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Research Article

Empirical Study on the Influence between Logistics Information Capabilities and Supply Chain Performance

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Abstract: In this study, first, the relational model between logistics information capability, distribution capability, flexibility capability and the service quality, the response and the financial performance of supply chain is build. Then the model was examined by structure equation modeling. The result shows that logistics information capability does not have direct impact on the performance of supply chain, but have impact on the service quality of supply chain and financial performance through the influencing distribution capability and flexibility capability. Moreover, through influencing distribution capability, logistics information capability can have strong impact on the response of supply chain.

Keywords: Logistics capability, supply chain performance, structure equation modeling

INTRODUCTION

The theory based on resources indicate that logistics capability is a part of firm's resource, when the logistics capability become the firm's unique resource that cannot be duplicated, it will be an important resource for the firm to get sustainable competitive advantage (Oliver, 1997). Nowadays, the competition between firms are becoming the competition between supply chains, thus, analyze the impact of logistics capability on the performance of supply chain becomes much more important for firms to get sustainable competitive advantage which cannot be duplicated. Foreign scholars used different angels to study different factors of logistics capability. The biggest one is the interview of 111 firms made by North America, Europe and Pacific Basin which made by Michigan State University Global Logistics Research Team (1995). Finally, 17 kinds of general factors of logistics capability were chosen from 32 kinds of factors that may form logistics capability. These 17 kinds of factors were divided into four groups: capability of allocation, capability of integration, agile capability and measurable capability, while the logistics information capability which includes logistics information technology and information share is the key factor in the capability of integration (Michigan State University Global Logistics Research Team, 1995). The results shows that logistics information capability plays an important role in improving the performance of supply chain, the application of information technology can promote logistics integration and the success of supply chain, which can both improve the service level of customer response and reduce the cost. The sharing of logistics information between the supply chain's cooperative partners is the key for the coordination of supply chain and the success of supply chain's cooperation and all the global top firms own the excellent logistics information capability (Closs *et al*., 1997; Kuo-Chung and Peter, 2005; Fawcett *et al*., 1997). However, the studies on the impact way and method of logistics information capability on the performance of supply chain are relatively weak, the studies on logistics capability in our country are just beginning and the studies on the impact of logistics information capability on the performance of supply chain are much more less.

In this study, we mainly discussed the relationship between logistics information capability and the performance of supply chain. First, on the basis of the theory analysis, the hypothesis models among logistics information capability, distribution capability, flexibility capability and the performance of supply chain, such as the service quality of supply chain, the response and the financial performance is build. Then the models were examined by structure equation modeling. Finally, on the basis of the analysis of examination results, the impact way and method of logistics information capability on the performance of supply chain is discussed, in order to give some guidance for the development of logistics and supply chain theory and practice.

HYPOTHESIZING

The application of logistics information technology and the realization of the information sharing between supply chain's cooperators are important factors for the success of supply chain. Logistics information

capability can increase distribution capability and the flexibility of logistics information system. Because when the customer order arrives, the logistics information system can fix the closest distribution terminal from the customer very soon from many distribution terminals and satisfy the customer's need efficiently. At the same time, the realization of internal plan-making and the flexibility to respond to outside demand of logistics information system cannot leave the support of the exact, timely, comprehensive and effective information. The empirical study also shows that logistics information capability can have strongly impact on distribution capability and flexibility capability.

In addition, the past studies also indicate that the logistics information capability have positive impact on the performance of logistics and supply chain. Thus, this study proposes such following hypothesis:

H_{1a}: The logistics information capability has positive impact on distribution capability.
H_{1b}: The logistics information capability has positive impact on flexibility capability.
H_{1c}: The logistics information capability has positive impact on the service quality of supply chain.
H_{1d}: The logistics information capability has positive impact on the response of supply chain.
H_{1e}: The logistics information capability has positive impact on the financial performance of supply chain.

