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The Main Affecting Factors of the B2B E-Commerce Supply Chain Integration and Performance

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Abstract

This paper is an attempt to investigate the main factors affecting the integration and performance of the B2B e-commerce supply chain, specifically the situations in a global manufacturing country-China. Fifteen B2B e-commerce companies take part in this research. Fisher's exact test is employed to identify the main affecting factors in terms of improving the integration and performance of the supply chain under the B2B e-commerce environment. The results demonstrate that business process redesign, process change, IT investment and unique knowledge are the main factors which have significant influence on the B2B e-commerce supply chain integration and performance. The managerial implications and suggestions for future research are also discussed in the last section.

Keywords: *B2B e-commerce, Supply chain integration, Fisher's exact test*

1. Introduction

The Information and Communication Technology (ICT) revolution and the introduction of e-commerce bring the companies in front of an excellent opportunity to facilitate and improve their business processes. Currently there are over 1000 established Business-to-Business (B2B) e-markets catering to a wide spectrum of industries such as agriculture, apparel, automotive parts, energy and chemicals, logistics, office supply and services. B2B e-markets are essentially aimed at significantly lowering transaction costs for both buyers and sellers.

There are many researches focused on the supply chain integration and performance. Lee *et al.*, (2007) explore the relationship between supply chain linkages and supply chain performance so that the management will be able to pursue better supply chain strategies applicable directly to their business environment. Power *et al.*, (2001) analyze results from a survey of 962 Australian manufacturing companies in order to identify some of the factors critical for successful agile organizations in managing their supply chains. Sezen (2008) investigates the relative effects of supply chain integration, supply chain information sharing and supply chain design on supply chain performance. Prajogo and Olhager (2012) investigate the integrations of both information and material flows between supply chain partners and their effect on operational performance. Specifically, examine the role of long-term supplier relationship as the driver of the integration. Considering the differences between the physical and e-commerce transactions, it is essential to study the main factors affecting the e-commerce supply chain integration and performance. However, there are not many researches focused on the e-commerce supply chain, which is the primary motivation of this research.

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The paper is organized as follows. The next section introduces the related literature about e-commerce and supply chain integration. Following is a brief introduction about the Fisher's exact test method used in this research. Section 4 describes an empirical analysis investigating the main factors which have high influence on customer satisfaction in B2B e-commerce supply chain integration and performance. The primary data for this research are collected through a questionnaire designed for this research. Finally, major issues and challenges in terms of promoting B2B e-commerce supply chain integration and performance are identified and discussed along with the related managerial implications.

2. Literature Review

E-commerce can be described as "any form of business transaction in which the parties interact electronically rather than by physical exchanges or direct physical contact" (Ecom, 1998). Cullen and Taylor (2009) argue that system quality, information quality, management and use, worldwide web and trust are perceived by users to influence successful e-commerce use. Banerjee and Ma (2012) study the B2B e-markets framework of four small firms and argue that changes in organizational characteristic, environmental characteristics, and perceptions of e-business over time influence movement along the routinization trajectory. Pedro and Aleda (2012) develop a new construct of B2B e-service capability, a term that captures a generic set which include five interrelated and complementary dimensions: e-service recovery, e-customization, ease of navigation, service portfolio comprehensiveness, and information richness. The results of the research show that service orientation and customer receptivity to technology are two factors influence B2B e-service capability. Tian *et al.*, (2013) also investigate the B2B e-commerce market structure and evolution mechanism of B2B e-commerce network based on a proposed network with several layers. Chen *et al.*, (2013) argue that process and collaboration quality have significant effects on usefulness and satisfaction, reinforcing the objective of using B2B e-commerce systems across supply chain members. The summary of the factors may have influence on the e-commerce supply chain integration and performance is shown in Table 1:

Table 1. The Factors may Affect the e-commerce Supply Chain Integration and Performance

Contingency variable and article	Findings
Organic organizational structure (e.g., decentralization, team utilization) (Brynjolfsson et. al., 2002)	The more advanced organic structure, the better the relationship between computer investment and company market valuation.
Strategic alignment (Byrd et al., 2006)	The better alignment for the process and outcome dimensions of strategic, the stronger the relationship between IT investment and firm performance.
Business process redesign (Devraj and Kohli, 2000)	The higher the business process redesign, the stronger the relationship of IT capital investment with profitability.
Staff size (Francalanci & Galal, 1998)	The more efficiency intercourse between in clerical and professional workers, the stronger the relationship between IT investments and productivity improvements.
Process change (Grover et al., 1998)	The bigger the perceived process change, the less support strength for IT diffusion with perceived productivity gains

