Empirical Analysis of Business Intelligence Empowering the Improvement of Benefits in Cross-border E-commerce Enterprises

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Abstract: With the rapid development of the Internet industry, the global e-commerce market is growing exponentially. Cross-border e-commerce enterprises, driven by the demand reflected by data mining and rapid market, are accelerating their transformation towards digitalization and intelligence [1]. The application of business intelligence technology is beneficial for transforming data into information and assisting the decision-making of enterprise management. This paper investigates and evaluates the influence degree, application functions, and benefits of business intelligence application of cross-border e-commerce enterprises in the Guangdong-Hong Kong-Macau Greater Bay Area by adopting the questionnaire "Survey on Business Intelligence Application Status of Cross-border E-commerce Enterprises". Through the construction of research models, the influence of the competitive intensity in the industry and the technological resources owned by enterprises on the business intelligence application is empirically analyzed. Furthermore, this paper examines whether the application of business intelligence significantly influences the benefit improvement of cross-border e-commerce enterprises.

Keywords: business intelligence, cross-border e-commerce enterprises, benefit improvement

1 Introduction

With the development of society and the continuous penetration of information technology into business activities, business intelligence technology has become an indispensable means of competition for modern enterprises [2]. This paper evaluates the application level of business intelligence in cross-border e-commerce enterprises. This study will provide specific data to demonstrate that the business performance of cross-border e-commerce enterprises has been improved after applying business intelligence technology. In this survey, 360 questionnaires were distributed and 358 valid responses were collected. The questionnaires mainly came from cross-border e-commerce enterprises in Shenzhen, Guangzhou, and Dongguan, and the main survey respondents were various levels of staff, including the chairman, general managers, department managers, foreign trade salesman, buyers, engineering and technical personnel, and other employees.

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2 The Proposal of Business Intelligence

The concept of business intelligence was first proposed by the Gartner Group in 1996, whose main core technologies include data warehouse technology, online analytical processing technology, and data mining technology. It is generally understood as a technology and application that transforms existing data within an enterprise into knowledge and assists the leadership in making management decisions.

3 Data Processing and Statistical Processing

Descriptive analysis is conducted on the application evaluation of business intelligence in cross-border e-commerce enterprises, with consideration given to respondents' application of business intelligence in these enterprises, as well as evaluations from domain experts.

The collected data will undergo reliability analysis and validity analysis to ensure the reliability and accuracy of quantitative data, especially the responses to attitude scale questions. Descriptive analysis, correlation analysis, regression analysis, and other models will also be used to analyze the influence degree of applying business intelligence technology and whether the application functions significantly affect the level of business intelligence application in cross-border e-commerce enterprises.

For cross-border e-commerce enterprises, the level of benefits derived from applying business intelligence is analyzed by using data modeling to evaluate the correlation between the influence degree and the benefit level.

To calculate the data quickly and reliably, statistical software such as Microsoft Excel and SPSS are used for statistical analysis.

4 Research Results and Analysis

4.1 Research Approach

To achieve the above objectives, the research team, based on the concentrated study of relevant theoretical knowledge, has determined the basic approach of the research. Firstly, they conduct surveys on cross-border e-commerce enterprises in the Guangdong-Hong Kong-Macao Greater Bay Area to understand the influence of business intelligence applications. Secondly, a questionnaire survey is conducted to understand the changes in the application capabilities and benefit levels of cross-border e-commerce enterprises in the Greater Bay Area after the application of business intelligence, providing valuable references for further decision-making on the implementation of information construction.

4.2 Research Design

Based on the basic approach of this study, the research team compiled the questionnaire "Survey on Business Intelligence Application Status of Cross-border E-commerce Enterprises", which mainly covers four aspects: firstly, it describes the influence degree of the application of business intelligence technology in cross-border e-commerce enterprises, mainly including the

level of competition in the industry and the technological resources of the enterprises; secondly, it describes the application functions of business intelligence levels, mainly including the perceptual capability, capture capability, absorption capability, and transformation capability of the enterprises [3]; thirdly, it describes the challenges encountered in the industry application of business intelligence technology [4]; finally, it describes the benefit level of business intelligence applications. After repeated discussions, verification, and revisions, the survey was conducted through various forms such as online platforms, WeChat, and field visits.