The distribution capability refers to the allocation and operation of organizations' network resources. When the coverage of the distribution network is wide and the logistics information system can fix the selectable distribution terminals effectively, the firm can meet customers' demand sustainably, such as delivery time and the quantity of products. From this, the firm can respond to customers' demand immediately and increase the response and service quality of the supply chain. Moreover, there are some empirical studies studied the impact of the logistics capability and logistics outsourcing on firm's performance under the electronic commerce environment. These studies indicate that how firms allocate and operate their distribution network is very important for it financial performance in electronic commerce activities. Thus, this study proposes such following hypothesizes:

H_{2a}: The distribution capability has strongly positive impact on the service quality of supply chain
H_{2b}: The distribution capability has strongly positive impact on the response of supply chain.
H_{2c}: The distribution capability has strongly positive impact on the financial performance of supply chain.

Bowersox indicates that flexibility is the result of standardization, measure and the application of technology and good firms own higher hold capability of flexibility than average level of firms (Bowersox *et al*., 1992). The study of Stank and Lackey (1997) indicates that there are big relevance between flexibility capability and logistics performance. Vickery *et al*. (1999) indicates that the flexibility of supply chain has close relationship with market growth and financial performance. Thus, this study proposes such following hypothesizes:

H_{3a}: The flexibility capability has strongly positive impact on the service quality of supply chain.

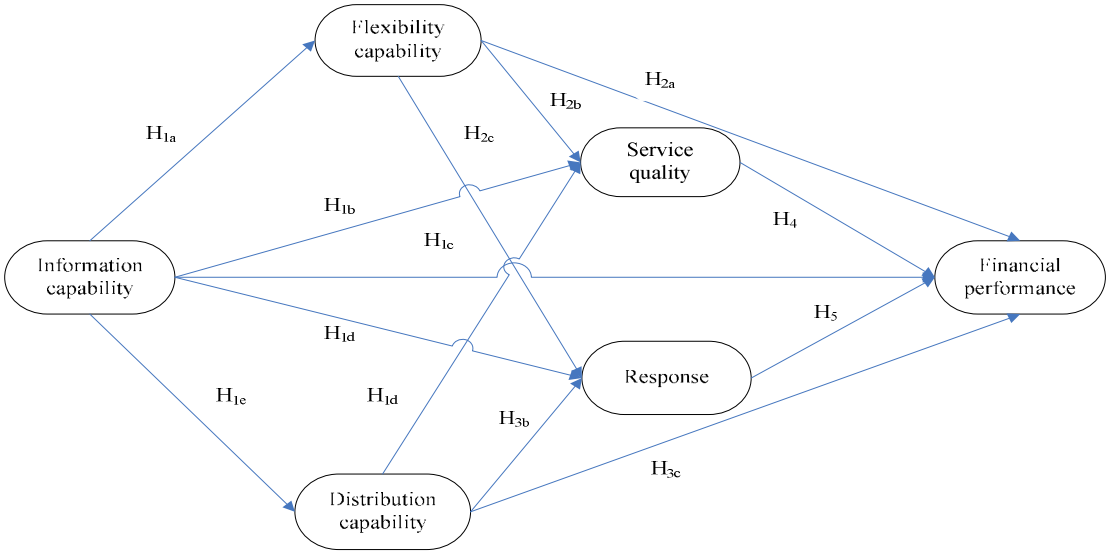

Fig. 1: Study framework

H_{3b}: The flexibility capability has strongly positive impact on the response of supply chain.

H_{3c}: The flexibility capability has strongly positive impact on the financial performance of supply chain.

The evaluation of the whole performance of the supply chain can be measured from different angles, such as customer response, service quality and financial performance. However, the final main indicator is the financial performance of supply chain and the increase of the service quality and response can finally influence the increase of the financial performance. Thus, this study proposes such following hypothesizes:

H_4: The improvement of the service quality of supply chain has strongly positive impact on the increase of the financial performance of supply chain.

H_5: The strengthen of the response of supply chain has strongly positive impact on the increase of the financial performance of supply chain.

In conclusion, the study framework of this study can be shown in Fig. 1.

