to offline traffic, the E brand will also through the "new tasting" "pull new gift" "into the group red packets" and other ways, so that more consumers and potential consumers to add the enterprise WeChat, and actively invite people around them to enter the group. The brand's exclusive WeChat customer service is real customer service, which can provide consumers with more timely and more humanized service, and improve consumer satisfaction. The brand community group members are highly active, the group chat content is not monotonous and boring advertising output, most of the product experience sharing and beauty teaching, not only can mobilize the group members to share the enthusiasm of the spontaneous, but also can stimulate the purchase desire of potential consumers to increase the user viscosity.

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Exploring the academic stress of Chinese university students majoring in Chemistry during the online studying period of the Covid-19

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Abstract: Since the outbreak of covid-19, the location of students' classes has changed from one where students could meet face-to-face with teachers at school to one where students can only study online at home, bringing a different student experience and a different kind of learning pressure. It is worth noting that for some theoretical classes, teachers can teach and students can listen through the internet, but for some practical classes, it is difficult for teachers to teach online and students do not learn the relevant knowledge. As a result, this brings about academic pressure on students. This study aims to examine the impact of online learning on Chinese university students majoring in chemistry during the 2020 epidemic preparedness period. A mixed-methods approach was used to gain insight into the perceptions and resolution strategies of online learning stress among undergraduate chemistry students at a Chinese university during the epidemic. In the quantitative phase, this study used questionnaires to reveal the impact of gender and grade level on students' academic stress; in the qualitative phase, semi-structured interviews were used to reveal how students coped with the stress associated with online learning. The results showed that Chinese male university students majoring in chemistry had significantly higher academic stress than Chinese female university students majoring in chemistry. Statistically significant differences in perceived levels of academic stress were found between fourth-year and first-year, second-year and third-year undergraduate students. Senior year students exhibited significantly higher levels of academic stress than students in other years. It was also found that studying online during the epidemic did not only cause negative academic stress among Chinese university students majoring in chemistry, but also had the aspect of reducing academic stress. The results of this study will help to better understand the needs of chemistry undergraduates in online learning, which will help teachers and schools to develop better teaching and learning activities and thus build a better university education.

Keywords: Academic stress, Chinese university students, Chemistry, Online, The Covid-19

1   Introduction

Beginning in late 2019, the COVID-19 pandemic expanded quickly within a short period of time (Du Toit, 2020). Due to the high transmission rate of the new coronavirus, most countries have adopted measures

to prevent transmission, including locking down cities, strictly enforcing contact isolation, and strict health system precautions (World Health Organization, 2021). It is worth noting that education systems around the world have also been adversely affected by the COVID-19 outbreak, and various preventive measures have been taken in different countries. Among them, governments all over the world have closed all educational facilities to ensure the safety of students and then launched online teaching initiatives to try to stop the disease from spreading. At the same time, reduced population mobility has led higher education institutions to eliminate face-to-face delivery and move to distance learning (Ali, 2020). Universities, places with large numbers of students, must develop similar precautions to minimize the impact of COVID-19 on higher education and beyond. For example, it started by promoting hygiene-conscious messages on campus, encouraging behaviors such as frequent handwashing and not touching face and eyes, while also advising students and teachers to stay home if they felt unwell. Soon, the university canceled large-scale public-facing events such as conferences and speaking engagements, shifting its approach to stricter measures. In other words, the COVID-19 pandemic forced universities to shift their entire teaching process to online classes overnight. As can be seen, the spread of the new coronavirus poses challenges to health systems and education in many countries. Notably, the outbreak presents a bigger threat to the vast Chinese population. The majority of Chinese colleges have implemented online learning in accordance with the government's directive for "uninterrupted studying and instruction" in reaction to the virus' quick spread throughout China. In a short amount of time, a lot of professors have switched to using computers in the classroom, and students are now able to access lessons online from home. (Bao, 2020).

Notably, the sudden change from classrooms to virtual digital spaces based on internet-based tools may have implications for students (Chandra, 2020). The original purpose of human use of computers is to assist learning. Since the 1990s, when the Internet first appeared, individuals have begun to use it for educational purposes (Volery and Lord, 2000), so online teaching is nothing uncommon to us. Online instruction is more repeatable for each student than traditional classroom instruction, and because there are no time or location restrictions, students can learn whenever and wherever is most convenient for them. They can also use resource playback to regularly review and consolidate their knowledge. (Huang, 2020), to a certain extent, reduce students' learning pressure. During the pandemic, the only key difference is that online teaching is the only source of learning due to the virus (Chandra, 2020). Due to the emergence of the COVID-19 pandemic crisis, e-learning has become a compulsory subject in educational institutions such as schools, colleges and universities around the world. In addition, it is no longer the question of whether online education can make high-quality higher education work, but how universities can immediately and effectively carry out online learning activities on a large scale (Liguori, E. and Winkler, C., 2020). Nevertheless, the majority of students are still inexperienced with distance learning despite the rise in enrolment in online courses over the previous few years. Lessons from online learning during the epidemic can only come from prior online course experience (Hachey et al., 2012).

In addition to this, this unprecedented experience of "home isolation" has had a multifaceted impact on students' learning. As a global public health emergency, the virus has caused disturbing psychological stress around the world (MA and Miller, 2021). In addition to the psychological problems caused by the

epidemic, it has also brought many challenges to students. With students isolating at home during the pandemic, this inexperienced online program can be exacerbated by challenging home conditions, including lack of access to academic resources (e.g., computer and internet connectivity) and disruptions in home learning environments (Clabaugh, Duque and Fields, 2021). As a result, there is a demand on students to perform academically. In order to achieve their educational objectives, university students must overcome numerous obstacles. The motivation and performance of students may suffer if these encounters are viewed negatively (Covington, 1993; Weiner, 1979). In addition, if these experiences are prolonged and viewed as uncontrollable, they can make students feel helpless (Abramson, Garber and Seligman, 1980) and stressed (Folkman and Lazarus, 1985), putting some students' academic future at risk among. By contrast, other students who have the ability to successfully endure the harmful consequences of a negative academic experience are easily encouraged later on after minor setbacks, and such challenges can motivate students to develop for the better. In the midst of the pandemic, we should pay special attention to the academic stress associated with college students in this new environment. Academic stress is a student's reaction to having to complete too many demands and tasks (Bedewy and Gabriel, 2015; Nist Olejnik and Holschuh, 2011). It has long been believed that students are least affected by any stress or problem and that the only task a student should undertake is learning, which is considered stress-free (Reddy, Menon and Thattil, 2018). But it turns out that students always live under more pressure than their peers. Their parents and teachers are always comparing them to other children of the same age, asking them to behave better, achieve better grades, excel in extracurricular activities, participate in interest classes, etc., causing these children to be confused and constantly Under pressure. When students experience unprecedented levels of academic stress, most of them report low self-esteem, difficulty concentrating, trouble sleeping, worrying about the future, developing symptoms of anxiety and depression, and being unable to manage coursework have a very negative impact. These affected their academic performance (Bedewy and Gabriel, 2015). In addition to this, less stress does not necessarily lead to better performance by students, as in this case they perceive the task as unchallenging and may also be easily bored (Uchil, 2017). Although a certain level of stress motivates students to perform at their best, when it cannot be managed due to ineffective ways of coping with stress, it can have negative consequences for students (Reddy, Menon and Thattil, 2018). Therefore, in the context of the unprecedented epidemic, the academic pressure of students should also be taken seriously.

As can be seen, this was an extremely challenging time for both students and teachers, especially since many were unaware of the weaknesses of online learning until they adopt an online learning environment (Pilkington and Hanif, 2021). While some courses may transition to distance learning with minimal disruption, such as theory courses, distance learning also hinders one component of many scientific disciplines: the laboratory (Kelley, 2020). Especially for chemistry and related disciplines, this part of the curriculum hinders teaching progress due to lack of access to laboratories (Pilkington and Hanif, 2021). For chemistry courses, much of the interest in the field is believed to originate from student experimentation to teacher demonstrations, while critical thinking, practical knowledge, observational skills, and strong operational skills are developed through laboratory experience (Kelley, 2020). However,

this process was interrupted by covid-19. During the epidemic, chemistry students may not be able to carry out their studies well because they cannot enter the laboratory, and then have related academic pressures. Therefore, this study aims to explore what are the academic stress factors that induce online learning of Chinese college students majoring in chemistry during the 2020 Covid-19 epidemic prevention and control period and how Chinese college students majoring in chemistry cope with academic stress.

1.1 Rationale for the study

Higher education in various countries is facing disruptions due to the emergence of the new crown epidemic. Chinese universities had no choice but to move their courses online. Online teaching is nothing new to students and the only difference from regular online teaching is that it has become the only source of education due to the coronavirus epidemic. The coronavirus epidemic has been accompanied by strict isolation measures, a disturbing social life and isolated learning that has left students feeling stressed. One of the main components of student stress is academic stress. Academic stress comes from a variety of factors experienced by students, such as family-related stress, class competition, curriculum-related stress and financial burdens. For some students, stress may also arise because they are moving from place to place to accommodate academic requirements. In addition, chemistry is part of higher education and unlike some humanities and social sciences chemistry is a laboratory science and during the epidemic students do not have access to laboratories to conduct experiments. These changes can be stressful for students academically, both positively and negatively, and this is part of their experience. Therefore, exploring the impact of online teaching during the epidemic on the academic stress of Chinese university students majoring in chemistry can help students address the issue of academic stress and put themselves in the students' shoes.

1.2 Objectives of the study

The purpose of this study is to consider the impact of gender and grade on the academic pressure of chemistry majors in Chinese universities during the period of epidemic prevention and control. To further determine how Chinese chemistry majors face these academic pressures.

1.3 Research questions

Quantitative phase: The impact of gender and grade on the academic stress of Chinese undergraduate chemistry students during the epidemic preparedness period

Qualitative phase: How Chinese undergraduates majoring in chemistry deal with these problems about academic stress during the epidemic prevention and control period.

1.4 Hypotheses

The following null hypotheses were formulated to guide the quantitative study:

1. In 2020, there was no significant difference in the perceived level of academic stress among Chinese undergraduates majoring in chemistry between males and females.

2. There is no significant difference in perceived academic stress levels among chemistry undergraduates in different grades.

2 Literature Review

2.1 Definitions of terms

2.1.1 academic stress, Chemistry courses in Chinese higher education, online studying

Academic stress is an unpleasant situation that occurs due to the many demands placed on a student or learner, including taking exams, maintaining a healthy and academic life, competing with peers, meeting the academic expectations of teachers and parents, and one's own academic expectations (Aihie and Ohanaka, 2019), meaning that academic stress is the body's response to academic-related demands that exceed students' ability to adapt (Wilks, 2008). Stress can have a positive or negative impact on students' academic performance. Lesser levels of stress may lead to positive outcomes, such as the phenomenon of self-motivation, while higher levels of stress can lead to psychological disorders such as anxiety. High levels of stress are associated with poor academic performance (Sohail, 2013). It is estimated that a significant proportion of students experience some level of academic stress during their academic careers (Johnson, 1979). In this research, I will focus on the academic pressure of college students majoring in chemistry in higher education in China, especially in the context of online learning during the epidemic, because in addition to theoretical courses in chemistry, chemistry experiments may constitute a major component of online teaching. The biggest challenge (Huang, 2020), followed by a series of academic pressures.

Traditional chemistry courses typically include lectures, tutorials, and laboratory components (Lo et al., 2021). In addition, compared with science education research in Western countries, China's chemistry education research stands out for the close connection between curriculum policy, textbook development, classroom teaching, and teacher education. It also distinguishes itself by emphasizing the connection between theory and practice (Liu, Liang and Liu, 2012).

For online studying, learning is defined here as the voluntary act of learning through the Internet (Thomas and Rohwer, 1986), and online learning systems are used to distribute learning knowledge and manage learning sessions through the Internet (Keis et al., 2017). Online learning systems include designing and delivering learning content and facilitating communication between students and teachers (Thanji and Vasantha, 2016). It also includes features such as chat rooms, polls, and quizzes that allow teachers and students to communicate online. These provide convenient ways to achieve learning objectives (Mukhtar et al., 2020).

