Measuring the performance of different supply-chain integration strategies

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Abstract

The best supply-chain integration strategy has been developed and explored in recent years. The related literature has argued that the structure of the best integration strategy is complete integration between suppliers and customers in the supply-chain operational environment, which improves competitive performance. However, considering the limitations in internal/external resources and the development environment, most manufacturers are often unable to develop the best integration strategy, and usually develop other integration strategies such as supplier integration, customer integration, and incomplete integration.

Different integration strategies have different integration structures, and different integration structures lead to different practical results and performance. However, most practitioners find it difficult to characterize the practical results and performance of different supply-chain integration strategies. This study investigated the practical

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results and performance of different supply-chain integration structures. The test results allowed us to identify the best and alternative integration strategy, and through our findings, manufacturers can understand which integration strategy can be considered when considering their limited resources and the nature of their development environment.

Keywords: Supply-chain integration strategy, practical performance, empirical study.

1. Introduction

In recent years, there has been a great deal of empirical evidence to show that supply-chain integration can create a powerful competitive advantage for manufacturers ([2] [20] [36] [37] [39] [43]). However, the supply-chain organizational structure involves many different business entities, including upstream suppliers and downstream customers, and manufacturers must connect and integrate firms at various stages in the supply chain if they wish to create competitive advantage. Indeed, supply-chain integration is the key to the development of competitive ability.

Successful supply-chain integration can improve competitive advantage and improve cost, quality, flexibility, and delivery for the manufacturer ([41]). As [4] noted, “the opportunity to use process integration across functional boundaries is now considered a key to competitive success”. However, what is the best integration strategy? As [15] indicated, the best integration strategy is “outward-facing”. This result also means that the best integration strategy should extend to upstream suppliers and downstream customers, therefore the best integration strategy could be termed “complete integration”.

Even though complete integration is the most successful integration strategy, most

manufacturers experience limitations in internal/external resources and their development environment, making it difficult to develop a complete integration strategy. In fact, as the test results of [15] showed, in addition to the best integration strategy, over 90% of manufacturers still adopted other integration strategies in supply-chain operational environments, such as supplier integration, customer integration, and incomplete integration.

In fact, different integration strategies have different integration structures, and different integration structures will lead to different practical results and performance. Manufacturers may adopt different integration strategies in order to be competitive in their supply-chain operational environment. However, most practitioners find it difficult to characterize the practical results and performance of different supply-chain integration strategies.

Although [15] explored different supply-chain integration strategies, their research only gave evidence of the best integration strategy. They identified different integration strategies, but failed to explore in detail the alignment relationship between different integration strategies and practical results and performance. [10] and [40] also explored the practical results of supplier integration strategies and customer integration strategies, but failed to consider and explore different supply-chain integration strategies.

Too much research focuses upon the exploration of the best integration strategy and disregards alternative integration strategies. We believe that managers must understand the effects of different integration strategies when they are faced with limited resources and different environmental situations, and must be able to decide upon an appropriate integration strategy that is effective and competitive.

For the above reasons, this study investigated the practical performance of different supply-chain integration strategies. In this study, we clearly define which integration strategies satisfy which level of competitive performance. Data from the International Manufacturing Strategy Survey (IMSS) database were used in this study. This article is organized as follows. In section 2, the related literature is reviewed and relevant hypotheses for study are formulated. Section 3 describes the methodology. Section 4 includes empirical testing and discussion of the results. Section 5 presents a conclusion to the study and the implications for future research.

2. Literature review and hypotheses

2.1 Importance of supply-chain integration strategy

Supply-chain integration has become a prominent issue during the last decade, and has been recognized as the key to the development of competitive ability. Successful supply-chain integration can help manufacturers to achieve competitive performance in areas such as cost, quality, flexibility, and delivery ([41]).

Related research by [6], [25], and [30] has explored the integration relationships and strategies of different supply-chain members, indicating that integration strategies can influence costs, delivery, and flexibility in a complex environment. [5] explored the integration strategy of distribution networks and indicated that delivery and flexibility can be satisfied through integration strategy. [38] also argued that integration strategy can influence the performance of cost, quality, and delivery through a replenishment integration strategy between supply-chain members. [22] and [33] explored the partner-firms integration strategy for new product development, and indicated that such an integration strategy can improve the market requirements of

cost and quality in new product development.