RESEARCH METHOD

Variable measure: This study uses the method of questionnaire survey. In order to ensure the reliability and validity of the measurable tool, this study uses the scales that used by the existing papers home and abroad as much as possible. The measure of the factors of logistics capability mainly refers to information capability, distribution capability and flexibility capability. The scale that measure information capability is from Kuo-Chung and Peter (2005), which are mainly measured in the expandability and standardization of information technology, the information sharing of each departments of core firms in the supply chain and the sharing of cooperative partners in supply chain, which includes suppliers, customers and third-part logistics suppliers. The scale of distribution capability mainly refers to the literature of Morash and Joony-kun Jay Cho, which are measured mainly in the wide range of coverage and the distribution area that can be selected. The scale of flexibility capability refers to the study of Stank and Lackey (1997) and Oliver (1997). and Fwacett, which are mainly measured in the response of logistics information system for the change of internal operations, the change of customer demand, the seasonal demand and accident (Joong-Kun, 2001; Morash *et al*., 1996).

This study mainly measure the performance of supply chain in the service quality of supply chain, customer response and financial performance in order to combine the internal and external evaluation, the financial performance and nonfinancial performance. The time period between accepting customers' order and delivering the goods and the whole time period of the supply chain (includes material purchase, production and delivery time) are used to measure the customer response of the supply chain. The service quality of the supply chain was measure by the complaint rate of customers, the rate of supplying goods just in time and the completion rate of orders. The scale of financial performance comes from the study of Zhao *et al*. (2001), which selected return on asset, return on investment and sales growth to measure.

The questionnaire used Likert scale. The answers to the question of logistics capability have five levels from totally disagree to totally agree. The number 1 means totally disagree and number 5 means totally agree. The answers to the question of the performance of supply chain have five levels from very bad to very good. The number 1 means the performance is very bad and number 5 means the performance is very good. After the design of the questionnaire, the experts and scholars' advices in logistics and supply chain were collected. Meanwhile, based on the development situation of logistics industry and the recognition of logistics, some relevant items were modified a little bit.

Research sample: The samples in the study are mainly from the top 1000 firms published by National Bureau of Statistics in 2011. In all there are 1000 questionnaires were sent out and 185 questionnaires were taken back, the recovery rate is 18.5%, which is a acceptable rate since the recovery rate of the study of Michigan State University Global Logistics Research Team's is 17.1%. Among the 185 sets, 14 sets were abandoned because of not answering all questions or getting the same answer to all questions. There are 171 valid questionnaires in all, which satisfy the demand of least 150 questionnaires for SEM analysis. From the region aspect, the Yangtze River Delta, the Pearl River Delta, central China and Southwest China all have firms answer the questionnaire, which has a good regional representation.

The detail of the reply can be seen in Table 1. The state-owned firms, state holding firms, private firms and foreign-owned firms take up more than 94 percent of all the surveyed firms. This represents the nature of our country's logistics industry. 60.8% of the firm's own more than 500 persons and 32.7% of the firm's own more than 2500 persons. 31.6% of the firms' annual sales beyond one billion Yuan, from which can see most of the firms being surveyed are large firms. The major industry being surveyed is manufacture and the other industries are relatively scattered. From the job of the answers, we can see that 44.4% are department heads and 26.3% are manager assistants. 91.2% of the answers have worked for more than four

Table 1: The statistical description of the questionnaires

Firms' nature	Percentage	Employees' number	Percentage	Annual sales	Percentage
State-owned	43.9%	Less than 100	15.8%	Less than 10 million	9.40%
Collectively-owned	2.30%	101-250	12.3%	10 billion to 0.1 billion	22.8%
Private-owned	22.8%	251-500	11.1%	0.1 billion to 0.5 billion	24.6%
Sino-foreign joint	15.8%	501-1000	15.2%	0.5billion to 1 billion	11.7%
Foreign-owned	12.3%	1001-2500	12.9%	More than 1 billion	31.6%
Others	2.90%	More than 2500	32.7%		
Industry involved	Percentage	Job	Percentage	Work seniority	Percentage
Electronic	17.0%	CEO	3.50%	Less than	38.2%
Food	9.40%	Vice president	3.50%	4-6	27.5%
Chemical	8.80%	Department head	44.4%	7-9	32.2%
Fiber/paper	0.60%	Manager assistant	26.3%	10-12	15.2%
Electrical machine	14.0%	others	22.2%	13-15	9.90%
Car	2.90%			More than 15	6.40%
Others	40.4%			Unanswered	0.60%

years, which ensured the credibility of the questionnaire survey.