2.2   The studies about the importance of academic stress

The COVID-19 pandemic presents a variety of unprecedented challenges, including a significant impact on the mental health of young people. Although there is evidence of a high prevalence of mental health disorders among university students, little is known about the specific impact of the COVID-19 pandemic on students' mental health and how they cope with this stress (Prowse et al., 2021). To address this gap, several researchers have examined the impact of the COVID-19 pandemic on the stress and mental health of university students and the extent to which they implement various coping strategies (Prowse et al., 2021; Li et al., 2021; Chen, Sun and Feng, 2020), finding that the main cause of stress among university students is academic stress (Bedewy and Gabriel, 2015), and the majority of articles currently examining the impact of online learning on university student stress during the epidemic have taken a quantitative approach (Li et al., 2021; Chen, Sun and Feng, 2020; Prowse et al., 2021).Comparing these three articles, it can be found that the stress of college students during the COVID-19 period has had a certain impact on their mental health. It also shows that academic stress is one of the sources of stress for students. The results of the reports are different. Li et al. (2021) and Chen, Sun and Feng (2020) believed that when the epidemic comes, men were under great pressure, but more notably, Li et al. (2021) believed that the COVID-19 disease was more aggressive to older male students in masters and doctoral programs living in Wuhan during the pandemic, because when the COVID-19 disease first emerged (National Health Commission of the People's Republic of China, 2020) , and most students have left their hometowns when it has not yet spread widely. This schedule has spared most of the students returning to their hometowns outside Wuhan from the vicious attack of COVID-19, so the pressure on masters and PhDs who have not completed their experiments at this time is even greater. On the other hand, Chen, Sun and Feng (2020) believed that young men were stressed. In addition, Prowse et al. (2021) argued that women were more stressed, and the data trends observed in this study are consistent with predictions from other studies related to young people's mental health, suggesting that their data may be representative of other college student groups, but the results of this study differed from the other two, because the current sample contains more female participants than males, and also gender queer and transwoman, so the sample was of mixed ethnic/racial backgrounds. For this reason, this approach will make research more general.

For Li et al. (2021), Chen, Sun and Feng (2020) and Prowse et al. (2021), the studies have certain limitations. Firstly, the research investigations were all conducted in one location, but due to cultural differences, different patterns may exist elsewhere, thus requiring cross-cultural comparative studies. Secondly, all three articles used quantitative methods, maximising the advantages of quantitative research and allowing more reliable data to be obtained. However, qualitative research could also be conducted to better understand the impact of academic stress on young people's mental health. The reason for these results could also be due to the fact that majors differ in the amount of tasks each major has, with some science majors requiring experiments while arts majors do not need tedious experiments to do, and therefore each individual has different academic tasks that cause different levels of academic stress.

It is evident that the epidemic brought many stressors to university students, and if stress is not treated correctly, students' mental health will suffer and the community should pay attention to students' stress, especially academic stress. There are many types of stress among university students, and although all three studies were designed to address the aspect of academic stress, they did not focus on the impact of online learning during the epidemic on students' academic stress, which is one of the main sources of stress among university students (Gonmei and Devendiran, 2017). We therefore need to go deeper and explore what sources of academic stress induce online learning among university students during the epidemic. Furthermore, all three experiments only utilized quantitative methods and did not take a qualitative approach, resulting in the researchers not being able to address the mental health issues associated with stress from the participants' perspectives and experiences, which should be investigated in a multidimensional manner to address the underlying issues. Therefore, for the study of stress among university students during the epidemic, we should focus on academic stress and use a mixed-method approach to investigate the perceptions of the sources of academic stress among university students, so that we can better address the mental health problems caused by stress from subjective data as well as objective data.

2.3 The studies about the relationship between academic stress levels of university students and gender

Another factor that has been found to influence students' levels of expressed stress is the gender of the student, according to previous research. However, reports of gender differences in the level of expressed academic stress are inconsistent. Some researchers have found that females report higher levels of academic stress than males (Calvarcse, 2015), but others report higher levels of academic stress in males (Mishra, 2018). In other studies (Gonmei and Devendiran, 2017), gender was found to have no significant effect on expression levels on academic stress.

Yikealo, Yemane and Karvinen (2018) used both quantitative and qualitative methods to distribute a questionnaire to students in the Faculty of Education and in addition to the questionnaire, 30 students were selected for focus group discussions. Uncontrollable stress was found to reduce people's social, environmental, and academic resilience. This study was interested in the main academic and environmental factors that contribute to increased stress among university students. In addition, investigating the stress management strategies used by university students was one of the main components of the study. The findings revealed that the majority of students in the School of Education experienced moderate levels of academic and environmental stress. Gender differences and academic performance of university students were also found not to differ significantly. The study is expected to make a significant contribution to assessing stress levels and identifying the most stressful academic and environmental factors.

While Mishra (2018) used a quantitative approach to distribute questionnaires to fifty education students, the findings of this study were that male students had higher levels of academic stress and that the causes of stress were rooted in the current educational and social system. It can be seen that Mishra

(2018) compared to the findings of Yikealo, Yemane and Karvinen (2018), although the participants were all education majors, the results of the study did differ. The reason for this difference could be that the participants in Mishra's (2018) survey were soon-to-be teacher trainees who were in the transition phase between student and teacher. They were worried about their future and their jobs. The scarcity of jobs and fierce competition for them caused them to feel anxious and depressed. Male students are more stressed academically than their female counterparts. Female students are less stressed and perform better than their male counterparts because they are more focused on their studies. They are less likely to be distracted by other social and recreational activities. They see exams and future goals as challenges and work hard to meet them. This is why they score higher in exams than their male counterparts. While male students are more casual and take their studies less seriously, they are easily distracted from the ongoing social and extra-curricular activities on campus and in society. So they start studying just before exams, and when the final deadline arrives, they panic to finish. Thus, the bad habit of procrastination can cause them too much stress. Ebrahim (2016) also used a quantitative approach by distributing questionnaires to the respondents and the study demonstrated that women were significantly more stressed than men. Furthermore, the results of this study indicated that higher education is stressful and that students have higher stress levels than the general population. Notably, the study also found that the subjective health of university students was related to the experience of stress and that good activity habits could reduce stress levels. Therefore, every physical activity should be practised in multiple areas of life, including university, family and leisure.

There are certain advantages and disadvantages for Yikealo, Yemane and Karvinen (2018), Mishra (2018) and Ebrahim (2016). Yikealo, Yemane and Karvinen (2018), this study adopts a mixed method to maximize the realization of the research purpose and obtain two different perspectives. The quantitative research perspective is taken from closed data, while the qualitative research perspective is taken from open individuals data, to obtain a more comprehensive perspective, and obtain more data than quantitative or qualitative research alone. Moreover, this study only focuses on students of the same major, which can focus more on one variable and make the data more accurate. In addition, one of the limitations of this study is that the sample size is limited, that is, the number of participants is small, and only one school in one area is selected, and the data are not generalizable. There is also a lack of time and sufficient financial support to expand research needs. Likewise, the studies by Mishra (2018) and Ebrahim (2016) had a small and limited number of students surveyed, who were not completely randomly selected, may not be representative of the general population, and therefore may not be of a general nature. Furthermore, Ebrahim's (2016) study was based solely on self-reported data, which affects the overall quality of data analysis.

From the above studies, it is also possible that academic stress is a different result for gender differences in students of the same major, because it is possible that the studies have different focuses, and although they both investigate the effect of gender differences on academic stress in university students, the different factors investigated, as well as the investigation of different geographical areas, each with different customs and habits, also contribute to the different results. In addition, Ebrahim (2016)

investigated different majors than the other two studies and the results of the study were different from the other two studies. It is evident that for different majors, each major is set up differently and the sources of academic stress to students are different. Therefore, reports of gender differences in expressing levels of academic stress are inconsistent (Aihie and Ohanaka, 2019). In conclusion, stress greatly affects all students, and it negatively affects the academic performance and well-being of almost all students, regardless of their gender. Many studies have reported significant gender differences. The current situation therefore deserves attention and we cannot ignore it. This issue must be taken seriously and addressed accordingly for students at different stages of their majors so that the stress of students can be reduced (Mishra, 2018).

3. Methods

3.1.1mixed methods research design models

The first stage of the explanatory sequential model, which will be used in this study, focuses on collecting data through a questionnaire and analyzing it using quantitative methods. The second stage is the collection and analysis of qualitative data to explain or extend the quantitative results of the first stage. The qualitative phase is designed to follow the results of the quantitative phase. That is, quantitative followed by qualitative in a sequential manner, ultimately to demonstrate the reliability of the quantitative findings.

3.1.2 interviews

Semi-structured interviews will be used in this study. In this type of interview, the researcher has the flexibility to adapt the questions to the actual situation of the interview. There are no specific requirements on the way participants answer, the form in which the researcher records the interview, the time and place of the interview, etc. All are left to the flexibility of the researcher depending on the actual situation.

It can be seen that, according to the needs of the research, I choose the mode of explanatory sequential design and semi-structured interviews. This study used a mixed method, including quantitative and qualitative research. In the quantitative research process, a questionnaire will be used to study the influence of gender and grade on the academic stress of Chinese undergraduates majoring in chemistry. Quantitative methods are used in the first stage because quantitative research is more standardized and precise, and logical reasoning is more rigorous, so it is more objective and scientific. Quantitative data that measures student cognition, academic stress and its sources. During the qualitative research process, a semi-structured interview method will be used. The qualitative approach was adopted in the second stage because the advantages of qualitative research lie in its simplicity and proximity to the respondents. Qualitative data are available on how Chinese university chemistry students deal with academic stress. Specifically, the quantitative phase saves time, money, and manpower through the use of questionnaires. The results of the questionnaire survey are easy to quantify, which is convenient for statistical processing and analysis of the perception of academic pressure of Chinese college students

majoring in chemistry during the epidemic. In the qualitative stage, semi-structured interviews were used to gain a deep understanding of the views and coping strategies of Chinese college students majoring in chemistry on academic stress, and direct and reliable information and data could be obtained. It is worth noting that if this research only adopts quantitative methods, then quantitative research will simplify the behaviors and concepts of the research subjects, ignore individual differences, and fail to reveal the complex relationship between phenomena and their causes; or if this research Only qualitative methods are used, and the research of qualitative methods is time-consuming and labor-intensive, and it is impossible to study large samples, and it is difficult to obtain general conclusions. Therefore, the mixed method used in this study can give full play to the advantages of the two types of research and obtain two different perspectives. The quantitative research perspective is taken from closed data, while the qualitative research perspective is taken from open personal data, overcoming the limitations of its single research method. Congenital insufficiency.

3.2 Validity and Reliability

Based on empirical evidence and a recent literature review, this study drew on previous experience and obtained the agreement of the researchers who developed the scale to use an 18-item scale to measure perceptions of academic stress and its sources (Bedewy and Gabriel, 2015). This scale was administered to (n = 12) students by experts (n = 12) who were involved in the content validation process of the instrument and each expert reviewed and provided comments on the relevance of the scale to be developed before testing it with students. The developed instrument had an internal consistency reliability of 0.7 (Cronbach's alpha), evidence of content validity, and factor analysis yielded four relevant and theoretically meaningful factors. Chinese university students have some basic knowledge of English, so completing the scale, which measures academic stress and its sources, took 10 minutes.

3.3 Credibility of interview

The interview component of the study was pilot tested by four students. During the interviews concerns and feedback were sought from the students: clarity of questions, identification and reporting of any ambiguous items, and items that were difficult to interpret. Make a list of questions beforehand, write out on paper what you want to know before conducting the interview, put it together as a list of items to ask, and work out the questioning ideas in your own mind beforehand. The list of questions can be used to prevent missing certain questions, but never follow the list exactly, as this will prevent the logical coherence of the person's expression, and also to carefully Listen carefully to what is being said and take each conversation seriously. The questions are in Chinese and the time required to complete the interview is 20 minutes.

3.4 Design of the study

This study adopted a mixed method approach, including both quantitative and qualitative research. In the quantitative phase, data related to gender and grade level on academic stress among Chinese university students majoring in chemistry during the epidemic could be obtained, facilitating statistical processing and analysis of academic stress related to Chinese university students majoring in chemistry.