Categorized with information intensity (Lee and Kim, 2006)	High information-intensive industry attract more attention of IT investment on firm performance than in low-information intensive industry.
Interdependent information needs with suppliers (Premkumar et al., 2005)	Companies with interdependent information needs with suppliers show poorer supplier behave if combined with high Internet supplier processing capabilities. Firms with low interdependent information needs exhibit better supplier performance when combined with high Internet supplier processing capabilities.
Unique knowledge (i.e., specific knowledge that a firm needs in order to exploit its IS for strategic flexibility) (Zhang, 2005)	The more the unique knowledge in the firm, the better the relationship of information systems support for product fiexibility with return on sales and for the sales growth.
IT intensity (e.g., the number of PCs) (Zhu, 2004)	The stronger the IT ability, the better the relationship of electronic commerce capability and performance (i.e., return on assets).
Firm size (Zhu et al., 2004)	In developed countries, size associates with e-business value (i.e., perceptions of whether e-commerce has improved productivity, increased sales), while in developing countries, the orderly social environment associates with e-business ability.

This paper is an attempt to test whether the factors mentioned in Table 1 are the main factors have significant influence on the B2B e-commerce supply chain integration and performance.

3. Methodology

Fisher's exact test was first proposed in 1992 (Fisher, 1922). It is a statistical significance test in the analysis of contingency tables, and is suitable for the analysis when some of the frequencies are low and use of the chi-squared test is ruled out (i.e. some expected values are 0 or less than twenty percents are less than 5). Fisher's exact test is one of a class of exact tests because the significance of the deviation from a null hypothesis can be calculated exactly, rather than relying on an approximation that becomes exact in the limit as the sample size grows to infinity, as with many statistical tests.

The following is an example to illustrate the theory of the fisher's exact test: a sample of teenagers might be divided into male and female on one hand, and those that are and are not currently dieting on the other. The hypothesis is that the proportion of dieting individuals is higher among the women than the men, and whether any difference of proportions is significant is tested, and the data is shown as follows:

Table 2. The 2*2 Contingency Table for the Sample

	Men	Women	*Row total*
Dieting	*1*	*9*	*10*
Non-dieting	*11*	*3*	*14*
Column total	*12*	*12*	*24*

These data would not be suitable for analysis by Pearson's chi-squared test, because the expected values in the table are all below 10, and in a 2 ***** 2 contingency table, the number of degrees of freedom is always 1.

Before we proceed with the Fisher's exact test, we first introduce some notation. We represent the cells by the letters a, b, c and d, call the totals across rows and columns marginal totals, and represent the grand total by n:

Table 3. The 2*2 Contingency Table for the Sample with the Representative Letters

	Men	Women	*Row total*
Dieting	*a*	*b*	*a+b*
Non-dieting	*c*	*d*	*c+d*
Column total	*a+c*	*b+d*	*a+b+c+d=n*

The probability of obtaining any such set of values was given by the hypergeometric distribution:

$$p = \frac{\binom{a+b}{a}\binom{c+d}{c}}{\binom{n}{a+c}} = \frac{(a+b)!(c+d)!(a+c)!(b+d)!}{a!b!c!d!n!}$$

Where $\binom{n}{k}$ is the binomial coefficient and the symbol ! indicates the factorial operator.

$$p = \frac{\binom{10}{1}\binom{14}{11}}{\binom{24}{12}} = \frac{10!14!12!12!}{1!9!11!3!24!} \approx 0.001346076$$

The formula above gives the exact hypergeometric probability of observing this particular arrangement of the data, assuming the given marginal totals, on the null hypothesis that men and women are equally likely to be dieters. To put it another way, if we assume that the probability that a man is a dieter is p, the probability that a woman is a dieter is p , and it is assumed that both men and women enter our sample independently of whether or not they are dieters, then this hypergeometric formula gives the conditional probability of observing the values a, b, c, d in the four cells, conditionally on the observed marginals. This remains true even if men enter our sample with different probabilities than women. The requirement is merely that the two classification characteristics: gender and dieter are not associated.