Based on the above, the importance of supply-chain integration strategy is clear. In fact, no matter what the industry dynamic ([14]) or value chain ([34]), all factors support the importance of supply-chain integration strategy. For this reason, supply-chain integration strategy has become important if manufacturers wish to gain competitive advantage ([7] [12] [31] [35] [36]).

2.2 The best integration strategy

Although a successful supply-chain integration strategy is critical if manufacturers wish to gain competitive advantage, what kind of integration strategy can lead to the best competitive performance? The test results of [15] showed that the best integration strategy must involve "complete integration". This means that the best integration strategy involves completely extending and connecting to upstream suppliers and downstream customers, forming a closed integration structure. [36] expanded upon the research by [15] and supported their findings. [31] indicated that a complete integration strategy can lead to better product quality, delivery reliability, process flexibility, and cost leadership.

However, why is complete integration the best integration strategy? As the test results of [19] and [28] indicate, the complete extension to suppliers and customers can improve close communication, reducing conflict and uncertainty between supply-chain members. Therefore, complete integration extending to suppliers and customers is the best integration strategy, and when manufacturers adopt this integration strategy, the best level of competitive performance will be achieved. This leads to the first hypothesis that we wish to examine in this paper:

Hypothesis 1: When manufacturers adopt a complete integration strategy, the best competitive performance will be achieved.

2.3 Different integration strategies and practical performances

As a result of limited internal/external resources and development environments, the majority of manufacturers are unable to develop a complete integration strategy. In fact, as the results of [15] show, over 90% of manufacturers still try to develop different integration structures in order to achieve competitiveness. However, when different integration strategies are developed and adopted, what level of competitive performance will be achieved?

Based on [34]'s value chain, we found that supply-chain integration can be divided into supplier integration and customer integration. [10]. [16] [36], and [42] found that firms may develop other integration strategies such as supplier integration or customer integration in order to achieve competitiveness. However, when firms adopt and practice a supplier integration or customer integration strategy, what level of competitive performance will be achieved?

[10] indicated that supplier integration can significantly improve the performance of purchasing costs and manufacturing costs. [33] indicated that manufacturers can reduce new product design costs through supplier integration. In terms of customer integration, [11], [17], [23], and [29] argued that the competitive performance of delivery and flexibility can be achieved through integration with customers. However, supplier integration is not limited to cost performance alignment, and customer integration is not limited to delivery and flexibility performance.

[42] showed that supplier integration also influences the delivery of service

constructs. [13] and [18] believed that competitive performance will be significantly influenced regardless of the level of supplier or customer integration. Therefore, based on the above, we believe that when supplier and customer integration strategies are practiced, competitive performance will be achieved. This leads to two further hypotheses that we wish to examine in this paper:

Hypothesis 2: When manufacturers adopt a supplier integration strategy, majority competitive performance will be achieved.

Hypothesis 3: When manufacturers adopt a customer integration strategy, majority competitive performance will be achieved.

In addition to the three integration strategies mentioned above, there are other integration strategies that exist in the real world. These integration strategies have a short integration scope and structure in terms of their supply-chain operational environment. [15] [16] found two types of integration strategy: “inward-facing” and “periphery-facing”. Inward-facing is limited in terms of the scope and structure of the manufacturing part, and is therefore a “limited integration” strategy. Periphery-facing is less than complete integration but slightly extends the connection with suppliers and customers, and is therefore an “incomplete integration” strategy.

In addition to these two integration strategies, more integration strategies with a shorter scope and structure exist in the real world, but have not been explored. However, if an integration strategy possesses short integration scope and structure, the practical results are unlikely to achieve competitive performance. This leads to another hypothesis that we wish to examine in this paper:

Hypothesis 4: When the scope and structure of an integration strategy are short, it is

difficult to achieve majority competitive performance.

3. Methodology

In this section we will describe the methodology, including sampling, operationalization of the variables, and the measurement of independent constructs.