The qualitative phase uses semi-structured interviews to gain insight into the perceptions and coping strategies of Chinese university students majoring in chemistry regarding academic stress, allowing for direct and reliable information and data to be obtained.

3.5 Sample of the study

All procedures are approved by the University of Southampton Institutional Review Board. The quantitative phase took 10 minutes to complete the survey and the qualitative phase took no more than 30 minutes to complete. All participants voluntarily agreed to participate after being informed of the purpose of the study. The questionnaire was anonymous to ensure confidentiality and reliability of the data. The quantitative study entailed an online questionnaire survey of 256 randomly selected undergraduate chemistry students from a university in China between 1 and 7 September 2022. To minimise personal contact during the outbreak, the link to the questionnaire was distributed via WeChat. Prior to completing the survey, participants were asked to read an informed consent form and indicate their agreement to participate in the study. Only after they had given their consent were they allowed to answer the questionnaire. Participants had to be aged $\geqslant 18$ years and be Chinese university students majoring in chemistry. Exclusion criteria were: age <18 years, which was the cut-off age for requiring parental consent; deletion of similar patterns of responses; or failure to complete the entire questionnaire. You can fill in your email address at the end of the questionnaire to facilitate the qualitative phase. A sample of eight university students (N=8; 5 females and 3 males) will be selected from the quantitative phase of the qualitative study. Participants will be contacted via email or WeChat and asked to participate in the study for a personal telephone interview. Telephone interviews will be conducted with those who agree to participate. Prior to the interview, a consent form was sent to the participants and they then gave informed consent. To reduce personal contact during the outbreak, interviews were conducted by telephone.

3.6 Instrument of the Study

A questionnaire was used for the quantitative phase and the Academic Stress Scale (PAS) (Bedewy and Gabriel, 2015) is an 18-item, 5-point Likert-type scale that measures students' perceived, academic stress and its sources. The scale is applicable to both undergraduate and postgraduate students. Responses range from (1 = strongly disagree to 5 = strongly agree). The overall internal consistency reliability was 0.7, with higher scores indicating higher levels of stress for students (Bedewy and Gabriel, 2015). The questionnaire was divided into two sections. Part A sought demographic information about respondents' age, gender and email address, while Part B was an 18-item perception of the Academic Stress Scale. A semi-structured interview method was used in the qualitative phase. The questions were viewed from the participants' perspectives in order to deepen the understanding of the respondents and to draw meaningful insights into the multidimensional phenomenon.

3.7 Procedure

During the quantitative phase, the researchers distributed the Academic Stress Scale to Chinese university students majoring in chemistry via the social media software WeChat. The researcher

explained the purpose of the study to the respondents and assured them of the confidentiality of their responses. Eight students were then selected to participate in the qualitative phase of the study during the quantitative phase. In the qualitative phase, the research instrument was a semi-structured in-depth questionnaire. The interviewer encouraged the participants to recall their experiences in 2020. The interviews were based on the questionnaire in the quantitative phase. The interviews were conducted with questions ranging from shallow to in-depth and participants agreed to record the interviews. Each interview lasted 30 minutes.

3.8 Data analysis

In the quantitative phase, data were analysed using SPSS version 26. The data collected were collated and analysed using descriptive (mean and standard deviation) and inferential statistics (t-test for independent samples and ANOVA). The alpha level was set at 0.05. The independent variables of the study were two, one being gender and the other being grade. The dependent variable of the study was the perceived level of academic stress among the Chinese university students majoring in chemistry who participated in the study.

Content analysis during the qualitative phase consisted of the following stages: 1) the primary researcher first read each interview transcript line by line, jotting down notes to capture and identify the categories that emerged from the data; 2) the researcher reviewed the main topics to prevent omissions; 3) the researcher identified connections between contextual and content-related themes and sub-themes. They compared all completed interviews to consolidate meaning and derive a theoretical structure; 4) core themes or major categories that emerged from the data were conceptually reordered and placed back in context.

4.Findings

4.1.1 Quantitative phase results

Table 1: Descriptive levels of perceived academic stress among male and female undergraduate students

1male

2Female

Sex	N	Mean	Std Deviation
1	112	63.51	7.553
2	144	55.08	6.968

The results on Table 1 show that the average score of men's perceived academic stress was 63.51 (SD=7.553), and the average score of women was 55.08 (SD=6.968).

Hypothesis 1: There is no significant difference in the perceived level of academic stress between male and female Chinese undergraduate chemistry students in 2020.

Table 2: Independent samples t-test on the difference in the level of perceived academic stress between male and female undergraduate students.

	Levene's Test for Equality of variances		t-test for equality of means				
	F	Sig	t	df	Sig. (2-tailed)	Mean diff	Std Error diff
Equal variances Assumed	.583	.446	9.251	254	.000	8.426	.911
Equal variances Not assumed			9.158	228.781	.000	8.426	.920

*significant at 0.05 level

The mean scores for males and females were compared using an independent samples t-test. The results shown in Table 2 indicate that the difference in means of 8.426 was significant at the 0.05 significance level. Therefore, it is inferred that male undergraduate students have significantly higher levels of academic stress than their female counterparts.

Hypothesis 2: There is no significant difference in the level of perceived academic stress between undergraduate chemistry students between years.

Table 3: Descriptive statistics showing the mean and standard deviation of perceived academic stress levels of undergraduate students at different levels of study

	N	Mean	Std Deviation
1	57	52.81	5.749
2	63	56.59	8.143
3	63	58.08	7.499
4	73	65.90	5.561
Total	256	58.77	8.343

The descriptive statistics shown on Table 3 indicate that fourth-year Chinese undergraduate students majoring in chemistry had the highest mean score for perceived academic stress (M = 65.90, SD = 5.561), followed by second-year undergraduates (M = 56.59, SD = 8.143), third-year undergraduates (M = 58.08, SD = 7.499) and first-year undergraduates (M = 52.81, SD = 5.749). A one-way ANOVA was conducted to determine if the differences between the three groups were statistically significant at the 0.05 significance level and the results are shown in Table 4 below.

Table 4: Summary of non-parametric tests on differences in academic stress levels of undergraduates at different stages of study

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of MD is the same across categories of grade.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

The results on Table 4 show the p-value = 0.000. The p-value is less than the alpha level of 0.05. The results therefore reject the original hypothesis. To determine the direction of the significant difference, a Independent-Samples Kruskal-Wallis Test was conducted and the results are shown in Table 5 below.

Table 5: Pairwise comparison of academic stress levels of undergraduates at different stages of study

Pairwise Comparisons of grade

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
1-2	-36.717	13.508	-2.718	.007	.039
1-3	-42.503	13.508	-3.147	.002	.010
1-4	-117.310	13.061	-8.982	.000	.000
2-3	-5.786	13.165	-.439	.660	1.000
2-4	-80.593	12.707	-6.343	.000	.000
3-4	-74.807	12.707	-5.887	.000	.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

The results in Table 5 above indicate that there is a statistically significant difference in the perceived level of academic stress among seniors versus freshmen, sophomores, and junior undergraduates. There is a significant difference in academic stress between freshmen and sophomores. There are also significant differences between freshmen and juniors. There is no significant difference in academic

pressure between junior and sophomore students

4.1.2   Qualitative phase results

In this section, we analyze the reported results and identify three main themes from the participants' narratives: 1) gradual adjustment to a new learning environment; 2) advantages and disadvantages of online teaching by teachers; and 3) academic integrity. Participants reported that these issues were prominent during the epidemic, away from campus, and during online learning at home. We will analyze how best to address academic stress among Chinese university students majoring in chemistry by observing the participants' state of mind in the face of the academic stress caused by the onset of the epidemic.

4.2.1. Gradual adaptation to a new learning environment

All eight participants in the qualitative phase described how their lives were affected by the new coronavirus. This change was unprecedented. At the beginning of the epidemic, when the virus was first discovered, participants felt that the virus was so far away from people's daily lives that they did not pay much attention to the epidemic. However, as the epidemic continued to spread, the scope of the people affected gradually expanded and spread to other countries, and the respondents' sense of shock and serious concern increased (Levkovich and Shinan-Altman, 2021). People received information from a variety of media sources. Some of these sources were reliable, such as the Chinese government. Other less reliable sources spoke of Wuhan, China as the origin of the virus (Sarkar, Mandal and Paul, 2021), but it was later confirmed that the virus did not start in China. In addition, the guidelines provided by the Ministry of Health were not clear to everyone, leading to confusion, information confusion and internal unrest (Levkovich and Shinan-Altman, 2021).

Zhang said, "A few months ago, I had just started university and was enjoying the good old days of starting university, then the winter break started and I was back home with my family looking forward to Chinese New Year. When Covid-19 was first reported, it didn't get much attention, but as the number of people in the viral crisis grew and I saw more and more requests for help and casualties, it became apparent to me that the mood of people around me began to change, becoming panicked and helpless. As the start of the school year approached, the school sent out a notice saying that the return to school would be suspended and teaching activities would be fully online. At first everyone was feeling new and even a tinge of excitement because they didn't have to go to school. It was a new time that we had never experienced before, and teachers and students began to familiarise themselves with the instruments and equipment. Although there were many jokes in the process because we were not familiar with the online equipment, we gradually adapted to the new learning environment. On top of that, I felt a great need to follow the news and find out what was happening in the world to dispel my uncertainty" (female freshman student in 2020, just six months into the course).

Six participants reported that their feelings ranged from indifference, to panic, to being organised for online learning. They began to adapt to the advantages as well as the disadvantages that online learning

brings. They therefore needed to download various learning software and become proficient in its functions. At the same time, the instability of the network is also a factor, as some students live in remote rural areas where communication facilities are not well developed, which greatly affects their academic progress.

Li said: "I thought the epidemic would pass quickly, I never thought it would reach such a large scale that all the universities in China were closed and teachers needed to turn on online teaching, so I needed to download some learning software to keep up with the teaching, because my family is in a rural area and sometimes the signal for online classes is not very good, which causes the classes to be intermittent, which affects my progress in learning" (female second-year student in 2020).

Seven participants described being shocked by the arrival of the outbreak. The subject of chemistry itself is an experiment-based science, so doing experiments is an important part of the chemistry course. However, the epidemic caused the school to close and students could not return to do their experiments, and the course schedule was changed.

Chen: "We have quite a lot of classes that require labs in our junior year of school, and the epidemic caused us to be unable to access the labs. The teachers cancelled some of the labs and made up for them offline after the school year started. Although, the pressure regarding online courses decreased during the epidemic, the pressure became high for everyone when we returned to school." (Male student in his third year of university in 2020).

Most participants reported that after initial shock, they found themselves gradually adapting to life in the presence of COVID-19. The difficulty in adapting stemmed from having to stay in their own homes and limiting their activities. These participants described how difficult this was, citing the fact that they felt their freedom had been taken away from them. However, the situation also provided them with an opportunity to reacquaint themselves with and draw closer to their families.

Dai: "When I was first at home, the family atmosphere was quite harmonious. But after staying at home for a long time, there was a lot of friction with my parents. I have my own schedule, but my parents think I should be doing other things during this time. This kind of demand makes me feel distressed" (female second-year student in 2020).

4.2.2 Advantages and disadvantages of online teaching for teachers

All study participants described the advantages and disadvantages of online classes for teachers. seven mentioned that the teachers taught through online devices and the students talked to their classmates and teachers through their mobile devices. The internet became the only means of communication between them, which increased their uncertainty. They described how the teacher's lack of proficiency with the device during the online teaching process led to deviations in the quality of the teaching and what could happen unexpectedly during the teaching process, adding to the uncertainty of teaching

online while leaving students feeling at a loss. However, online lessons are repeatable and students can watch them repeatedly after the lesson.

Zeng said: "In class, because my major involves the need to write chemical equations, teachers are not skilled in the operation of online equipment and use PowerPoint presentations directly, resulting in this result not being so comprehensible. In previous offline classes, teachers could teach people step by step on the blackboard to come up with the result of this equation, but online teachers cannot so The result of the chemical equation could not be written out so intuitively. So this has had some impact on my learning. But thankfully, the online class was recorded by the teacher and I could watch it again and again offline" (male second year student, 2020).

