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**Empirical study on the relationship between performance of Supply chain and coordination strategies**

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**Abstract:** Based on agile supply chain context, this paper presents a framework that examines the impact of coordination strategies of supplier and buyer on supply chain performance. Using data analysis tool of SPSS software, the paper tests and analyzes hypotheses in the model. In the framework model, the coordination strategies include: (1) communication; (2) management experience exchange; (3) high level leader contact; (4) information linkage; (5) involved in problem solving; (6) cooperate to cut down cost. The coordination performance includes (1) average on time delivery level; (2) supplier’s responsibility to buyer’s demand change; (3) supplier’s efficiency of solving complains from buyer; (4) buyer’s ability of on time clearing payment; (5) Supplier’s trust degree to buyer; (6) buyer’s trust degree to supplier. Based on the analysis in the paper, suggest on how to improve the coordination performance of supply chain are also given out.

**Keywords:** Agile supply chain, supply chain coordination, performance measurement, empirical study.

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1. INTRODUCTION

Coordination performance is a key part of supply chain performance. Recent years, literatures on coordination of supply chain are increasing; different coordination strategies have been advanced, but what are the most effective coordination strategies for practice? what is the relationship between strategies and coordination performance? These problems have not been paid enough attention to in the past years.

“Coordination” has a wide meaning. Thomas W. Malone and Kevin Crowston(1994) think that coordination can be defined as the process of managing dependencies among activities, such as shared resources, producer/consumer relationships, simultaneity constraints and task/subtask dependencies. Ram Narasimhan and Soo Wook Kim (2002) examined the effect of supply chain integration on the relationship between diversification and a firm’s competitive performance. Their research shows that supply chain integration strategy modifies the relationship between diversification and performance. James H. Martin and Bruno Grbac (2003) research shows strong supplier relationships tend to impact the firm’s performance, because the firm can respond to customer needs in a more timely fashion, supplier relationships tend to be stronger in firms where there is cross-functional sharing of supplier and customer information. Amelia S. Carr and Larry R. Smeltzer(1999) researched the relationship of strategic purchasing to supply chain management, their research results indicate that strategic purchasing is positively related to supplier responsiveness, changes in the supplier market, supplier communication and the firm’s performance. Amelia S. Carr and John N. Pearson (1999) research results shows that strategic
managed buyer-supplier relationships with key suppliers can have a positive impact on the firm’s financial performance.

This paper researches the relationship between performance of supply chain coordination and coordination strategies. The remainder of the paper is organized as follows. The next section discusses the literatures review and develops research model and advances relative hypotheses to be tested. The following section discusses the sampling frame, measures and data collection. This is followed by a discussion of the results of hypotheses test. In the final section implication and conclusions on improving the coordination performance of buyer-supplier is presented.

2. RESEARCH FRAMEWORK AND HYPOTHESES

Academic has researched supply chain coordination strategies for a long time. Kirstin Zimmer (2002) investigated the coordination mechanism of buyer and supplier in a just in time settings. Through supplier contact parameter optimization, decentralized supply chain can obtain the same performance like centralized system. KAMLINI Ramdas and Robert E. Spekman (2000) pointed that product variety and great market customization have complicated the task of managing supply chains. Their research shows that the practices and thinking between functional-product and innovative-product supply chain are different. High performers among innovative-product supply chain use practices that enhance revenues more than high performers among functional-product supply chain.

Conventional supply chain coordination research most focused on the operations level. Thomas (1996) first defined three categories of operational coordination: buyer–vendor
coordination, production–distribution coordination and inventory–distribution coordination. According to this classification, a lot of research literatures on the operational coordination of supply chain can be found in journals, such as incentive contact coordination, ordering and pricing coordination, production planning coordination, joint ordering policies, pricing and lot size decision coordination (Michael Moses and Sridhar Seshdri, 2000; T.D. Klastorin, Kamran Moinzadeh and Joong son, 2002; Tamer Boyaci, Guillermo Gallego, 2002; Rajeev Kohli Heungsoo Park, 1994; Gulay Barbarosoglu, 2000). Other researchers (Timon Chil-Ting Du, Hsun-Ming Lee, Ane Chen, 2002, M.J. Shaw, D.M. Gardner, H. Thomas, 1997) from perspectives of information technology to research the coordination strategies of supply chain. Most of them from the perspectives of information sharing and IT utilization discuss the impact of information coordination on the performance of supply chain (Xiande Zhao, Jingxing Xie and W.J. Zhang, 2002; Funda Sahin, E. Powell Robinson, 2002).