Analytical steps: In this study we use the method of structural equation modeling. First, this study used SPSS 16.0 to test the reliability of the measurable model and then used AMOS 7.0 to make the confirmatory factor analysis which mostly used maximum likelihood estimation to make parameter estimation in order to the validity of the measurable model. After testing the reliability and validity of the measurable model, this study made the estimation of the measurable model. Considering the limit and the hypothesizes' premise of the structural equation modeling's method, the data that collected need to be some preprocessing, which includes the missing data, outlier, normalizing treatment and so on. There are some missing data in the 171 questionnaires, but the missing percentage for each variable is very low (less than 4.1%) and we use the method of mean substitution to process the missing data, thus, the missing data would not cause bad affect for the result of the statistical analysis. Outliers mean the data which are very big or very small compared with the average data. When the testes are few, very few outliers can influence the value of X^2 vary greatly? In this study, we used the method of frequencies analysis map to modify and delete the outliers. Since the method of maximum likelihood estimation demands that variables must be multivariate normal distributed, thus, before we make the analysis of structural equation modeling, the sample variables were normalized.

DATA ANALYSIS AND HYPOTHESIS TEST

Reliability and validity test: Reliability is mainly used to evaluate the internal consistency between the items which are observed. The internal consistency is an important indicator for the software of AMOS, because the part of measurable model of structural equation modeling main uses the technology of confirmatory factor analysis, which demands the internal consistency between the measurable variables that designed for potential variables. This study use Cranach Alpha to evaluate the internal consistency among the variables observed. The Cranach Alpha of each potential variable can be seen in Table 2. From the Table 2, we can see that the Cranach Alpha of all the variables is between 0.67 and 0.87, which meet that standard of internal consistency.

Table 2: There liability of measurable model

Variable	Cronbach alpha
Information capability	0.87
Distribution capability	0.67
Flexibility capability	0.81
The quality of the service	0.82
Response	0.80
The financial performance	0.81

In validity test, since the questionnaire used in this study mostly come from past literatures, many foreign scholars have used these scales to measure relevant variables. This study made some modifications according to the different background of our country. Before we fix the questionnaire we consulted the experts in the relevant areas and revised the contents of the questionnaire through trail test. Thus, the questionnaire owns a good content validity. Whereas the construct validity is used for discriminating whether the measurement bound artificially added is suitable. The discrimination basis is the five statistical method of measurable model, which areX^2, DF, TLI, CFI and RMSEA. The specific method is to use the software of SEM to make CFA analysis for measurable model. From the Table 3, we can see that the construct validity is satisfying, because the parameter of the measurable model as follows: X^2 is 194.325, the degree of freedoms137,and X^2/d.f. is between 1.418 to 3.0, the Tucker-Lewis Index is 0.951, which is bigger than the demand 0.9, the CFI is 0.964, which is bigger than the demand of 0.9, the RMSEA is 0.050, which is smaller than the demand of 0.08, the significance level is 0.001, which all meet the demand. All the factors loading are greater than 0.5 except the increase rate of sales, which is one measurable item of the performance of supply chain. However, theoretically speaking, the increase