Five participants felt anxious about communicating with their teachers, as the students could only communicate with them via mobile devices due to the epidemic, but the lack of face-to-face communication resulted in students not being able to communicate with their teachers in depth. These concerns led to feelings of uncertainty about online learning, anxiety and a lack of control over the current situation.

Liu said, "During class, I would have some knowledge that I didn't understand and needed to ask the teacher for advice. But because everyone communicates online, it leads to a lot of problems, for example, if the internet is down, you can't communicate with the teacher very well; sometimes the results of a chemistry experiment need to be demonstrated, and this is difficult to answer online. These cause a hindrance to my studies." (Female student in her third year of study in 2020).

4.2.3 Academic integrity in relation to online examinations

All eight participants described the school's arrangements for online exams during the epidemic, which involved the academic integrity of the exams. five mentioned that the exams were held online without the supervision of teachers around them, who could only observe students taking the exams through cameras, and that students had to rely on self-awareness to comply with the exams.

Lu said, "Our exam was online and the teacher asked us to turn on the webcam during the exam because the computer's webcam is not 360 degrees free. After the exam, I heard from another student that he had searched the answers on another device and got a high score and that the teacher hadn't noticed him doing so. This made me feel very unfair. Our school is guaranteed by grades and some students care about the high marks, but I think this behaviour is wrong and unfair." (Male third-year student in 2020).

Four participants expressed concern about the online examinations because the online teaching equipment was not very well equipped and the quality of the online teaching was slightly less than that of the offline teaching, but the content of the examinations was assessed according to offline standards.

Lin said, "The exams at our school are taken online and some teachers ask us to turn on a double camera,

which means one camera in front and one in the back. I feel that this has improved the authenticity of the exams. But some teachers in our school, who were not that familiar with the use of the equipment, just distributed the question papers and asked us to finish writing them within the time limit, without even turning on the camera, so that the students could pass the answers among themselves. Many times in our class, after the teacher had called the roll, some students left the computer screen, and they were not very clear about what the teacher was doing in class. When it was time for the exams, the top students in the class started to be approached and asked for the key points of the exams. The exams for the lab classes were moved to the offline start of the school year, and many students were also improvising to catch up on their knowledge. It can be found that students are not very efficient in the online learning process" (female 2020 second-year student)

Some participants described how their schools did not hold online exams, but rather followed regular offline exams, with some schools notifying students to return to school in June and July for exams when most schools begin to resume regular schooling in September in the fall of 2020.

Li said, "I feel that the arrangement of the school is very unreasonable, why can't we wait until we are in a safe period before we return to school? Instead, we were told to return to school in June and July. We had offline exams after we returned to school and wore masks throughout the exams, which meant I couldn't breathe well enough to focus on my exams. The campus was closed and students were confined to their dorm rooms, resulting in us being very unfree and mentally tortured. Why can't the school postpone the start of school backwards, like most schools do? We are also closed when we return to school and we are isolated in our dormitories and suffer mentally and physically. It is better to be isolated at home and postpone the start of school like most schools. I don't know what the point of schools starting earlier is?" (female 2020 second-year student)

5.Discussion

The results of the quantitative study showed that male students majoring in chemistry in Chinese universities had significantly higher academic stress than female students majoring in chemistry in Chinese universities. This result is inconsistent with the results of Ebrahim (2016) and Calvarese (2015), who found that female students have higher academic stress than male students. Furthermore, the results of Gonmei and Devendiran (2017) and Yikealo, Yemane and Karvinen (2018) showed that gender did not have any effect on students' academic stress. However, the results of this study showed that male university students were more academically stressed than females. This could be because patriarchal societies are more male seeking (Aihie and Ohanaka, 2019), or it could be because the study group in this study was university students majoring in chemistry, while the results of other studies differed depending on the study group. Another reason is that males are more casual in their studies than females, which leads to procrastination, which can lead to more work and going through assignments near the end of the task, which in turn can lead to tension and stress (Mishra, 2018). The results indicate that there is a statistically significant difference in the perceived level of academic stress

among seniors versus freshmen, sophomores, and junior undergraduates. There is a significant difference in academic stress between freshmen and sophomores. There are also significant differences between freshmen and juniors. There is no significant difference in academic pressure between junior and sophomore students. The findings do not support Khan, Altaf and Kausar (2013) who found higher levels of academic stress in lower grades than in higher grades. Notably, the qualitative phase of the study also found that students in their final year of university felt significantly more academic stress than those in their first three years of university. This result could be due to the fact that in 2020, being juniors, their lab classes were shifted to their senior year courses due to the epidemic. This reason leads to an increased workload for them, including pressures such as a final year thesis in their final year of university. This may also be due to concerns and anxieties about the final results and future employment. Students in their final year are about to graduate and failure in their courses may result in them not graduating successfully. This finding is in line with Elias, Ping and Abdullah (2011) and others who found that final year undergraduates felt more stressed than students in other years.

In addition, qualitative findings on participants' perceptions of academic stress during the epidemic provide insights that complement and clarify the meaning of the quantitative findings. To briefly review: three themes emerged from the content analysis of participants' responses to the open-ended questions, which reflect the perceptions of Chinese university students majoring in chemistry regarding the stress of studying online. Specifically, online learning during the epidemic not only created negative academic stress for Chinese university students majoring in chemistry, but also had the aspect of reducing academic stress. The qualitative study revealed the prevalence of academic stress among chemistry undergraduates during the outbreak and their need to readjust to a new learning environment. The participants' negative academic stress was found to come mainly from the online teaching process, where some older teachers were not able to use online teaching tools well, resulting in students not being able to understand the knowledge well, and from senior students facing job hunting and writing their thesis. In addition, many participants said that they felt less academic pressure during the online learning process than during offline studies because they did not take lab classes during the epidemic. Another important qualitative finding - after the epidemic subsided, students felt high academic pressure upon returning to school. Because almost all institutions were closed during the epidemic, chemistry majors could not access laboratories to conduct experiments, and when universities started their offline studies, they needed to make up for the laboratory classes they had not taken during the epidemic. The pressure is particularly high for juniors and seniors, who are faced with the task of studying for graduate school, studying for graduate school, and doing internships to find jobs. In addition to these tasks, senior students have the task of writing their thesis, and writing their thesis requires a lot of experimental data, so they also need to go into the laboratory to complete the data for their thesis, causing the pressure on senior graduates to be higher than those in other years, which explains why the pressure on senior graduates is found to be higher than that on freshmen, sophomores and juniors in the quantitative.

Limitations and recommendations: This study highlights the impact of online learning on academic

stress among Chinese university students majoring in chemistry during the 2020 epidemic. However, this study still has some limitations and more research is needed to understand what types of online learning can reduce academic stress and anxiety. The data for this study was collected from only one Chinese university and the sample size was too small, which may limit its applicability. The study relied primarily on questionnaires and interviews about the Perceived Academic Stress Scale to assess academic stress among Chinese university students majoring in chemistry, and did not make a clinical diagnosis that would allow for a deeper understanding of student stress. In addition, the qualitative research questions used semi-structured interviews aimed to understand the study participants' feelings, behaviours and ways of coping with academic stress online during the 2020 epidemic. However, they limited the possibility of obtaining more realistic information from participants, and it portrayed that the review of university students majoring in chemistry about academic stress from studying online at home during COVID-19 in 2020 would have been subject to memory bias and the results could have been affected. As the virus continues to spread, research should continue to explore the psychological and emotional responses of this group of university students over time, given the rising morbidity and mortality rates worldwide. Notably, the use of mixed methods limits the ability to generalise our results to a broader population (Levkovich and Shinan-Altman, 2021).

Problems identified during the research process can be addressed in the following ways. Teachers socialise via a virtual platform and provide regular briefings about course assessments. Teachers use motivational remarks to help students stay focused and strive for excellence (Riaz et al., 2021). In terms of rewards, students are rewarded for any positive behaviour (El-Seoud, El-Khouly and Taj-Eddin, 2016). This initiative by the teacher stimulated students to continue to achieve and perform at the highest level. The next step was to reduce their stress. There are no strict deadlines set for attendance, participation or submission, which helps students engage better with online courses (Allam et al., 2020). Teachers can also use more online learning methods, such as group discussions, to enhance communication between students, and can also set up instant messaging systems so that teachers can help students in a timely manner. In this way, academic stress and anxiety can be reduced (Riaz et al., 2021).

In addition, universities should provide counselling and behavioural techniques to help students manage academic anxiety. Most important for online learning to work well is the need for government departments to remove the availability of barrier devices that limit students' access to the Internet, which is necessary to register for online learning courses. In future research, organised clinical interviews could also be used to diagnose academic stress in university students. Therefore, in view of this occurrence, universities could bring forward their offline theory classes if they are once again fully online, thus reducing the academic stress of chemistry undergraduates when they return to school. Alternatively, for some simple experiments, small programs could be developed that students could operate online to get a more intuitive feel for the experimental process. In addition, the researchers recommend that higher education institutions acknowledge students' experiences and adopt more relaxed policies during these difficult times in order to promote the learning experience and safeguard students' academic achievement and, more importantly, their physical and mental well-being. Schools also need

to train teachers in the skills of online teaching and for some older teachers, some teaching assistants could be recruited to assist them in their teaching. However, it is important for teachers to understand the negative impact of online learning on students' academic performance during the epidemic. Teachers' teaching skills should be adapted to the needs of their students. Schools can provide planning support for changes in online teaching and learning, access to academic resources and changes related to COVID-19 can both predict changes in academic stress. Those responsible for designing university courses should proactively address stress in the student body and help individuals to access specific coping strategies (Vaez and Laflamme, 2008). Helping students develop realistic expectations of learning and incorporating their previous school experiences. Stress management programmes can be offered by education professionals, as self-help, or as part of a university course. Universities should provide health training courses in stress reduction (Stormont and Young-Walker 2017). Courses on academic career guidance planning could be offered to new university students, as well as career guidance and transition for final year students.

It is worth noting that universities should also launch health awareness campaigns to address the coping mechanisms and healthy habits needed to deal with existing challenges. Students are the ones facing academic losses. All this can lead to disturbances in their mental state. Students should also use coping strategies such as yoga, exercise and pastime therapy, such as spending time with their families on watching television. Academic, environmental, social and health issues all play an important role in the development of stress, however, academic factors are the most important stressors (Yasmin, Khalil and Mazhar, 2020); during the qualitative phase, we observed that students isolated in halls of residence were prone to stress; therefore, regular reviews of halls of residence by the school based on student feedback, as well as complaints from students should be addressed in a timely manner. Although some students are frequently reluctant to use support services, the majority of students support the inclusion of stress management education in the curriculum (Deasy et al., 2016). Concrete and targeted measures are therefore needed to significantly reduce the stress burden on students.

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The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of Interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Innovative Development of Vocational Education in Guangxi under the RCEP Framework

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Abstract：Within the RCEP framework, vocational education in Guangxi faces significant opportunities and challenges. This paper proposes strategies in three aspects: industry-education integration, faculty development, and internationalized teaching. To deepen industry-education integration, emphasis is placed on collaborative research and development with businesses, establishing diverse collaboration models, and refining the school-enterprise cooperation mechanism in conjunction with government and industry. Strengthening faculty development involves improving salaries, facilitating faculty exchanges with ASEAN universities, and supporting professional development to attract and retain outstanding teachers. In terms of internationalized teaching, advocating collaboration with ASEAN nations to jointly offer courses, promoting credit recognition, and addressing educational system differences and language barriers are crucial. The establishment of strict teaching quality standards and assessment mechanisms is also emphasized. Through these strategies, vocational education in Guangxi aims to better adapt to the globalization trend within RCEP, cultivate talent with enhanced international competitiveness, and actively contribute to regional economic and social development.

Keywords：RCEP, Guangxi, Vocational Education

1. Introduction

In the context of accelerating globalization, regional economic integration has become a key force driving global economic development. The Regional Comprehensive Economic Partnership (RCEP), covering one-third of the world's population and three-quarters of GDP through a free trade agreement, aims to reduce tariff barriers, promote service and investment facilitation, and further propel regional economic integration. The implementation of RCEP not only facilitates economic cooperation and exchange among member countries but also has profound implications for global economic stability and development.