Togar M. Simatupang, Alan C. Wright and Ramaswmi Sridharan (2002) pointed out current research often emphasizes a single coordination mode as the act of managing specific objects such as interdependent processes, information and knowledge, little attention has been given to exposing different coordination modes and their interactions. They advance taxonomy of coordination modes in a supply chain, shows in figure 1.
This paper divides the coordination strategies into four classes: work flow coordination, information flow coordination, cash flow coordination and logistics coordination, correspondingly, the performance of coordination is also divided into four types. According the characteristics of agile supply chain management (Martin Christopher, 2000, 2001; Damien J. Power and Amrik S. Sohal and Shams-Ur Rahman, 2001). This paper focuses the performance of coordination in the time performance and flexibility performance. Meantime, we divide the performance measurement indexes into strategic level and operational level. Operational level coordination measurement indexes are (1) Average on time delivery level ; (2) Supplier’s response ability to the change in demand ; (3) Supplier’s efficiency of dealing with the feedback complain; (4) Buyer’s ability of on time clearing payment. Strategic level coordination performance measurement indexes are (5) supplier’s trust degree to buyer and (6) buyer’s trust degree to supplier.

The figure 2 shows relationship of coordination performance and coordination strategies.
Because the relationship between coordination strategies and coordination performance is very complicated, figure 2 does not include all the strategies and performance measurement indexes; this paper only examines part of strategies and performance measurement indexes. For this purpose, this paper only presents six hypotheses to be tested.

**Hypothesis 1:** Contact between high level leader in supplier and buyer is positively related to the strategic level performance, e.g. it can increase mutual trust degree of buyer and supplier.

**Hypothesis 2:** Communication in management experience between supplier and buyer is positively related to strategic level performance and operational level performance.

**Hypothesis 3:** Information linkage between buyer and supplier is positively related to operational level performance.

**Hypothesis 4:** Periodically quality information communication between buyer and supplier is positively related to strategic level performance and operational level performance.
**Hypothesis 5:** the degree of supplier and buyer involved in problem solving is positively related to both strategic and operational level performance.

**Hypothesis 6:** The effort of supplier and buyer cooperating to cut down cost is positively related to both strategic and operational level performance.

### 3. METHODOLOGY

#### 3.1 Sample and response data collection

We undertook one survey from August of 2002 to October of 2003. Using questionnaire and statistics analysis method, we analyze the situation of Chinese enterprise in buyer-supplier cooperation. Table 1 is the result of the two times sampling.

<table>
<thead>
<tr>
<th>Sampling time</th>
<th>Sent out sample</th>
<th>Collected sample</th>
<th>Response rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Mail</td>
<td>Spot</td>
</tr>
<tr>
<td>First</td>
<td>1520</td>
<td>1420</td>
<td>100</td>
</tr>
<tr>
<td>Second</td>
<td>575</td>
<td>275</td>
<td>300</td>
</tr>
<tr>
<td>Total</td>
<td>2095</td>
<td>1695</td>
<td>400</td>
</tr>
</tbody>
</table>

Among the returned questionnaires, enterprise ownerships distribution is followings: 79 state-owned enterprises (account for 37.4%), 45 private-owned enterprises (account for 21.3%), 40 Sino-foreign jointed venture enterprises (account for 19.0%), and 42 foreign capital
enterprises (19.9%), other type is 5. Enterprise type distribution is: family apparatus industry accounts for 10%, chemical industry account for 3%, mechanical industry account for 18%, auto industry account for 8%, food industry account for 5%, telecommunication and IT industry account for 8%, pharmacy industry account for 5%, metallurgy industry account for 4%.

3.2 Measures

Because there are no standard measures for the coordination of supply chain strategies and performance, we developed our measures based on case study and literatures review. We select six independent variables and six dependent variables as our study variables, the followings test reliability and correlations of measures.

3.2.1 Dependent measure: performance indexes of agile supply chain

Table 2 shows the dependent variables for measuring performance of coordination, among indexes, the Q1 to Q4 is strategic level performance indexes, and Q5 and Q6 is strategic level indexes.