Table 3: The validity of measurable model

Variable	Average value	S.D	Factor capacity
Information capability			
Expansibility of the logistics information system	3.12	1.15	0.71
The gain of standard information of the members of the supply chain organization	3.22	1.09	0.82
Sharing of the operational information among the core firm's department in the supply chain	3.23	1.02	0.80
Sharing of the standardizing and customizing information among core firms, suppliers and customers	3.06	0.97	0.80
Sharing of the standardizing and customizing information among core firms and third part logistics firms	2.92	1.10	0.68
Distribution capability			
The extensity of distribution coverage	3.47	1.20	0.62
The selectable distribution areas	3.75	0.95	0.85
Flexibility capability			
The adaptability of the logistics system for product design or quantities change	3.16	0.93	0.69
The response capability of the logistics system for the rapidly increased demand	3.30	0.93	0.86
The adaptability of the transport capability during the sales variability of busy season	3.40	1.04	0.61
The implementation capability of the logistics system during accidents	3.18	0.96	0.75
The quality of the service			
The complaint rate of customers	3.41	0.87	0.63
The percentage of just in time delivery	3.54	0.86	0.87
The finish rate of perfect orders	3.40	0.90	0.83
Response			
The delivery time of orders	3.25	0.88	0.81
The period of the whole supply chain	2.98	0.94	0.83
The financial performance			
Return on assets	3.19	0.97	0.91
Return on investment	3.22	0.99	0.93
The growth rate of sales	3.22	0.89	0.49

Measurable model' matching $X^2 = 194.325$; d.f. = 137; CFI = 0.964; TLI = 0.951; RMSEA = 0.050, p = 0.001

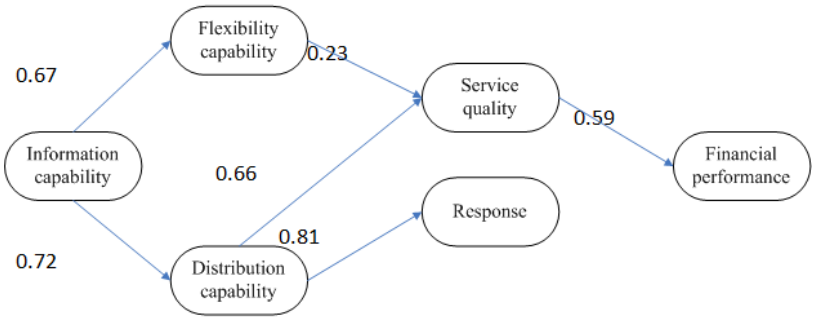

Fig. 2: The relationship between corrected model and variables; $X^2 = 241.718$, d.f. = 146, X^2/d.f. = 1.656, TLI = 0.923, CFI = 0.940, RMSEA = 0.062, p<0.001

rate of sales reflex the performance of the development of supply chain, so this study also apply this index, thus, the measurable model own a very good construct validity.

Structural model test: Use AMOS 7.0 to test the whole structure, the result shows that the fitting degree of the measurable model is satisfying. The model's X2 is 224.055, the degree of freedom is 139 and X2/d.f. is 1.612, less than 3.0, the Tucker-Lewis Index is 0.928, greater than 0.9, the CFI is 0.947, greater than 0.9, the RMSEA is 0.050, less than 0.08, the significance level is 0.001, which all meet the standard. Then eliminate the paths which are not significant step by step according to the significance of each path, the process is mainly implemented by parametric test and chi-square test. The corrected model can be seen in Fig. 2. From Fig. 2 we can see X2 is 241.718, the degree of freedom is 146 and X2/d.f. is 1.656, less than 3.0, the Tucker-Lewis Index is 0.923, greater than 0.9, the CFI is 0.940, greater than 0.9, the RMSEA is 0.062, less than 0.08, the significance level is less than 0.001. From the parametric test, all the parameter passed the test, which means the model has a good fit. Chi-square test mainly compares the value of ΔX2 and Δd.f., when the degree of freedom add 1, the value of X2 increases, but the increased value is less than 6.63 (the marginal value of X2 when p is 0.01), we think that delete the paths which are not significant is worth. In this study, the degree of freedom of the corrected model is 7 and the add part of X2 is 17.663, less than 18.475 (the marginal value of X2 when p is 0.01 and d.f. is 7). Thus, the corrected model is desirable.

RESULTS AND DISCUSSION

According the final result of the corrected model, after deleting the paths which are not significant, the test results of hypothesizes can be seen in Table 4.