For example, suppose we knew probabilities P, Q, p, q with $P+Q=p+q=1$ such that (male dieter, male non-dieter, female dieter, female non-dieter) had respective probabilities (Pp, Pq, Qp, Qq) for each individual encountered under our sampling procedure. The next step is to calculate the exact probability of any arrangement of these teenagers into the four cells of the table, but Fisher's exact test showed that to generate a significance level, we need consider only the cases where the marginal totals are the same as in the observed table, and among those, only the cases where the arrangement is as extreme as the observed arrangement, or more so. In this example, there are 11 such cases. Of these only one is more extreme in the same direction as our data:

Table 4. The 2*2 Contingency Table for the Sample Considering the Marginal Totals

	Men	Women	*Row total*
Dieting	*0*	*10*	*10*
Non-dieting	*12*	*2*	*14*
Column total	*12*	*12*	*24*

So the probability is $p = \frac{\binom{10}{0}\binom{14}{12}}{\binom{24}{12}} \approx 0.000033652$

In order to calculate the significance of the observed data, *i.e.*, the total probability of observing data as extreme or more extreme if the null hypothesis is true, we have to calculate the values of p for both these tables, and add them together. This gives a one-tailed test, with p approximately 0.001346076 + 0.000033652 = 0.001379728. This value can be interpreted as the sum of evidence provided by the observed data for the null hypothesis (that there is no difference in the proportions of dieters between men and women). The smaller the value of p, the greater the evidence for rejecting the null hypothesis; so here the evidence is strong that men and women are not equally likely to be dieters.

For a two-tailed test we must also consider tables that are equally extreme, but in the opposite direction. An approach used by the Fisher' exact test is to compute the p-value by summing the probabilities for all tables with probabilities less than or equal to that of the observed table. In the example here, the 2-sided p-value is twice the 1-sided value—but in general these can differ substantially for tables with small counts, unlike the case with test statistics that have a symmetric sampling distribution.

4. Data Collection and Results Analysis

4.1. Questionnaire Design

B2B cross-firm process integration results in the development of higher-order capabilities, such as streamlined material, information and financial flows across the supply chain (Rai, *et al.*, 2006). Process integration and real-time information means that firms can reduce inventory and associated cost. Electronic links with trading partners can reduce labor cost and improve production and delivery schedule accuracy (Sanders and Premus, 2002), and affect the revenue or market performance (Bharadwaj, 2000). So the measures of B2B e-commerce supply chain integration and performance are identified as follows:

Table 5. The Measures of the B2B e-commerce Supply Chain Integration and Performance

Goal	Aspect	Criteria
B2B e-commerce supply chain integration and performance	C_1 Finance	Revenue Labor cost
	C_2 Market	Market share Customer satisfaction
	C_3 Operations	Delivery schedule accuracy Flexibility

The factors which may have high influence on the integration and performance of the B2B e-commerce supply chain are identified based on the related literature and summarized in Table 6:

Table 6. The Factors may have High Influence on the B2B e-commerce Supply Chain Integration and Performance

No.	Factors
A_1	Firm size
A_2	Organic organization structure
A_3	Strategic alignment
A_4	Business process redesign
A_5	Staff size
A_6	Process change
A_7	IT investment
A_8	Interdependent information needs with supplier
A_9	Unique knowledge
A_{10}	IT intensity

So the questionnaire is designed based on the factors in Table 5 and Table 6. In this survey, 50 questionnaires were sent out, 20 were returned and 15 were valid.

4.2. Internal Consistency Test

In statistics and research, internal consistency is typically a measure based on the correlations between different items on the same test (or the same subscale on a larger test). It measures whether several items that propose to measure the same general construct produce similar scores. Cronbach's α is used to measure the internal consistency of the data in this research. It was first named alpha by Lee Cronbach in 1951, and it is widely used in the social sciences, business, nursing and other disciplines.

Cronbach's α is defined as:

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum S_i^2}{S_T^2}\right)$$

Where K is the number of the components (K -items), S_T^2 is the variance of the observed total test scores, and S_i^2 is the variance of component i for the current samples.

The Cronbach's α is 0.6210 in this research which means that the internal consistency is acceptable.

4.3. Fisher's Exact test

Finance is taken for example to show the Fisher's exact test, and the hypotheses and the Fisher's exact test process related with finance are as follows:

Hypothesis-1(a): Firm size has a significant influence on finance performance

Hypothesis-1(b): Firm size has a lower influence on finance performance

Table 7. Finance* Firm Size Impact Analysis

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	4.562a	6	.601	.662		
Likelihood Ratio	5.876	6	.437	.700		
Fisher's Exact Test	5.026			.715		
Linear-by-Linear Association	2.913b	1	.088	.100	.070	.049
N of Valid Cases	15					

a. 12 cells (100.0%) have expected count less than 5. The minimum expected count is .13.

b. The standardized statistic is 1.707.