5 Correlation Analysis

5.1 Descriptive Analysis

5.1.1 Demographic Descriptive Analysis.

In this survey, a total of 358 questionnaires were collected. Among them, male respondents accounted for 53.6%, while female respondents accounted for 46.4%. The male-to-female ratio is close to 1:1, which helps reduce the interference of sample gender differences on the survey results to some extent. Regarding the analysis of respondents' positions, 203 individuals were enterprise employees, accounting for 56.7%, and 67 individuals were engineering and technical personnel, accounting for 18.7%. The proportions of other personnel are relatively small, indicating that the survey group is mainly enterprise employees and engineering and technical personnel. Regarding the urban distribution, 19.8% of respondents were from Dongguan, 19.8% from Guangzhou, 11.7% from Foshan, 21.2% from Shenzhen, and 10.6% from Zhongshan. The remaining respondents were from Zhuhai, Zhaoqing, and Huizhou, accounting for a small proportion, See Table 1.

Table 1. Data statistics collected by questionnaires.

Variables	Options	Frequency	Percentage
Gender	Male	192	0.536
	Female	166	0.464
Enterprise positions	Chairman of the board	5	0.014
	General manager	7	0.02
	Department manager	10	0.028
	Foreign trade salesman	23	0.064
	Engineering and technical personnel	67	0.187
	Buyer	43	0.12
	Employee	203	0.567
City	Guangdong, Dongguan	71	0.198
	Guangdong, Foshan	42	0.117
	Guangdong, Guangzhou	71	0.198
	Guangdong, Huizhou	1	0.003
	Guangdong, Jiangmen	21	0.059
	Guangdong, Shenzhen	76	0.212
	Guangdong, Zhaoqing	19	0.053

	Guangdong, Zhongshan	38	0.106
	Guangdong, Zhuhai	19	0.053
Whether to conduct cross-border e-commerce business	Yes	358	1
Whether to apply business intelligence technology	Yes	358	1

5.2 Reliability and Validity Analysis

5.2.1 Reliability Analysis.

The main factors in this study are measured in the form of scales, so examining the data quality of the measurement results is an important prerequisite to ensure the significance of subsequent analyses. Firstly, the internal consistency of each dimension is tested and analyzed through Cronbach's Alpha coefficient reliability test method. Generally, Cronbach's Alpha coefficient values range from 0 to 1, and the higher the coefficient value in the test results is, the higher the reliability is. It is generally believed that if the reliability coefficient is below 0.6, the reliability is considered unreliable, so it is necessary to redesign the questionnaire or attempt to collect data again and reanalyze it. Reliability coefficients between 0.6 and 0.7 are reliable, 0.7~0.8 are relatively reliable, 0.8 ~ 0.9 are highly reliable, and 0.9 ~ 1 are extremely reliable.

In this analysis, the results of the reliability analysis are shown in Table 2. The reliability coefficients of enterprise technological resources, competitive intensity, perceptual capability, capture capability, and absorptive capability are all within 0.8 ~ 1, while the reliability coefficients for transformation capability and information management are 0.766 and 0.748, respectively, falling into the range of relatively reliable, indicating that the scales used in this study possess good internal consistency and reliability.

Table 2. Reliability analysis of each dimension scale.

Variables	Cronbach's Alpha coefficient	Number of items
Technological resources	0.811	6
Competitive intensity	0.836	4
Perceptual capability	0.886	8
Capture capability	0.946	12
Absorptive capability	0.907	9
Transformation capability	0.766	4
Enterprise benefit	0.897	10
Internal and external support	0.858	6
Information management	0.748	3
Plan control	0.891	6
System function	0.835	6

5.2.2 Validity Analysis.

The validity analysis requires examining the KMO coefficient and the significance of Bartlett's test of sphericity. The KMO coefficient ranges from 0 to 1, with values closer to 1 indicating better structural validity of the questionnaire. If the significance of Bartlett's test of sphericity is less than 0.05, it can also be considered that the questionnaire has good structural validity. The data in Table 3 shows that the KMO coefficient is 0.953, and the significance of Bartlett's test of sphericity is 0.000, indicating the good structural validity of this questionnaire.