<table>
<thead>
<tr>
<th>Serial number</th>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Description of variable</th>
<th>Cronbach Alpha if item deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Q1</td>
<td>3.63</td>
<td>0.709</td>
<td>Supplier’s responding ability to buyer’s purchasing planning change</td>
<td>0.605</td>
</tr>
<tr>
<td>2</td>
<td>Q2</td>
<td>3.64</td>
<td>0.620</td>
<td>Supplier’s efficiency of dealing with the</td>
<td>0.618</td>
</tr>
<tr>
<td></td>
<td>Q3</td>
<td>Q4</td>
<td>Q5</td>
<td>Q6</td>
<td>Cronbach Alpha</td>
</tr>
<tr>
<td>----</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td>----------------</td>
</tr>
<tr>
<td>3</td>
<td>Q3</td>
<td>3.35</td>
<td>0.988</td>
<td>0.657</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Buyer’s ability of on time clearing payment</td>
</tr>
<tr>
<td>4</td>
<td>Q4</td>
<td>3.50</td>
<td>0.911</td>
<td>0.673</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Supplier’s on time delivery rate</td>
</tr>
<tr>
<td>5</td>
<td>Q5</td>
<td>3.87</td>
<td>0.653</td>
<td>0.624</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Supplier’s trust to buyer</td>
</tr>
<tr>
<td>6</td>
<td>Q6</td>
<td>3.58</td>
<td>0.583</td>
<td>0.632</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Buyer’s trust to supplier</td>
</tr>
<tr>
<td>Cronbach Alpha</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.675</td>
</tr>
</tbody>
</table>

Table 3 correlations among dependent variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>0.501**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q3</td>
<td>0.263**</td>
<td>0.239**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q4</td>
<td>0.274**</td>
<td>0.281**</td>
<td>0.213**</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q5</td>
<td>0.335**</td>
<td>0.276**</td>
<td>0.307**</td>
<td>0.094</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Q6</td>
<td>0.236**</td>
<td>0.251**</td>
<td>0.227**</td>
<td>0.184**</td>
<td>0.560**</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**p<0.01

Table 2 reveals that although the Cronbach Alpha value is not very high, it is met the reliability acceptable standard (higher than 0.4). From table 2, we can see that all indexes correlation relationship is notable. Q5 and Q6 also reveal higher correlated than other variables,
this reveals that the two indexes can be use as strategic level.

3.2.2 Independent measure: strategies of agile supply chain

The independent measures in this study for coordination strategies of agile supply chain are six variables

(1) Management experience communication between buyer and supplier.

(2) Information system linkage.

(3) Contact between high-level leaders of supplier and buyer.

(4) Periodically quality information communication.

(5) Degree of supplier and buyer involved in problem solving.

(6) The effort of supplier and buyer cooperating to cut down cost.

Table 4 shows the Cronbach Alpha value of independent measure.

<table>
<thead>
<tr>
<th>Serial number</th>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Description of variable</th>
<th>Cronbach Alpha if item deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>R1</td>
<td>2.83</td>
<td>0.905</td>
<td>Management experience communication between buyer and supplier</td>
<td>0.606</td>
</tr>
<tr>
<td>2</td>
<td>R2</td>
<td>1.97</td>
<td>1.119</td>
<td>Information system linkage</td>
<td>0.652</td>
</tr>
<tr>
<td>3</td>
<td>R3</td>
<td>3.24</td>
<td>0.777</td>
<td>Contact between high-level</td>
<td>0.673</td>
</tr>
</tbody>
</table>
leaders of supplier and buyer.

<table>
<thead>
<tr>
<th></th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>Periodically quality information communication</th>
<th>Degree of supplier and buyer involved in problem solving</th>
<th>The effort of supplier and buyer cooperating to cut down cost.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2.97</td>
<td>3.89</td>
<td>2.84</td>
<td>0.168</td>
<td>0.795</td>
<td>1.248</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>0.567</td>
<td>0.631</td>
<td>0.664</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cronbach Alpha 0.676

Table 4 reveals that the reliability of measure of independent variable is acceptable. Table 5 shows the correlation of variables. The result shows that all variables are correlated, the only one exception is R6 and R3, their correlation is negative. But this does not affect the total correlation and measure reasonability of indexes.
In order to test the relationship between dependent variables and independent variables, there are different data analysis methods can be used. Because different performance indexes have complicated correlations, so we use correlation analysis method to analyze the relationship between dependent and independent variables. The analysis result is showed in table 6.