As shown in Table 7,the value of Fisher's Exact Test is 5.026,Exact Sig.(2-sided) is 0.715,which is greater than 0.05,therefore Hypothesis-1(a)is refused with significant level of 5%,which means that firm size has a lower influence on finance performance.

Hypothesis-2(a): Organic organization structure has a significant influence on finance performance

Hypothesis-2(b): Organic organization structure has a lower influence on finance performance

Table 8. Finance* Organic Organization Structure Impact Analysis

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	5.893a	4	.207	.193		
Likelihood Ratio	7.947	4	.094	.157		
Fisher's Exact Test	5.956			.163		
Linear-by-Linear Association	.554b	1	.457	.608	.323	.161
N of Valid Cases	15					

a. 9 cells (100.0%) have expected count less than 5. The minimum expected count is .40.

b. The standardized statistic is -.745.

As shown in Table 8,the value of Fisher's Exact Test is 5.956,Exact Sig.(2-sided) is 0.163,greater than 0.05,therefore Hypothesis-2(a)is refused with significant level of 5%,which means that organic organization structure has a lower influence on finance performance.

Hypothesis-3(a): Strategic alignment has a significant influence on finance performance

Hypothesis-3(b): Strategic alignment has a lower influence on finance performance

Table 9. Finance* Strategic Alignment Impact Analysis

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.614a	4	.072	.114		
Likelihood Ratio	6.365	4	.173	.169		
Fisher's Exact Test	5.616			.169		
Linear-by-Linear Association	3.961b	1	.047	.055	.048	.044
N of Valid Cases	15					

a. 8 cells (88.9%) have expected count less than 5. The minimum expected count is .13.

b. The standardized statistic is 1.990.

As shown in Table 9,the value of Fisher's Exact Test is 5.616,Exact Sig.(2-sided) is 0.169,greater than 0.05,therefore Hypothesis-3(a)is refused with significant level of 5%,which means that strategic alignment has a lower influence on finance performance.

Hypothesis-4(a): Business process redesign has a significant influence on finance performance

Hypothesis-4(b): Business process redesign has a lower influence on finance performance

Table 10. Finance* Business Process Redesign Impact Analysis

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.925a	4	.063	.062		
Likelihood Ratio	10.098	4	.039	.041		
Fisher's Exact Test	7.521			.041		
Linear-by-Linear Association	6.443b	1	.011	.010	.009	.009
N of Valid Cases	15					

a. 8 cells (88.9%) have expected count less than 5. The minimum expected count is .13.

As shown in Table 10,the value of Fisher's Exact Test is 7.521,Exact Sig.(2-sided) is 0.041,lower than 0.05,therefore Hypothesis-4(a)is accepted with significant level of 5%,which means that business process redesign has a significant influence on finance performance.

Hypothesis-5(a): Staff size has a significant influence on finance performance

Hypothesis-5(b): Staff size has a lower influence on finance performance

Table 11. Finance* Staff Size Impact Analysis

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	2.188a	4	.701	.920		
Likelihood Ratio	2.737	4	.603	.920		
Fisher's Exact Test	2.624			.920		
Linear-by-Linear Association	.042b	1	.838	1.000	.517	.189
N of Valid Cases	15					

a. 9 cells (100.0%) have expected count less than 5. The minimum expected count is .40.

b. The standardized statistic is .204.

As shown in Table 11,the value of Fisher's Exact Test is 2.624,Exact Sig.(2-sided) is 0.920,greater than 0.05,therefore Hypothesis-5(a)is rejected with significant level of 5%,which means that staff size has a lower influence on finance performance.

Hypothesis-6(a): Process change has a significant influence on finance performance

Hypothesis-6(b): Process change has a lower influence on finance performance

Table 12. Finance* Process Change Impact Analysis

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.517a	4	.074	.091		
Likelihood Ratio	7.235	4	.124	.124		
Fisher's Exact Test	5.900			.217		
Linear-by-Linear Association	4.411b	1	.036	.057	.036	.032
N of Valid Cases	15					

a. 9 cells (100.0%) have expected count less than 5. The minimum expected count is .13.

b. The standardized statistic is 2.100.

As shown in Table 12,the value of Fisher's Exact Test is 5.900,Exact Sig.(2-sided) is 0.217,greater than 0.05,therefore Hypothesis-6(a)is rejected with significant level of 5%,which means that process change has a lower influence on finance performance.