Table 3. KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.933
Bartlett's Test of Sphericity	Approximate Chi-Square	15595.503
	df.	2701
	Sig.	0.000

6 Model Construction

6.1 Model Setting

To analyze the influence degree of enterprise competitive intensity and technological resources on the application of intelligent technology by cross-border e-commerce enterprises, this paper constructs the following models for analysis:

$$\ln zz = \alpha_0 + \alpha_1 \ln x + \varepsilon$$

To analyze the influencing factors of enterprise benefits in cross-border e-commerce transactions, this paper sets the following linear model for analysis:

$$\ln y = \alpha_0 + \alpha_1 \ln q + \alpha_2 \ln j + \alpha_3 \ln g + \alpha_4 \ln b + \alpha_5 \ln x + \alpha_6 \ln z + \varepsilon$$

where zz is business intelligence technology; x is enterprise competitive intensity or enterprise technological resources; y is the explained variable of enterprise benefits in this paper; q is enterprise technological resources; j to z represent control variables, including enterprise technological resources (q), enterprise competitive intensity (j), enterprise perceptual capability (g), enterprise capture capability (b), enterprise absorption capability (x), and transformation capability (z); ε represents the stochastic error term. To reduce multicollinearity problems, all variables in this paper are logarithmic.

6.2 Variable Descriptive Statistics

Table 4 presents a descriptive statistical table of all variables used in this paper, including the mean and standard deviation of the seven variables.

Table 4. Descriptive statistics of variables.

Variables	N	mean	sd	min	max
lny	358	1.364	0.196	0.262	1.609
lnj	358	1.378	0.179	0.773	1.609
lnq	358	1.326	0.271	0	1.609
lng	358	1.371	0.212	0.318	1.609
lnb	358	1.331	0.256	0.0800	1.609
lnx	358	1.316	0.246	0.105	1.609
lnz	358	1.322	0.237	0	1.609

6.3 Data Declaration

To analyze the influencing factors of the benefits of cross-border e-commerce enterprises, this paper assigns values to the collected questionnaires, where higher agreement receives higher values. Then, the mean is calculated to determine the average score for each influencing factor. The data used in this paper are all derived from questionnaires, providing a certain level of authenticity and reliability.

7 Empirical Analysis

7.1 Baseline Regression

Before conducting the baseline regression, it is necessary to carry out multicollinearity tests on variables such as enterprise technological resources and competitive intensity. Generally, the value of VIF being less than 10 indicates that there is no collinearity among the variables. Table 5 provides the results of the VIF test, showing that all variables have values less than 2, with a mean of 1.10, which is far below the critical value. Therefore, it can be considered that there is no collinearity among the related variables such as enterprise technological resources and competitive intensity, and the baseline regression can be conducted.

Table 5. VIF test.

Variables	VIF	1/VIF
lnq	1.08	0.922
lnj	1.08	0.93
lng	1.14	0.88
lnb	1.11	0.90
lnx	1.07	0.93
lnz	1.09	0.91
Average	1.10	

Table 6 reports the regression results of the factors influencing business intelligence technology. Both competitive intensity and technological resources are positive and have passed the significance test at the 1% level, indicating that the higher the levels of enterprise competitive

intensity and technological resources are, the more likely the enterprise is to use business technology.

Table 6. Regression of factors influencing business intelligence technology.

Variables	lnzz	lnzz
lnj	0.181***	
	(4.75)	
lnq		0.106***
		(4.22)
Constant	1.103***	1.211***
	(20.87)	(35.46)
Observations	358	358
R-squared	0.060	0.048
adj_R2	0.0569	0.0449
F	22.53	17.77

This study employs OLS regression, and the results of the baseline regression are reported in Table 7. It can be observed that the core explanatory variables in this study are positive and pass the significance test at the 10% level, which indicates that for every one percentage point change in enterprise technological resources, there is an average change of 0.062% in enterprise benefits. Thus, the improvement of enterprise technological resources contributes to improving the benefits obtained by enterprises in cross-border e-commerce transactions. The coefficients of enterprise competitive intensity (lnj), perceptual capability (lng), capture capability (lnb), absorption capability (lnx), and transformation capability (lnz) are all positive. Except for the low significance of competitive intensity, the coefficients of other variables pass the 1% significance level test, indicating that when the perceptual capability, capture capability, absorption capability, and transformation capability of cross-border e-commerce enterprises are improved, their empirical benefits will also be increased, aligning with expectations.

Table 7. Baseline regression.

Variables	lny
lnq	0.062*
	(1.82)
lnj	0.099*
	(1.94)
lng	0.176***
	(3.97)
lnb	0.168***
	(4.65)
lnx	0.163***
	(4.42)
lnz	0.141***
	(3.63)
Constant	0.280***
	(2.88)
Observations	358
R-squared	0.296
adj_R2	0.284
F	24.59

Note: Standard error in brackets; *** means p<0.01, ** means p<0.05, * means p<0.1, the same below.