Table 6 Correlate results of dependent variables and independent variables

<table>
<thead>
<tr>
<th></th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>0.126</td>
<td>0.152*</td>
<td>0.123</td>
<td>0.139*</td>
<td>0.245**</td>
<td>0.226**</td>
</tr>
<tr>
<td>R2</td>
<td>0.043</td>
<td>-0.015</td>
<td>0.135</td>
<td>0.090</td>
<td>0.066</td>
<td>0.110</td>
</tr>
<tr>
<td>R3</td>
<td>0.030</td>
<td>0.033</td>
<td>-0.020</td>
<td>-0.034</td>
<td>0.037</td>
<td>0.027</td>
</tr>
<tr>
<td>R4</td>
<td>0.276**</td>
<td>0.296**</td>
<td>0.363**</td>
<td>0.336**</td>
<td>0.273**</td>
<td>0.327**</td>
</tr>
<tr>
<td>R5</td>
<td>0.215**</td>
<td>0.264**</td>
<td>0.136</td>
<td>0.158*</td>
<td>0.144*</td>
<td>0.217**</td>
</tr>
<tr>
<td>R6</td>
<td>0.189*</td>
<td>0.229**</td>
<td>0.284**</td>
<td>0.247**</td>
<td>0.270**</td>
<td>0.158*</td>
</tr>
</tbody>
</table>

* p<0.05, **p<0.01
4. RESULTS DISCUSSION

The results of the analysis provide support for several of our hypotheses and some contradictory evidence. This section discusses key results from the table6.

4.1 Hypothesis 1

The first hypothesis stated that Contact between high level leader in supplier and buyer is positively related to the strategic level performance, e.g. it can increase mutual trust degree of buyer and supplier. The data analysis does not give enough support this point, because the correlations coefficients is only 0.037 (R3 and Q5) and 0.027 (R3 and Q6), not significant under p<0.05 and p<0.01.

This result is not surprising, because from our survey statistical result, we found that most companies answered that their high level leader seldom contact with suppliers’ leader, unless they have important matter to negotiate with suppliers. This situation reveals that, nowadays, many Chinese enterprises have not constructed strategic cooperation relationships with partners in supply chain management. This directly affects the mutual trust degree of buyer and supplier.

4.2 Hypothesis 2

The second hypothesis stated that Communication in management experience between supplier and buyer is positively related to strategic level performance and operational level performance. The correlation analysis reveals that the correlation coefficients of coordination strategy R1 with strategic level performance level about trust degree is 0.245 (Q5) and 0.226(Q6),
both are significant under the p<0.05 and p<0.01, support the hypothesis. Also, our analysis is consistent with the survey result of David Pyke, David Robb, John Farley (2000) based on their data collected in Shanghai region.

In the level of operational performance, result reveals that performance indexes Q2 (Supplier’s efficiency of dealing with the feedback complain from buyer) and Q4 (Supplier’s on time delivery rate) is significant related to coordination strategy R1 under significant level of p<0.05 and p<0.01, support the point of hypothesis. The correlation of R1 with another two indexes of Q1 (Supplier’s responding ability to buyer’s purchasing planning change) and Q3 (Buyer’s ability of on time clearing payment) does not reach the significant level under P<0.05 and p<0.01.

This situation shows that management experience communication can be helpful for increasing the work efficiency of supplier in dealing with complain from buyer and improving the delivery performance, but regarding to the clearing of payment and supplier’s responding ability to buyer’s demand change, the influence of coordination strategy of management experience communication is weak. From our analysis, we think there are two reasons, first is that most Chinese enterprises commonly exist the phenomena of delaying payment in domestic trade, second is that, as supplier, most Chinese enterprises have not formed a fast response mechanism to market change, including not information sharing, so the management experience communication can’t result significant impact on the supplier’s response ability.

4.3 Hypothesis 3
The third hypothesis stated that information linkage between buyer and supplier is positively related to operational level performance. The correlation analysis shows that all the correlation coefficients of coordination strategy R2 with operational level performance indexes (Q1, Q2, Q3, and Q4) do not reach significant level under p<0.05 and p<0.01, this do not support the hypothesis viewpoint.

Theoretically speaking, information system linkage between supplier and buyer, such as P&G and Wal-Mart has a joint initiative called collaborative forecasting and replenishment (CFAR), can significantly improve the operational performance of buyer and supplier, but, in China, we found many enterprises have not this kind collaborative initiatives, this situation reveals that Chinese enterprises need increase the investment on cooperation information sharing infrastructure.

4.4 Hypothesis 4

The fourth hypothesis stated that periodically quality information communication between buyer and supplier is positively related to strategic level performance and operational level performance. The correlation analysis shows that all the correlation coefficients of coordination strategy R4 with both operational level and strategic level performance indexes (Q1, Q2, Q3, Q4, Q5 and Q6) are significant under p<0.05 and p<0.01, and support the hypothesis viewpoint.