Chongzuo City in Guangxi, located on the border between China and Vietnam with a 533-kilometer-long boundary, serves as one of China's most convenient land gateways to ASEAN and boasts numerous border ports. The implementation of RCEP will tighten economic and trade connections between China and the ASEAN region, particularly for southwestern border provinces with

ASEAN, and Guangxi, positioned at the southern end of mainland China, uniquely connected to ASEAN by land and sea, becomes a forefront and gateway for China's open collaboration with ASEAN.

In this context, vocational education, as a crucial pillar supporting regional economic development, plays an indispensable role. Firstly, vocational education is a vital avenue for cultivating high-quality skilled talents, the core force propelling regional economic development. Through vocational education, students gain practical operational skills and theoretical knowledge, providing essential talent support for the development of industries within the region. Secondly, vocational education enhances the overall quality of the workforce, promoting social fairness and stability. By offering diverse educational opportunities, vocational education enables more individuals to acquire professional skills and knowledge, increasing employment opportunities and elevating living standards. This contributes to narrowing the wealth gap and maintaining social harmony and stability. Additionally, vocational education promotes industrial upgrading and innovation within the region. With continuous technological advancements and adjustments in industrial structures, vocational education can timely update its curriculum, nurturing talents adaptable to the new economic landscape. This not only aids in driving industrial upgrading within the region but also stimulates innovative vitality, enhancing the competitiveness of the regional economy.

In summary, vocational education holds irreplaceable importance in regional economic development. Through the cultivation of high-quality skilled talents, elevation of workforce quality, and promotion of industrial upgrading and innovation, vocational education robustly propels sustained development and social progress in the regional economy.

2. Literature Review

Zhao J believe that the signing of RCEP will deepen economic integration in the Asia-Pacific region, enhance trade among member countries, and positively impact global economic recovery and development, creating opportunities for higher vocational education.[1] In the face of evolving regional economies and industrial upgrades, Zhang San and March L J argue that higher vocational institutions must adapt by flexibly adjusting program offerings and educational models to align with emerging market demands. [2][3] Zhang Bo et al. contend that under the backdrop of RCEP, the cultivation of ASEAN students in China presents new opportunities and challenges. Institutions are adopting a collaborative training model to enhance educational quality and international competitiveness. Optimization strategies include increasing training efforts, refining regulatory mechanisms, expanding training channels, and deepening international cooperation, contributing to the construction of the China-ASEAN community of shared destiny and the internationalization of higher education.[4] Liu H and Zhao Q assert that, as a member of RCEP and a prominent global economic and educational influence, China must prioritize the cultivation of exceptional talents through high-quality education, making a substantial contribution to global education integration. [5] Zhang Yimin and Sun Jie argue that under the backdrop of the high-quality joint construction of the "Belt and Road," Sino-ASEAN vocational education cooperation faces new opportunities. However, challenges such as unclear cooperation objectives, weak cohesion among stakeholders, scattered policy support, and a monotonous collaboration approach

exist. To advance deep cooperation, it is essential to clarify cooperation goals, strengthen stakeholder responsibilities, integrate policy tools, and diversify collaboration methods. These strategies hold significant importance for the high-quality development of vocational education. [6]Wang Min, Zhou Huamin, and Wang Lan highlight that with the formal implementation of the Regional Comprehensive Economic Partnership (RCEP), the agreement has brought numerous conveniences to economic trade in the region. However, a talent gap has emerged to meet the demands of this developmental trend, particularly for individuals with international perspectives and professional skills. Undergraduate vocational education plays a crucial role in talent development, prompting vocational colleges to actively adjust talent development paths to align with the needs of RCEP, especially in ASEAN countries. To address these challenges, reforms are needed in top-level design and exploration of new pathways for international talent development. This approach aims to better cultivate technical and skilled professionals suitable for RCEP needs, further supporting education services for RCEP and addressing the shortage of high-quality technical and skilled professionals in China, providing a foundation for serving the construction of RCEP in the ASEAN region. [7][8] Li Mingwan, Zhang Sihong, and Hu Shuang emphasize that language services play an indispensable role in the implementation of RCEP, serving as a crucial element in constructing the China-ASEAN community of shared destiny. Guangxi, as a vital gateway for connectivity between China and ASEAN countries, possesses abundant language resources, offering extensive opportunities for the development of language services oriented towards ASEAN. However, Guangxi still faces shortcomings in language service development strategies, utilization of language resources, and the application system. Therefore, there is a need to strengthen Party leadership, promote new developments in language services, and create a new landscape for language services.[9][10]In summary, the Regional Comprehensive Economic Partnership (RCEP) has positively influenced economic integration, trade, and global economic recovery, bringing new opportunities for higher vocational education. To meet market demands, schools need continuous reforms to enhance the adaptability of talent development. In the process of education, it is essential to comprehensively consider the training needs of both ASEAN international students and domestic students, encompassing comprehensive development in language, technical skills, and internationalization. These studies will contribute to advancing reforms in vocational education.

3. Significance of Innovative Development of Vocational Education in Guangxi under RCEP

Against the backdrop of accelerating globalization, the development of vocational education in Guangxi has undergone various stages. In the early stages of reform and opening up, Guangxi gradually established a vocational education system, primarily focusing on secondary vocational education. With economic development and adjustments in industrial structures, the scale of vocational education in Guangxi has expanded, the quality of education has continuously improved, and there has been a shift towards higher vocational education. Currently, the vocational education system in Guangxi is relatively well-established, encompassing secondary vocational schools and higher vocational colleges. The number of schools and enrolled students has significantly increased, and there is a more diverse range of majors covering multiple fields such as industry, agriculture, commerce, and humanities. Despite achieving certain accomplishments, challenges persist, including inadequate teaching facilities in some

schools, a shortage of qualified faculty, and mismatches between some majors and market demands. Overall, vocational education in Guangxi is evolving and improving but needs to address these issues further to better serve regional economic development.

Under the RCEP framework, the innovation and development of vocational education in Guangxi hold significant importance. Firstly, with the implementation of RCEP, economic cooperation between Guangxi and ASEAN countries will become closer, leading to a growing demand for talents with international perspectives and professional skills. Therefore, through innovation and practical approaches, vocational education in Guangxi can cultivate highly skilled talents more aligned with market demands, contributing to the stable development of the regional economy. Secondly, the innovation and development of vocational education in Guangxi contribute to enhancing its international competitiveness. Within the RCEP framework, vocational education in Guangxi can leverage cooperation and exchange mechanisms among member countries to introduce advanced educational concepts and teaching resources. Strengthening collaboration with foreign vocational schools, promoting the renewal of educational philosophies, and improving teaching methods will enhance the international competitiveness of vocational education in Guangxi. Additionally, the innovation and development of vocational education in Guangxi have positive effects on promoting cultural exchange and people-to-people connectivity. Vocational education is not only a place for cultivating professional skills but also a bridge for cultural dissemination and friendship-building. Collaboration and exchange with vocational schools in RCEP member countries can facilitate mutual understanding and recognition between different cultures, foster friendships among people, and lay the foundation for peace and development in the region.

In conclusion, the innovation and development of vocational education in Guangxi under the RCEP framework are crucial for nurturing internationally competent high-skilled talents, enhancing international competitiveness, and promoting cultural exchange and people-to-people connectivity. Therefore, vocational education in Guangxi should seize the opportunities presented by the RCEP framework, actively engage in innovation and practical initiatives, and make greater contributions to the sustained development of the regional economy and the realization of people-to-people connectivity.

4. Opportunities and Challenges of Vocational Education in Guangxi under RCEP Background

In the context of the implementation of RCEP, the economic and trade cooperation between Guangxi and ASEAN countries is poised to deepen, presenting broader prospects for the development of vocational education in Guangxi. Seizing this opportunity, Guangxi has the chance to enhance collaboration and exchange in the field of vocational education with ASEAN countries, aiming to elevate the international influence of vocational education. However, as external openness expands, vocational education in Guangxi will encounter intense competition from the international market. Consequently, to adapt to the upgraded trade rules and standards within the RCEP framework, vocational education in Guangxi needs to strengthen alignment with industries, elevate the quality and adaptability of talent development. Simultaneously, considering the educational disparities among member countries under the RCEP framework, vocational education in Guangxi must enhance its internationalization, catering to

diverse educational needs more effectively.

4.1 Industry-Education Collaboration

In the context of RCEP, vocational education in Guangxi faces both significant opportunities and challenges, with school-enterprise cooperation standing out as a critical area. Firstly, Guangxi's proximity to ASEAN countries provides a unique geographical advantage for school-enterprise collaboration. Sharing similar cultures, histories, and customs creates a natural bridge for businesses to integrate into the local society and market. This cultural connection facilitates a better understanding and adaptation to the local environment, promoting mutually beneficial outcomes in school-enterprise cooperation. Secondly, with the implementation of RCEP, Guangxi's agriculture, manufacturing, and service sectors have opportunities for deep collaboration with ASEAN countries. This implies that enterprises and educational institutions can explore new technologies and products collaboratively, conducting targeted personnel training to enhance competitiveness and cooperation benefits. In this process, vocational education institutions in Guangxi play a crucial role in supporting the development of highly skilled talents responsive to international collaboration needs.

Despite the abundant opportunities, Guangxi faces several challenges in school-enterprise cooperation. One such challenge is the relatively lower levels of experience and technological expertise. To address this, Guangxi needs to deepen the integration of theoretical research and practical applications, ensuring that academic research outcomes better serve industrial development. Additionally, the mechanisms for school-enterprise cooperation in Guangxi are not yet robust enough, with collaboration forms being relatively singular and lacking depth and breadth. Enterprises often have lower participation levels, placing schools in a passive position. To unlock the full potential of school-enterprise cooperation, Guangxi must strive to enhance and expand collaboration mechanisms, making them more comprehensive and profound. In addressing this issue, attention should be given to the interactivity and balance of school-enterprise cooperation. Schools and enterprises should maintain close interaction, jointly devising cooperation plans to ensure a balanced interest for both parties. Fostering students' practical abilities and adapting to international market demands are crucial goals of school-enterprise cooperation, and Guangxi needs to focus on the quality of practical education in cooperation, improving students' hands-on skills.

In conclusion, vocational education in Guangxi, under the backdrop of RCEP, has the potential to achieve internationalization in talent development and enhance the international competitiveness of industrial development through strengthened school-enterprise cooperation. Leveraging geographical and cultural advantages while addressing existing challenges in cooperation, vocational education in Guangxi could become a significant engine driving regional economic development, injecting new vitality into RCEP cooperation.

4.2 Faculty Development

Under the RCEP framework, vocational education in Guangxi faces both new opportunities and a series of challenges in the construction of its teaching staff, particularly in terms of education

cooperation and exchange with ASEAN countries. With the increasing trade and investment, the ties between Guangxi and ASEAN countries have become closer, leading to a high demand for professionals proficient in ASEAN languages and cultures. To seize this opportunity, Guangxi can consider implementing targeted measures, such as introducing outstanding teachers from ASEAN countries and promoting teacher exchange programs with ASEAN countries, to achieve diversity and internationalization in its teaching staff.

Firstly, introducing outstanding teachers from ASEAN countries is a crucial approach to diversifying Guangxi's teaching staff. By bringing in education experts with knowledge of ASEAN languages and cultures, not only can the language proficiency of students be enhanced, but strong support can also be provided for the international development of schools. This initiative not only contributes to deepening students' understanding of ASEAN countries but also injects new disciplinary and cultural elements into vocational education in Guangxi.

Secondly, implementing teacher exchange programs with ASEAN countries will be a vital means to promote the internationalization of the teaching staff. By establishing collaborative relationships with educational institutions in ASEAN countries, Guangxi can facilitate mutual teacher exchanges and encourage the sharing of teaching experiences. This not only helps expand teachers' international perspectives but also enhances their cross-cultural communication and collaboration skills, promoting the effective integration of educational resources in the ASEAN region.

Despite favorable conditions provided by policy support and market demand for the construction of Guangxi's teaching staff, challenges still exist. Firstly, compared to other regions in China, the remuneration level in Guangxi may be relatively lower, potentially affecting the attractiveness and retention rates of teachers. Secondly, cultural differences and disparities in educational systems with ASEAN countries may pose challenges to the construction of the teaching staff.