7.2 Heteroscedasticity Test and Correction

The cross-sectional data used in this paper for regression analysis may suffer from heteroscedasticity. To examine the existence of heteroscedasticity, White's test and BP test are employed. The results are shown in Table 8, with both tests yielding p-values of 0.000, which are less than the 10% significance level. Thus, the null hypothesis of no heteroscedasticity is rejected, indicating the existence of heteroscedasticity in the data, which may lead to biased regression coefficients.

Table 8. Heteroscedasticity test.

Tests	Chi2	P-value
White test	121.4	0.000
BP test	51.07	0.000

To correct the heteroscedasticity present in the data, the weighted least squares (WLS) method is employed for heteroscedasticity correction. Specifically, regression and computation of residuals e1 are conducted, then the squares of e1 are taken to obtain e, followed by auxiliary regression. The results are shown in Table 9. It can be observed that after using the WLS method, the core explanatory variable of this study has been significantly improved from 0.062 to 0.177, and the significance level has changed from 10% to 1%, indicating statistical significance.

Table 9. WLS regression.

Variables	lny
lnq	0.177***
	(2.91)
lnj	0.151***
	(3.06)
lng	0.198***
	(4.39)
lnb	0.147***
	(3.92)
lnx	0.091**
	(2.48)
lnz	0.103**
	(2.55)
Constant	0.192
	(1.56)
Observations	358
R-squared	0.249
adj_R2	0.236
F	19.43

8 Conclusion

For cross-border e-commerce enterprises, whether to apply business intelligence technology should be considered in their competitive environment before application. For instance, the more intense the industry competition is, the greater the demand for enterprises to apply business

intelligence. Additionally, when enterprises consider applying business intelligence, they should focus on their technological resource capabilities. The more sufficient the technological resources an enterprise possesses, the easier it is for them to apply business intelligence [5].

After descriptive analysis and data modeling validation, it is indicated that the higher the competitive intensity and the level of technological resources are, the more enterprises tend to use business intelligence technology. Simultaneously, the improvement of both factors contributes to promoting the benefits obtained by enterprises in cross-border e-commerce transactions.

The conclusion drawn by the researchers is that the application of business intelligence technology is beneficial for improving the profitability of enterprises and strengthening their competitive advantage over competitors.

9 Strategies for Applying Business Intelligence to Improve the Benefits of Cross-Border E-Commerce Enterprises

According to the research findings, the researchers propose the following suggestions:

9.1 Involvement of Enterprise Leadership, Establishment of Information Management Departments

Cross-border e-commerce enterprises can establish corresponding information departments based on their scale, where the employees need to understand both foreign trade business knowledge and business intelligence technology. They are responsible for the daily maintenance and management of the business intelligence system to ensure its stable operation. The head of the information department participates in senior-level decision-making and assists leaders in planning the construction of enterprise business intelligence from the perspective of overall enterprise development by understanding the operating principles and objectives of enterprises.

9.2 Reasonable Planning for Enterprises and Selection of Business Strategies Based on Practical Situations

Cross-border e-commerce enterprises should adopt market operation penetration strategies based on specific business themes and manage department-level data marts comprising data warehouses separately. Alternatively, through the successful implementation of business intelligence applications in a single domain, they can deepen the understanding of business intelligence.

9.3 Strengthening the Construction of Information Security Laws and Regulations to Safeguard System Security

When cross-border e-commerce enterprises apply business intelligence systems, information security becomes the greatest concern. Among them, the sharing of information may lead to the theft of enterprise achievements and trigger security crises. To facilitate the fast and efficient development of business intelligence in cross-border e-commerce enterprises, it is imperative to construct relevant laws and regulations [6]. It is far from sufficient for enterprises to attach importance to information security, and it is necessary to rely on the relevant laws and

regulations promulgated by the government.

9.4 Strengthening the Talent Cultivation in the Application of Business Intelligence Technology

The successful cultivation of talents in the application of business intelligence technology is one of the important indicators of the success of an enterprise's business intelligence. Enterprises can either recruit specialized talents to drive the development of business intelligence technology or actively cultivate talents specialized in cross-border e-commerce business intelligence through university-enterprise cooperation, to meet the practical needs of the development of business intelligence in cross-border e-commerce within the Greater Bay Area.

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