Traditional quality concept in purchasing and supply management is to establish the optimum level in receiving inspection. At best, this approach detects defective materials but it does not focus on improving the quality of products delivered by supplier (Bernardo Pridam Gil
Gutierrez, 1996). In supply chain management environment, suppliers commit to continuous improvement, buyer promote quality assurance within suppliers by supplying adequate information and supporting education programs. Robert E. Spekman et al (1998) in their empirical investigation also revealed that “integrated quality information” ranked the top ten items. Nowadays, more and more Chinese enterprises begin pay attention to problem of quality improvement; this will not only help improve the operational efficiency supply chain, but also improve the strategic partnerships between supplier and buyer.

4.5 Hypothesis 5

Hypothesis fifth stated that degree of supplier and buyer involved in problem solving is positively related to both strategic and operational level performance. The correlation analysis reveals that the correlation coefficients of coordination strategy R5 with three operational level performance indexes (Q1, Q2 and Q4) and strategic level performance indexes (Q5 and Q6) are significant under $p<0.05$ and $p<0.01$, this strongly support the viewpoint of hypothesis, with another operational level performance index Q3 (on time clearing payment) is not significant, but is positively related (0.136), also can be viewed weakly support hypothesis 5. This result is consistent with practice, because buyer and supplier involve in problem solving maybe improve the performance of on time payment, but there are also other factors impacting performance of on time payment, such as bank system operation and contact relationship.

In supply chain management research literatures, many authors emphasize the importance of interaction between buyer and supplier, especially in agile supply chain (Colin Rigby et
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al.2000; Damien J. Power et al 2001; Theodore H. Clark and Ho Guen Lee, 2000). Under the increasingly complex environment of marketing, in order to synchronize the supply chain operation, supply chain partners should respond quickly to customer problem, immediately report any internal problem discovered which might affect customer service, and collaborate to solve problem and quick respond to customer change.

4.6 Hypothesis 6

The hypothesis 6 stated that the effort of supplier and buyer cooperating to cut down cost is positively related to both strategic and operational level performance. The correlation analysis reveals that the correlation coefficients of coordination strategy R6 with coordination performance indexes (both operational and strategic level) are significant under $p<0.05$ and $p<0.01$, and this strongly support the viewpoint of hypothesis.

In supply chain management, cost is very important performance index, such as Ellram (1991) suggest that the goal of supply chain management is to improve customer service at reduced overall cost. No matter what kind coordination strategies buyer and supplier use to cut down cost, such as suggested by Douglas J. Thomas and Paul M. Griffin (1996), they will be helpful for the improvement of entire supply chain performance.

5. LIMITATIONS AND FUTURE RESEARCH

As with all research, this study has limitations, the following sections identify a number of limitations and offer some suggestions for future research.

5.1 Sampling
There are some limitations in sampling. First, we collected data from different regions of China, but results show that our samples most from the economy developed regions, like Guangdong Province, Shanghai city and other coast regions of east and south China. This affects the result representative for so big country like China. Second, the responding rate is too low, especially responding rate from mail. Third, our questionnaires ask respondents answer the questions from perspective of purchasing, so most answers are from department of purchasing or relative departments, the coordination strategies and performance measurement of downstream supply chain have not been taken into account. As entire supply chain coordination management research, in the future research, we should improve above three limitations.

5.2 Survey

The survey instrument was developed based on literatures review and referred to our visiting of enterprises. However, none of these questionnaires had been tested by practical enterprises whether they were best indexes for the coordination strategies or coordination performance, meanwhile, the coefficient $\alpha$ levels for this research were within the acceptable range, but not reach 0.7, future research should add more indexes for strategies or performance, improve the reliability level.

5.3 Model

The hypotheses tested by the relationships in the model were mostly supported, but also some relationship between strategies and performance were not supported by the survey data analysis result, even some result is conflict, this indicates that our model is not perfect, there are
other factors impacting the relationship between coordination strategy and performance, the model should more optimized to use other method to reexamine the relationships between factors in the model.

6. CONCLUSION

This research set out to answer a number of questions. Specially, what is the strategy of supply chain coordination and key performance indexes for coordination? What is the relationship between strategy for supply chain coordination and the performance? These questions were answered by testing the hypotheses. Although many authors have researched different strategies for supply chain, and also, there have some literatures about performance measurement of supply chain management, there is little about the relationship between them. The knowledge we gained by testing these relationships was the different importance of supply chain coordination strategies on the operation level or strategic level performance, theses analysis result will be helpful for improving supply chain management.

This research also gains knowledge about the situation of Chinese enterprises on supply chain management. Chinese enterprises now begin pay more and more attention to the improvement of supply chain management, but from the survey result, we can see that many Chinese enterprises still lack strategic cooperation initiative, such as high level leader contact and information sharing.

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