Facing new opportunities and challenges, vocational education in Guangxi, through continuous improvement in the construction of its teaching staff, can further enhance its internationalization. This, in turn, contributes to the sustainable development of the regional economy by nurturing talents with increased global competitiveness.

4.3 Internationalized Teaching

Under the implementation of RCEP, Guangxi has encountered valuable opportunities to establish a broader platform for internationalized teaching. The close economic cooperation has led to a growing demand for professionals proficient in ASEAN languages and cultures. In this context, Guangxi has immense development potential, and it can achieve this by strengthening educational cooperation with ASEAN countries, collaboratively advancing curriculum development, credit recognition, and joint training programs. This will provide students with more opportunities for internationalized learning while deepening cooperation with ASEAN countries.

Firstly, Guangxi can actively engage in educational cooperation with ASEAN countries by organizing joint international academic conferences, educational exchange activities, and promoting the sharing of

educational resources. This facilitates the attraction and cultivation of a faculty team with international perspectives, thus enhancing the level of internationalized teaching.Secondly, Guangxi can enhance curriculum development in collaboration with ASEAN countries. By co-offering professional courses involving ASEAN culture, language, and business, students can benefit from a richer academic experience. Additionally, promoting a mechanism for credit recognition allows students to flexibly participate in cross-school cooperation, expanding their academic horizons.

However, in the realm of internationalized teaching, Guangxi faces several challenges. Firstly, there are differences in the education systems of ASEAN countries, requiring flexibility and adaptation to ensure the seamless progress of internationalized teaching. Schools need high adaptability and innovation in collaboration to provide teaching content closer to international standards.

Secondly, communication with ASEAN countries may encounter language barriers. Guangxi needs to strengthen language training to improve the communication skills of teachers and students in a multilingual environment, ensuring accurate information transmission for effective teaching progress.

Moreover, ensuring educational quality does not decline while internationalizing is a key concern. This requires the establishment of a scientific assessment system, the introduction of exemplary internationalized teaching practices, and continuous efforts to improve educational quality, ensuring comprehensive student development in internationalized learning.

Finally, as cooperation with ASEAN countries deepens, there may be an increase in student mobility. Guangxi needs to implement measures to address this challenge, including strengthening students' awareness of safety, establishing a sound student service system, and ensuring that students receive adequate care and support while studying abroad.

In summary, Guangxi has enormous development potential in internationalized teaching. Through flexible cooperation mechanisms and comprehensive educational reforms, it can construct a more internationalized teaching platform within the RCEP framework. This will contribute to cultivating talents with international perspectives and competitiveness, propelling vocational education in Guangxi to higher levels.

5. Strategies for Vocational Education in Guangxi under RCEP

With the formal implementation of the Regional Comprehensive Economic Partnership (RCEP), vocational education in Guangxi enters a vibrant new era. As a crucial hub for China's close collaboration with ASEAN, Guangxi holds a unique position and strategic advantage within the RCEP framework, presenting unprecedented opportunities and challenges for vocational education. This historic transformation not only propels deeper economic and trade cooperation between Guangxi and ASEAN nations but also imposes new developmental demands on vocational education in Guangxi. Faced with the challenges and opportunities of globalization, how Guangxi's vocational education innovatively evolves to better align with the trends of the RCEP era becomes an urgent question. Hence, a series of practical strategies should be proposed to guide Guangxi's vocational education toward a new developmental journey.

5.1 Deepening Industry-Education Integration

Firstly, vocational colleges in Guangxi will intensify collaboration with enterprises, focusing on joint research and development of new technologies and products tailored to meet the demands of the ASEAN market. Within the RCEP framework, schools and enterprises will capitalize on collaborative opportunities, sharing research and development resources to enhance technological proficiency and innovation capabilities. To precisely address industry needs, there will be adjustments to program offerings, incorporating additional relevant courses and training content to ensure graduates possess practical skills closely aligned with the market.

Secondly, diverse collaboration models will be established, including co-building training bases and integrating industry, academia, and research. This comprehensive involvement in talent development collaboration will not only improve the quality and practicality of education but also foster sustainable development and technological innovation within enterprises. Through the establishment of training bases, students will have the opportunity to gain real-world experience in actual work environments, better adapting to vocational requirements.

Thirdly, vocational colleges in Guangxi will collaborate with the government and enterprises to enhance the mechanisms and policy environment for industry-education collaboration. The government will provide support through measures such as tax incentives and financial assistance to encourage more corporate participation. Clearly defined implementation rules and assessment criteria will be formulated to specify the rights and responsibilities of both parties, ensuring the quality and effectiveness of collaboration.

Lastly, continuous improvement and evaluation of industry-education collaboration projects will take place, collecting feedback and making necessary adjustments. Through regular assessments and experience summaries, schools and enterprises can continually refine collaboration models and mechanisms, enhancing the effectiveness and sustainability of cooperation. This series of strategies aims to make industry-education collaboration more systematic and targeted, driving innovation and development in vocational education in Guangxi, and providing students with a higher quality and more practically relevant educational experience.

5.2 Strengthening Faculty Development

To attract and retain outstanding teaching resources, vocational colleges in Guangxi should first enhance teachers' salary packages to make them more competitive in the domestic market, thereby inspiring teachers' enthusiasm and creativity. Building on this foundation, active promotion of faculty exchanges with universities in ASEAN countries will be pursued, establishing exchange platforms to strengthen interaction and collaboration between teachers on both sides. Support will be provided for teachers to participate in international academic conferences, research projects, and other activities to broaden their international perspectives and enhance their professional competence.

To support teachers' professional development, the schools will offer clear career development paths and promotion opportunities, encouraging teachers to achieve higher accomplishments in their

respective fields. Special emphasis will be placed on supporting teachers in undertaking research projects related to ASEAN countries, providing necessary research resources and financial support to elevate research and academic standards. To better manage and utilize faculty resources, the schools will establish a database of teachers from ASEAN countries, promoting information sharing and communication, enhancing mutual understanding and collaboration between teachers on both sides, and facilitating educational cooperation and exchanges between Guangxi and ASEAN countries.

Lastly, regular evaluations and feedback mechanisms will be implemented for faculty development projects. By collecting opinions and suggestions, continuous improvement of strategies and measures will be pursued to enhance the overall quality and standards of the faculty team. Encouraging teachers to provide suggestions will stimulate their participation, fostering ongoing improvement and optimization of faculty development. This comprehensive set of strategies aims to build a more competitive and internationally oriented faculty team, laying a solid foundation for the development of vocational education in Guangxi.

5.3 Expanding International Exchanges and Cooperation

To foster educational cooperation between Guangxi and ASEAN countries, schools should prioritize the development of joint programs, credit recognition, and collaborative training projects with ASEAN nations, providing students with more opportunities for internationalized learning. During this process, it's crucial to adapt flexibly and bridge the differences in educational systems with ASEAN countries to ensure smooth implementation of internationalized teaching. Addressing language communication barriers can be achieved by strengthening language training, offering ASEAN language courses, and enhancing the cross-cultural communication abilities of both faculty and students.

Secondly, Guangxi should establish stringent teaching quality standards and evaluation mechanisms, actively promoting exchanges and collaboration with universities in ASEAN countries. Prioritizing student safety and rights, establishing a sound student management system, and enhancing communication mechanisms with ASEAN countries are necessary steps. To facilitate cultural exchange and understanding, organizing cultural exchange courses and activities will deepen the cultural identity of faculty and students.

Lastly, regular assessments and feedback for internationalized teaching programs should be conducted, encouraging faculty and students to provide suggestions and opinions to continuously improve the quality and effectiveness of internationalized education. Through the formulation and implementation of these strategies, Guangxi is poised to deepen its cooperative relations with ASEAN countries and cultivate a greater number of talents with international perspectives and competitiveness.

6. Conclusion

In conclusion, the innovative development of vocational education in Guangxi under the RCEP framework presents unprecedented historical opportunities. Following an in-depth exploration of industry-education integration, faculty development, and internationalized teaching, this paper proposes a series of practical strategies. Firstly, in terms of industry-education integration,

strengthening collaboration with enterprises will propel vocational education in Guangxi to better serve local industries, fostering a deep integration of technological innovation and talent cultivation. Secondly, the strategies for faculty development will provide robust support in attracting and retaining outstanding educators, enhancing the international profile of faculties in vocational institutions in Guangxi and contributing to the improvement of educational quality and academic standards. Lastly, the strategies for internationalized teaching will facilitate the broader integration of vocational education in Guangxi into the global education system, providing students with richer learning opportunities and nurturing talent equipped with international perspectives and competitiveness. Looking ahead, Guangxi's vocational education should consistently implement these strategies, making continual adjustments for optimization to meet the challenges of the globalized era. Only through the comprehensive advancement of industry-education integration, faculty development, and internationalized teaching can vocational education in Guangxi embrace a more brilliant future amidst the waves of the RCEP era. Serving as a crucial engine for regional development in the tide of global economic integration, vocational education in Guangxi will not only offer more opportunities for students but also make a significant contribution to the sustainable development of the local socio-economic landscape.

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Research and interpretation of statutory inheritance and testamentary succession of the Civil Code

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Abstract: The Inheritance Law of the People's Republic of China (hereinafter referred to as the Inheritance Law) promulgated in 1985 plays an important role in coordinating the civil legal acts existing in the family. However, with the development and progress of the times, some laws and regulations can no longer serve the current era and show a lag. In order to make up for this shortcoming, China officially implemented the Civil Code of the People's Republic of China (hereinafter referred to as the "Civil Code") on January 1, 2021, which incorporated this part of the inheritance into the Civil Code, and the "Civil Code Inheritance" (hereinafter referred to as the "Inheritance Edition"), retaining the essence of the "Inheritance Law", respectively from the general provisions, statutory inheritance, testamentary inheritance and bequest,The four parts of inheritance treatment have been revised, which is in line with the spirit of today's legislation, conforms to the trend of the times, makes China's inheritance legislation more perfect, protects citizens' private property, stabilizes the relationship between family members, promotes national development, and stabilizes social order. In order to make better use of laws and regulations in judicial practice and to make inheritance cases more fairly and legally resolved, legal inheritance and testamentary succession are studied.

Keywords: Inheritance, Legal Succession, Testamentary Succession

I. Research and interpretation of the "General Provisions" in the Inheritance Compilation

1.1 Overview of General Provisions

In China, the scope of adjustment of inheritance is the civil legal relationship arising from inheritance, of which Article 1119 of the Civil Code stipulates the scope of adjustment of the inheritance part.This law and regulation respectively elaborates on inheritance and civil relations, inheritance refers to the legal system in which a natural person dies and a surviving person who has a family relationship with him acquires his property in general; a civil relationship is a civil legal relationship, not a criminal legal relationship, an administrative legal relationship, and other legal relationships.What is protected is the inheritance right of natural persons, i.e. legal persons and unincorporated organizations do not enjoy the inheritance rights of the deceased."Article 13, paragraph 2, of the Constitution stipulates that

the State shall protect citizens' rights to private property and inheritance in accordance with the law, and shall combine citizens' rights to private property with the right to inheritance. It is believed that the right of inheritance falls within the protection of the right of private property, so the Constitution protects the right of inheritance by protecting the right of private property.[5]The inheritance rights of the heirs and the rights of the deceased are protected by the Constitution, which is in line with the legislative spirit and core gist of the Constitution of our country. The right of inheritance is protected by the Constitution, and on the one hand, it protects the property rights of citizens and improves the property protection system within the family. It not only guarantees the public economy, but also greatly guarantees the important position of the non-public economy in our country, and the property relations within the family are also a manifestation of the non-public economy. On the other hand, from ancient times to the present, China attaches great importance to the concept of family, the concept of family members, and the right of inheritance is protected by the Constitution to further promote family harmony, maintain the relationship between family members, and make the property within the family run and distribute by itself, which also reflects that the civil law is a private law, which greatly protects the legitimate rights and interests of citizens.