Hypothesis-7(a): IT investment has a significant influence on finance performance

Hypothesis-7(b): IT investment has a lower influence on finance performance

Table 13. Finance* IT investment impact analysis

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	11.375a	4	.023	.032		
Likelihood Ratio	9.328	4	.053	.043		
Fisher's Exact Test	7.639			.043		
Linear-by-Linear Association	5.847b	1	.016	.018	.015	.015
N of Valid Cases	15					

a. 8 cells (88.9%) have expected count less than 5. The minimum expected count is .13.

b. The standardized statistic is 2.418.

As shown in Table 13,the value of Fisher's Exact Test is 7.639,Exact Sig.(2-sided) is 0.043,lower than 0.05,therefore Hypothesis-7(a)is accepted with significant level of 5%,which means that IT investment has a significant influence on finance performance.

Hypothesis-8(a): Interdependent information needs with supplier has a significant influence on finance performance

Hypothesis-8(b): Interdependent information needs with supplier has a lower influence on finance performance

Table 14. Finance* Interdependent Information needs with Supplier Impact Analysis

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.964a	2	.031	.133		
Likelihood Ratio	4.575	2	.102	.133		
Fisher's Exact Test	4.234			.133		
Linear-by-Linear Association	3.375b	1	.066	.133	.133	.133
N of Valid Cases	15					

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .13.

b. The standardized statistic is 1.837.

As shown in Table 14,the value of Fisher's Exact Test is 4.234,Exact Sig.(2-sided) is 0.133,greater than 0.05,therefore Hypothesis-8(a)is rejected with significant level of 5%,which means that interdependent information needs with supplier has a lower influence on finance performance.

Hypothesis-9(a): Unique knowledge has a significant influence on finance performance

Hypothesis-9(b): Unique knowledge has a lower influence on finance performance

Table 15. Finance* Unique Knowledge Impact Analysis

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	9.612a	4	.047	.049		
Likelihood Ratio	9.052	4	.060	.086		
Fisher's Exact Test	6.710			.086		
Linear-by-Linear Association	4.541b	1	.033	.040	.032	.029
N of Valid Cases	15					

a. 8 cells (88.9%) have expected count less than 5. The minimum expected count is .27.

b. The standardized statistic is 2.131.

As shown in Table 15,the value of Fisher's Exact Test is 6.710,Exact Sig.(2-sided) is 0.086,greater than 0.05,therefore Hypothesis-9(a)is rejected with significant level of 5%,which means that Unique knowledge has a lower influence on finance performance.

Hypothesis-10(a): IT intensity has a significant influence on finance performance

Hypothesis-10(b): IT intensity has a lower influence on finance performance

Table 16. Finance* IT Intensity Impact Analysis

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	10.062a	6	.122	.120		
Likelihood Ratio	8.962	6	.176	.252		
Fisher's Exact Test	6.988			.275		
Linear-by-Linear Association	.738b	1	.390	.493	.277	.135
N of Valid Cases	15					

a. 12 cells (100.0%) have expected count less than 5. The minimum expected count is .13.

b. The standardized statistic is .859.

As shown in Table 16,the value of Fisher's Exact Test is 6.988,Exact Sig.(2-sided) is 0.275,greater than 0.05,therefore Hypothesis-10(a)is rejected with significant level of 5%,which means that unique knowledge has a lower influence on finance performance.

5. Conclusions and Suggestions for Future Research

This study is focused on identifying the main factors affecting the B2B e-commerce supply chain integration and performance. The objectives for this research are threefold: (1) to examine and evaluate the effectiveness of supply chain performance of the B2B e-commerce companies in China; (2) to investigate the main factors which have high influence on the integration and performance; and (3) to discuss and explore the potential managerial implications for future research.

The primary data for this research are collected through a questionnaire. Fisher's exact test is employed to identify the main factors of the B2B e-commerce supply chain integration and performance. According to the results of the analysis, the main factors affecting integration and performance of the B2B e-commerce supply chain are shown in Table 17:

Table 17. The Analysis Result of the Main Factors of the B2B e-commerce Supply Chain Integration and Performance

Goal	Aspect	Main factor	Exact Sig. (2-sided)
B2B e-commerce supply chain integration and performance	C_1 Finance	Business process redesign IT investment	0.041 0.043
	C_2 Market	Business process redesign Process change IT investment Unique knowledge	0.030 0.050 0.033 0.001
	C_3 Operations	Process change Unique knowledge	0.002 0.024

Based on the results of this research, our recommendations for improving the supply chain integration and performance of the B2B e-commerce companies are: (1) improving the IT investment because it has significant influence on the finance performance and market performance; (2) applying business process redesign and process change for the B2B e-commerce companies; (3) enriching the unique knowledge since it can improve the relationship of information system support for product flexibility with return on sales.

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