In hypothesizes about logistics information capability, H_{1a} and H_{1e} are supported and H_{1b}, H_{1c} and H_{1d} are not supported. That means logistics information

Table 4: The reliability and validity of measurable model

Relations between variables	Path coefficients	p	Hypothesizes	Results
Information and distribution capability	0.67	<0.001	H_{1a}	Support
Information and flexibility capability	0.72	<0.001	H_{1b}	Support
Information and service quality	-	>0.050	H_{1c}	Not support
Information and response	-	>0.050	H_{1d}	Not support
Information and financial performance	-	>0.050	H_{1e}	Not support
Distribution capability and service quality	0.66	<0.001	H_{2a}	Support
Distribution capability and response	0.81	<0.001	H_{2b}	Support
Distribution capability and financial performance	-	>0.050	H_{2c}	Not support
Flexibility capability and service quality	0.23	=0.010	H_{3a}	Support
Flexibility capability and response	-	>0.050	H_{3b}	Not support
Flexibility capability and financial performance	-	>0.050	H_{3c}	Not support
Service quality and financial performance	0.59	<0.001	H_4	Support
Response and financial performance	-	>0.050	H_5	Not support

capability has direct positive impact on distribution capability and flexibility capability, while has no direct positive impact on the service quality of supply chain, response and financial performance.

In hypothesizes about the impact of distribution capability and flexibility capability on the performance of supply chain, H_{2a}, H_{3a} and H_{3b} are supported, which means that flexibility capability has significant positive impact on service quality. However, H_{2b}, H_{2c} and H_{3c} are not supported, which means that flexibility capability does not have significant impact on the response of supply chain, meanwhile, distribution capability and flexibility both have no direct positive impact on financial performance.

In hypothesizes about the impact of the service quality and response on financial performance, H_4 is supported, which means that the service quality has significant positive impact on financial performance of the supply chain. However, H_5 is not supported, which means that the response has no direct positive impact on financial performance of the supply chain.

From the above results we can see that the logistics information system which can provide correct and timely information and information sharing can not only play an important role in the exertion of logistics capability, but also can improve the performance of supply chain through influencing on distribution capability and flexibility capability. The result is consistent with former study (Joong-kun, 2001; Kuo-Chung and Peter, 2005). Under the support of the correct and timely information of customer demand and the selectable distribution terminals, firms can provide suitable products and services for customers in suitable place and time, which can improve the service quality and response of the supply chain. The information sharing between cooperators of supply chain can reduce the dependence on demand prediction and increase the flexibility capability, which can improve the service quality of supply chain. However, logistics information capability does not have direct impact on the performance of supply chain, thus, when firms pay attention to the invest on information capability, they should not only pay attention to the improvement of information technology, but also should pay attention to the information sharing between each departments and cooperators of supply chain.

The distribution capability and flexibility capability both have significant impact on the service quality of supply chain and finally influence the financial performance of supply chain, which means that the service quality is an important expression of the performance of supply chain. This support professor Roger's view, that service quality is an important evaluation of the performance of supply chain. Thus, in the practice of our country's logistics and supply chain, the improvement of service quality should be valued and the financial performance of supply chain can be improved by increase service quality of customers.

CONCLUSION

In this study, the relations between logistics information capability, distribution capability, flexibility capability and service quality, the response and the financial performance of supply chain was analyzed through questionnaire survey using structural equation. The result shows that logistics information capability does not have direct impact on the performance of supply chain, but have impact on the service quality of supply chain and financial performance through the influencing distribution capability and flexibility capability. Moreover, through influencing distribution capability, logistics information capability can have strong impact on the response of supply chain. From this we can see the importance of logistics information capability on improving the performance of supply chain. It can not only promote the development of logistics capability, but also can have important indirect impact on the service quality, response and financial performance of supply chain. Through improving logistics information capability and then improve distribution capability and flexibility capability to improve the service quality of supply chain can finally improve the financial performance of supply chain.

Though this study get some important conclusions on the theory of logistics and supply chain, there are some limitations. On one hand, this study does not

consider the influence of different industries. The future studies can study the difference of different industries. On the other hand, this study only studied from the aspect of core firms of supply chain, which did not make deep analysis of the influence of the relations between core firms and suppliers and distributors, which also can be a direction for future studies.

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