1.2 Study of the time of succession in the General Provisions

Regarding the starting time of inheritance, the first paragraph of Article 1121 of the Civil Code stipulates that inheritance begins at the time of the death of the decedent; in judicial practice, there will also be cases where persons with mutual inheritance rights die at the same time, and the second paragraph of this Law provides for such situations: if several persons who have a mutual inheritance relationship die in the same event, if it is difficult to determine the time of death, it is presumed that there are no other heirs who died first. If there are other heirs to inherit and have different generations, it is presumed that the elder died first; if they are of the same generation, they are presumed to have died at the same time and do not inherit from each other. What is the underlying logic of this regulation? " First of all, several persons who have a relationship of inheritance with each other die in the same event, and there are other heirs, and if their generations are different, it is presumed that the elder died first and the younger died later, so there is a normal inheritance relationship, that is, if the elder dies first, the younger heir who died in the same event can inherit his estate, and if the younger heir also dies, his other heirs will inherit his estate; second, if the person who died in the same event is of the same generation, he is presumed to be of the same generation They die at the same time, so that they do not inherit each other, and their inheritance is inherited by their respective heirs. The provision of such a presumption rule is based on decades of judicial experience as the basis of legislation, and is also fully in line with the requirements of the law of inheritance."[9]It is generally believed that the system of presumption of time of death is fundamentally aimed at protecting the legitimate rights and interests of the heirs and effectively reducing the situation in which the inheritance of the deceased cannot be inherited and belongs to the state. The relationship between family members and between citizens and society is maintained.

As for the provisions of Article 1122 of the Civil Code on the scope of inheritance, the core content is the legal property of the person left behind in the event of natural death. First of all, the inheritance must be personal. When part of the estate is the joint property of the husband and wife, the property should

be dissolved first. Second, the inheritance must be legitimate. "Legal" here refers to property acquired in accordance with the law, which can be inherited according to its nature.

Articles 1123 and 1124 of the Civil Code stipulate the manner of inheritance and the acceptance of abandonment. According to the principle of autonomy of civil law, the decedent has the right to dispose of his property by way of will and bequest; heirs also have the right to choose to accept and renounce. The right of inheritance belongs to a branch of civil rights, and the capacity for civil rights stipulated in the general provisions of the Civil Code is the right granted by law to natural persons, and the right of inheritance is the same as the right to life and personality, and they cannot give up their rights at will. However, does the provision in the Inheritance Part that the right of inheritance may be renounced, is this in conflict with the general provisions that the capacity for civil rights cannot be waived at will? The general view is that there is no conflict between the two. The renunciation of the right of inheritance can be given after the commencement of the inheritance and before the division of the estate, while the inheritance section protects the rights for this period. The "shall not arbitrarily renounce one's rights" mentioned in the General Provisions section refers to the fact that the inheritance rights enjoyed by the heirs shall not be waived at will before the inheritance has begun. In judicial practice, the heir renounces the inheritance in writing before the death of the decedent, but participates in the inheritance after the death of the decedent. The heir's renunciation of the right of inheritance is before the commencement of the inheritance, and the civil rights may not be waived at will, so the written promise made is invalid, and the heir still has the right to inherit. However, it is valid to participate in the inheritance after the death of the decedent, because the heir has not expressly renounced the inheritance after the inheritance has begun, and therefore the inheritance is valid. When hearing such cases, attention should be paid to the time when the heirs renounce their inheritance rights, so as to accurately and efficiently resolve such inheritance disputes.

There into, The Civil Code also has provisions on the loss of inheritance rights. "Academics divide the loss of inheritance rights into two concepts: broad and narrow. Among them, the loss of inheritance rights in a broad sense includes the absence of heirs and the cancellation of heirs; the loss of inheritance in the narrow sense only includes the absence of heirs. According to the relevant provisions of China's Civil Code, the loss of inheritance rights in China refers to the absence of heirs.[1] Article 1125 specifies in detail the circumstances under which the right of inheritance is lost: (1) Intentional killing of the decedent; (2) Killing other heirs for the purpose of competing for an inheritance; (3) Abandoning the decedent or abusing the decedent; (4) Forging, forging, concealing, or destroying a will, where the circumstances are serious; (5) Where the circumstances are serious, fraud, coercion, or other means are used to compel or prevent the decedent from making a will, modifying or withdrawing the will.It can be seen from the laws and regulations that the legislator adopts the broad sense of loss of inheritance rights, because the legislator strictly restricts the acquisition of property in an attempt to harm the deceased and does not violate ethics and morals.These five acts seriously endangered the personal rights, health and other rights of the decedent, and violated the principle of public order and good customs. However, there are several views on the "intentional killing of the decedent" in the first paragraph of this Law: first, the heir kills the decedent due to intentional acts, which is equivalent to "self-harm", seriously undermines family harmony, has a negative impact on society, and should lose the

right of inheritance; Secondly, the defensive acts that lead to the death of the decedent need to be studied in light of the specific circumstances: (1) For the legitimate defensive acts that cause the death of the decedent and do not lose the inheritance rights, the defensive acts are not illegal and subjectively not intentional; (2) For the death of the decedent caused by excessive defense, a comprehensive analysis is required, and the judgment should be made based on the subjective aspects of the heir. Whether there is a deliberate mentality. However, paragraphs 2 and 3 of this Law also stipulate the circumstances of relative loss of inheritance right, that is, if the heir has committed the acts in items 3 to 5 of the preceding paragraph, he has indeed repented, and the decedent has expressed forgiveness or is listed as the heir in a later will, and the heir will not lose the right of inheritance. If the bequest commits the acts provided for in paragraph 1 of this article, he loses the right to receive the estate. There in to Zhang San deliberately killed his father in his eagerness to inherit his father's inheritance, but failed, and repented.Since Zhang San's act was to intentionally kill the decedent, which did not fall under items 3 to 5 of the first paragraph, Zhang San's inheritance rights were not restored.From this article, the legislator protects the legal interest of the right to life of the decedent.Violations of the right to life are never condoned, and this embodies the principle of protecting human rights. The right to life is an important human right and must not be infringed upon by any person or organization. It is generally believed that the rights and interests of the deceased and the loss of legal inheritance rights protected by legislators are in line with the spirit of legislation, the basic principles of civil law, and the core values of socialism with Chinese characteristics.However, in judicial practice, even if there is an absolute reason for the loss of inheritance rights, some heirs can obtain part of the property of the decedent through testamentary inheritance or statutory inheritance, but other heirs are not aware of it. In view of this phenomenon, from the perspective of legal publicity, publicity should be strengthened through community law popularization and network dissemination; from the perspective of inheritance relations, it is necessary to regulate and restrict the heirs who have lost their legal inheritance rights, so as to reduce legal disputes arising from inheritance. In judicial practice, in such cases, the inherited property shall be returned, and if it cannot be returned or its value is reduced, it may be auctioned and sold for another legal heir to inherit it in accordance with the order of succession. This practice not only conforms to the laws of our country, but also makes our laws better reflected in practice.

II. Research and interpretation of "legal inheritance" in the inheritance section

2.1 Overview of Statutory Succession

Statutory inheritance refers to a inheritance method that inherits the inheritance of the decedent in accordance with the scope of heirs, the order of inheritance, and the share of inheritance directly stipulated by law.

2.2 Interpretation of the order of succession in "Legal Succession"

Article 1126 of the Civil Code of China provides for equality of inheritance rights. The position of the legislator is very clear that legal succession is not based on gender, but on the basis of inheritance status. This negates the primogeniture inheritance system under China's ancient feudal system and conforms to the basic principles of legislation.

Articles 1127 and 1129 set out the order of legal succession. The first order is spouse, children, parents, widowed sons-in-law and daughters-in-law who fulfill their primary maintenance obligations.

Among them, the term "children" as used in this Law includes legitimate children, illegitimate children, adopted children and stepchildren. Among them, the widowed son-in-law and daughter-in-law who fulfill the main maintenance obligation are included in the first order of heirs, which is a continuation of the fine traditional culture of "filial piety" in China, which fully reflects the preservation of the essence of traditional Chinese culture in the inheritance editor, and organically integrates the excellent traditional concepts of ancient and modern times, with distinctive Chinese characteristics. In China's judicial practice, the widowed daughter-in-law Chen has been taking care of the elderly and seriously ill Ma, and her two children, and inherited a part of the inheritance after Ma's death. This case embodies the idea of "family-oriented" in China, the widowed daughter-in-law has always fulfilled her obligations and done her best, and the law protects the legitimate rights and interests of the widowed daughter-in-law who are conscientious and conscientious. In traditional China, families live together, respect the old and love the young, and the family is a safe haven for social security and a strong backing for preventing social risks.

2.2.1 Comparison of the legal order of inheritance at home and abroad

The legal order of succession in the United States is spouse and children first, parents and siblings second, and grandparents and other close relatives last. First, the U.S. legal system focuses on personal liberty and the protection of private property, and it is essentially spouses and children who live with the deceased. Therefore, in kinship, the spouse and children are the closest to the deceased and are therefore inherited by the spouse and children first. China attaches greater importance to public ownership and social welfare protection. In addition to spouses and children as first-order heirs, China also includes parents, widowed daughters-in-law, and sons-in-law, who fulfill the obligation to support first-order heirs. It is generally believed that "among them, the widowed daughter-in-law mainly supports her parents-in-law and son-in-law." It is also listed as a first-in-line heir. This shows that the legal status of all heirs is equal, and there is no situation where the deceased is biased. Therefore, all heirs, regardless of their relatives, have equal rights to inherit the estate and must not be ranked behind each other. These factors can all affect the legal arrangements and practices of inheritance. Second, there are differences in the priority of wills between China and the United States. In the United States, wills are the main basis for dealing with inheritance, while in China, laws and regulations clearly stipulate the scope, order of succession, and share of legal heirs. In some cases, a will may also need to meet the requirements of the law. Therefore, for the inheritance of family wealth, it is necessary to make reasonable planning on the premise of complying with the laws and regulations of different regions. Finally, the scope of heirs who do not have a will is also different between the two countries. In China, first-order heirs include spouses, children, and parents. Second-order heirs will involve siblings, grandparents, or maternal grandparents. However, in the absence of a will, the legal obligation to support relatives in the United States can participate in the inheritance. This needs to be analysed and dealt with on a case-by-case basis.

2.2.2 Provisions on legal inheritance of children, parents, and siblings in China

Paragraphs 2, 3 and 4 of Article 1127 of the Civil Code stipulate that children include legitimate children, adopted children and stepchildren; parents include biological parents, adoptive parents, and stepparents; siblings include siblings of the same father and half-siblings, brothers or half-brothers,

adopted siblings, and dependent stepsisters. As can be seen, the legislator has a very broad definition of the scope of heirs. As long as they are related to one of the immediate family members, they are entitled to inheritance. The internal logic is that the principle of civil law protection and the legitimate rights and interests of the parties, such as illegitimate children, stepchildren, and stepparents, cannot be presumed to have no obligation to support and no right of inheritance because the father or mother has an illegitimate child born of illegal cohabitation with another person or because the obligation to support the child is not clear in the divorce of the parties. The legitimate rights and interests of the child cannot be harmed by the fault of one of the parties. With regard to the relationship between the adoptive child and the adoptive parents, when applying for the registration of adoption, the establishment of an adoptive relationship and the establishment of a fictitious blood relationship have greatly ensured social stability and family harmony. The couple considered the adopted child to be their biological child, and the child also had the right to inheritance. To sum up, the interpretation of children, parents and siblings also confirms China's principle of actively protecting human rights and fairness, and it is also the application of China's excellent ethical and moral norms by legislators when legislating, reflecting the temperature of legislation.

2.2.3 Subrogation under Article 1128 of the Civil Code

" As an important supplement to China's legal inheritance system, the subrogation system reasonably distributes the inheritance of the deceased among the heirs' branches in the family in accordance with the usual handling of private property in ancient China, so as to realize the function of supporting the elderly and children, and realize the inheritance of social property within the family. " [4]Subrogation includes the following four meanings: (1) Subrogation can only occur in legal succession; (2)Subrogation occurs when the decedent's children or siblings die before the decedent; (3)Subrogated heir is a direct descendant of the decedent's children or the children of his or her siblings; (4)The share inherited by the subrogated heir is the share that the subrogated heir should inherit.

"Including brothers and sisters in the scope of subrogated persons can ensure the circulation of private property within the blood family, reduce the situation of no inheritance of inheritance, and at the same time promote the development of kinship relations, strengthen exchanges and communication between relatives, and guide people to attach importance to family affection, encourage relatives to support each other, support each other, support the elderly, and watch over together."[10]

There are two theories of subrogation: the doctrine of inherent rights holds that it is the inherent right of the subrogated heir to participate in the inheritance, and the subrogated heir inherits the inheritance of the deceased according to his own rights. The right of inheritance of the subrogated heir is not premised on the inheritance right of the subrogated heir, as long as the subrogated heir cannot inherit. Subrogation can be done by subrogation. The doctrine of representation holds that the inheritance inherited by the decedent is not based on its inherent rights, but participates in the inheritance on behalf of the subrogated heir, that is, the subrogated heir can only obtain the corresponding share of the subrogated heir if the subrogated heir enjoys the right of inheritance. When the heir to the throne loses the right of inheritance, he or she is subrogated.

Mrs. Chen had a son, Chen, and Chen had a son, Chen Xiao, who died before Mrs. Chen. In this case, combined with laws and regulations, China's legislation adopts the theory of representation, that is,

Chen Xiao inherited Mrs. Chen's estate based on Chen's inheritance rights. This greatly guarantees the reasonable distribution of the property of the decedent, and the view of the theory of representation is essentially that the direct descendants of the heir inherit the inheritance right of the heir, rather than directly inheriting the property of the decedent over the heir. The general view is that if the analysis is based on the theory of inherent rights, the grandson of the decedent inherits the property of the decedent over the heirs of the decedent. Combined with the above case analysis, that is, according to the analysis of the inherent power theory, Mrs. Chen's grandson Chen Xiao can inherit the inheritance as the heir. According to Article 1127 of the Inheritance Code, the (foreign) grandchildren are not included in the legal heirs, and if the inherent power theory is adopted, then the underlying logic of subrogation is contrary to the legal heirs stipulated in Article 1127. Therefore, the adoption of the doctrine of representation is a better option for legislators. In judicial practice, to determine whether a natural person has the right to inherit by subrogation, it is necessary to examine whether the subrogated heir has lost the right of inheritance to the heir. Only then can we improve the efficiency of adjudication and jointly promote the progress of the rule of law in society.

2.3 Interpretation of inheritance distribution rules

Articles 1130 and 1131 of the Civil Code of China provide for the rules for the distribution of estates. Circumstances of multiple divisions of inheritance: China's civil law stipulates that two categories of persons may be appropriately divided into multiple divisions. First, those with insufficient working capacity embody China's principle of protecting vulnerable groups, protecting basic human rights and improving citizens' happiness. Second, they can fulfill the main maintenance obligations of the decedent or jointly bear them with the decedent. The living conditions reflect the principle of consistency of rights and obligations in China. There are many aspects of the inheritance as a reward for caring for the deceased. The discretion of the estate is based on the fact of maintenance and gives legal subjects other than the actual heirs the right to claim an appropriate share of the estate. Article 14 of the Inheritance Law divides the subjects of rights into two categories, namely, those who are unable to work and have no source of livelihood and those who rely on the dependents of the deceased to support them. The discretionary division of the estate will include non-heirs who have a dependency relationship with the decedent within the scope of the distribution of the estate, with priority over statutory inheritance. This is undoubtedly a major breakthrough in the inheritance method of blood relations and the internal circulation of family property between in-laws, making the inheritance methods more diversified and embodying the principle of consistency of rights and obligations. Effectively combine social and personal interests. The existence of this right is based on the idea of posthumous maintenance, the theory of the presumption of the will of the deceased, "the legislative orientation of the protection and encouragement of the weak, and compensation for the act of maintenance, which is of great significance for solving the problems of the protection of rights and interests arising from the new family structure and family form." The relevant provisions in the current Succession Title also draw on the relevant provisions of the Inheritance Law, and are reservations for the beneficiary part.

"Article 14 of the Inheritance Law of the People's Republic of China promulgated in 1985 formally stipulates the discretionary system of inheritance in the form of law, and the subsequent Opinions on the Implementation of the Inheritance Law also make some provisions on the application of this article.

The system is based on the theory of posthumous maintenance and reward for maintenance behavior, which guarantees the right of heirs other than heirs who meet certain conditions to receive the inheritance based on the relationship of support or maintenance, and expands the scope of beneficiaries of the estate. The Civil Code amends the provisions of the system of discretionary power of inheritance, abolishes the strict conditions of "no ability to work and no source of livelihood" required by those who rely on the support of the deceased, and expands the scope of "persons who rely on the support of the deceased", giving full play to the role of the inheritance." [2]

III. Research and interpretation of "testamentary succession" in the "Inheritance Edition"

3.1 General provisions on testamentary succession

Article 1133 of the Civil Code of the People's Republic of China stipulates that a natural person may make a will to dispose of his personal property in accordance with the provisions of this Law, and may appoint an executor. A natural person may make a will designating his or her personal property to be inherited by one or more legal heirs. A natural person may make a will to donate his or her personal property to organizations and individuals other than the state, collectives, or legal heirs. A natural person may establish a testamentary trust in accordance with the law.

Through this law, it can be seen that China's testamentary bequest system fully gives every natural person who makes a will full rights. The disposition of property is not limited to family members, but also extends to those who can share the property. It is a high degree of expression of the principle of autonomy. The legitimate rights and interests of the decedent are fully protected so that they can follow the wishes of the decedent. This also reflects that the Civil Code is a private law that protects the legitimate rights and interests of citizens, that is, "it can be prohibited by law".

3.2 Form and validity of the Will

Articles 1134 to 1139 of the Civil Code stipulate several forms of wills, namely, self-written wills, written wills, printed wills, audio and video wills, oral wills and notarized wills.

There are not many countries in the world that adopt the form of audio and video wills. In addition to China, South Korea also uses audio and video wills as a form of will (Article 1067 of the Civil Code of Korea).

3.2.1 Determination of the validity of the will

By reading the law, it can be concluded that all wills except self-written wills need to be witnessed by witnesses, and their fundamental purpose is to ensure the authenticity, reliability and fairness of the will. The use of legal means to prevent the decedent from handling the estate protects the common interests of the heir and the decedent. In judicial practice, the decedent can make several wills, which are all legal and valid. At this point, there is the question of determining the validity of the will. Paragraph 3 of Article 1142 of the Civil Code of the People's Republic of China stipulates that if there are several wills that conflict with the contents, the final will shall prevail. However, this does not mean that only the final will is valid and the others are invalid, but there are several wills that are legally valid except for oral wills.

3.2.2.1 The difference between the validity of oral wills and other wills

Article 1138 of the Civil Code of China stipulates that the testator may make an oral will in a crisis situation. An oral will should be witnessed by two or more witnesses. After the critical situation is

eliminated, if the testator can make a will in writing or in the form of an audio or video recording, the oral will is invalid. As can be seen from this law, the conditions for the validity of an oral will are more stringent, and can only be established when the condition is critical, because the situation is urgent. It is generally accepted that an oral will is an emergency measure to dispose of property in an emergency. When it encounters a critical situation, a will should be made in other ways to ensure the fairness of the will. Reliable and reasonable. When the decedent's oral will is no longer valid after the crisis situation is eliminated, the decedent can continue to use the previous valid will, or choose to create a new will. This is a voluntary principle given by law to the decedent.

3.2.2.2 Issues that need to be paid attention to in judicial practice of oral wills

In judicial practice, it is easy to confuse an oral will with an oral distribution agreement, for example, when the decedent gathers the heirs together to distribute his estate in an emergency. In addition, if the decedent is in an emergency, inform the two nurses of the distribution of their estate. How can we distinguish between an oral distribution agreement and an oral will? In both cases, the condition of "in case of emergency" is satisfied, and the variable is the "class of persons" to whom the decedent is informed of the distribution of the estate. It can be seen that the two nurses were informed of the oral will. Although they are all unilateral expressions of intent of the decedent, their legal nature is different. In practice, the heirs or witnesses of the will should explain in detail to the court to avoid the parties falling into difficulties in adducing evidence due to misunderstanding of the oral will and the oral distribution agreement.

3.2.3 Conditions for witnesses to a will

The testamentary witness is a necessary condition to ensure the authenticity and fairness of the will, and there are strict requirements for the will. Article 1140 of the Civil Code stipulates the negative conditions for witnesses to make a will: (1) Persons with no capacity for civil conduct, persons with limited capacity for civil conduct and other persons with incapacity; (2) Heirs and legatees; (3) Persons who have an interest in the heirs or legatees.

3.3 Wills are invalid

Article 1143 of the Civil Code of the People's Republic of China stipulates that a will made by a person who lacks or has limited capacity for civil conduct is invalid. The will must express the true intention of the testator, and the will made by fraud or coercion is invalid. A forged will is invalid, and if the will is tampered with, the tampered content is invalid. It can be seen from this law that after the will is invalid, the property involved in the will should be inherited in the order of legal succession. Before his death, a man appointed two lawyers to write a will on his behalf, and the lawyer wrote the will according to the man's will, but there was no audio or video recording throughout the whole process, and the witness had no evidence to prove that the will was the man's true expression of his will, so the will was invalid. Testamentary succession, as an important form of inheritance, reflects the testator's freedom of will. Whether a will is valid or not, the most important thing to respect is the true will of the testator, so as to avoid the invalidity of the will due to defects in the testator's witnesses. [6]

Conclusion

Throughout the text, an important constituent element of statutory inheritance and testamentary succession is whether the parent-child relationship is established, which affects the accuracy of

judgments in such cases in judicial practice. The presumption of paternity is also an important factor in judging inheritance. Article 1073 of the Civil Code stipulates the relevant content of the confirmation of paternity。"Parents or adult children have the right to request the confirmation of parentage, and parents also have the right to request the denial of parentage. From this, two points are evident: first, parentage determination involves the plaintiff initiating a lawsuit to seek a judicial alteration of parent-child identity, with a strict approach taken towards the filing of such suits to prevent undue interference by public authority into private civil rights; second, in China, the eligible plaintiffs for parentage determination are explicitly enumerated, and only those who qualify have the right to request the court's confirmation or denial of the presumption of parentage."[7]This does not violate the principle of equality between civil subjects, and it is an important means to maintain family harmony and maintain a balance in the relationship between parents and children. Both parties can file a lawsuit for the confirmation of paternity, which can reduce the fragmentation of the family in society and thus maintain social stability. and the principle of protecting the right to inherit private property in the event of inheritance between parents and children.

Before the promulgation of the Civil Code, China used the Inheritance Law to regulate people's inheritance relationships. Compared with the Inheritance Law, the Succession Section of the Civil Code has certain changes in some contents: (1) The scope of heirs has been expanded. With the implementation of the Civil Code, nephews, nieces, nephews and nieces can also inherit the property of the decedent in accordance with the law, more effectively avoid the outward flow of private property, expand the scope of inheritance, effectively protect the relationship between relatives, and promote family harmony. (2) The Civil Code adds printed wills and audio and video wills. Printing a will is easy to preserve, not easy to be damaged or lost, and the establishment of a will by way of audio and video recording provides a new way to set up a will for the decedent who is unable to write. Both printed wills and audio and video wills can protect the decedent's willingness to dispose of personal property, and fully reflect the principle of autonomy of will under civil law. (3) The Civil Code newly stipulates the testamentary forgiveness system, and the inheritance rights lost by a momentary mistake can also be won back through reform. The main reason for the relative loss of inheritance rights stipulated in the Civil Code is that the relative cause of loss is not an act that seriously endangers the decedent compared with the absolute cause of loss. At the same time, it is also necessary to fully reflect the excellent traditional Chinese culture, and the addition of the testamentary forgiveness system to the Civil Code is an extension and protection of the fine traditional virtues. [8]The above content is the research and interpretation of legal inheritance and testamentary succession in the inheritance of the Civil Code. This paper analyzes the general provisions, statutory succession and testamentary succession in the Inheritance Compilation, understands the deep connotation of legislator's legislation from various aspects, and at the same time uses cases to explain the law, applies laws and regulations to practice, and achieves the combination of theory and practice.。

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