3.1 Data collection and respondent's profile

This study is based on the International Manufacturing Strategy Survey (IMSS-Ⅳ) database. From the IMSS database we sieved appropriate samples to test. The IMSS is a cooperative research network of manufacturing strategy research that aims to develop a variety of perspectives and research questions in order to establish a global database for the study of manufacturing and supply-chain strategies and performance. The primary method of gathering data is by questionnaire, and surveys in this iteration focus upon ISIC 28–35: ISIC 28 – manufacturing of fabricated metal products; 29 – machinery and equipment; 30 – office, accounting and computing machinery; 31 – electrical machinery and apparatus; 32 – radio, television and communication equipment and apparatus; 33 – medical, precision and optical instruments, watcher and clocks; 34 – motor vehicles, trailers and semi-trailers; 35 – other transport equipment. Here, IMSS data were used to test the research objective of this study.

In the IMSS database, the total responses number 711 firms from 23 different countries. In 2006, Taiwan joined IMSS and provided 50 samples. Of all of the samples in IMSS, a total of 761 firms were collected. In this study, we randomly sieved 439 samples from the IMSS database (58%), and the total test samples are summarized by region in Table 1. In an additional test sample, the ANOVA method

was used to check for significant differences between the test samples and total sample. There were no significant differences ($p > 0.05$) between the test sample and the total sample. The ANOVA results show that we can avoid doubt about the test sample results.

Table 1: Sample by region

Region	Test samples	
	Count	Percentage
Asia	81	18.45%
West Europe	217	49.43%
East Europe	60	13.67%
Ocean	27	6.15%
America	54	12.30%
Total	439	100%

3.2 Operationalized variables and independent construct measurement

Two different kinds of operationalized variables were explored in this study: supply-chain integration strategies and competitive performances. Different integration strategies were formed through related integration activities of suppliers and customers, and different competitive performances were formed through related indices of performance.

Supply-chain integration activities: The IMSS survey integrates eight kinds of integration activities in the supplier and customer: (1) share inventory level knowledge, (2) share production planning decisions and demand forecast knowledge, (3) order tracking/tracing, (4) agreements on delivery frequency, (5) dedicated capacity, (6) require supplier(s) and customer(s) to manage or hold inventories of materials at your site (e.g., vendor-managed inventory, consignment stock), (7) collaborative planning, forecasting and replenishment, (8) physical integration of the supplier into the plant. The questions were measured on a five-point Likert scale. In this study, we also adopted different integration activity items in order to develop different integration strategy variables.

Competitive performance: Low cost, high quality, short delivery times, high flexibility, and product innovation ability are critical in order to satisfy market requirements. In fact, the level of satisfaction of market requirements is often used to judge competitive performance against competitors. Most researchers, such as [1], [8], [21], [24], [26] have used five priorities or goals in order to measure competitive performance. [9] pointed out that cost, quality, flexibility, delivery, and innovation are well-established competitive performance priorities. The IMSS survey integrates 20 different kinds of performance indices: (1) manufacturing conformance, (2) product quality and reliability, (3) product customization ability, (4) volume flexibility, (5) volume flexibility, (6) time to market, (7) product innovativeness, (8) customer service and support, (9) delivery speed, (10) delivery dependability, (11) unit manufacturing cost, (12) manufacturing lead time, (13) procurement lead time, (14) procurement costs, (15) labor productivity, (16) labor productivity, (17) capacity utilization, (18) overhead costs, (19) employee satisfaction, and (20) environmental performance. The questions were measured on a five-point Likert scale. In this study, we integrated 20 performance indices in order to develop cost, quality, delivery, flexibility, and innovation competitive performance variables.

Before developing the operationalized variables, we measured the raw data of integration activity items and competitive performance indices through reliability, validity of content, validity of construct, and Confirmatory Factor Analysis (CFA) tests in order to ensure the operationalized variables satisfied the requirements of this research.

From the reliability results we first tested integration activity. Integration activity can be distinguished from supplier and customer integration activity. The reliability of

supplier integration activity was 0.776. We found the reliability of "share production planning decisions and demand forecast knowledge" and "agreements on delivery frequency" to be significantly lower than other activity items. In order to avoid these two activity items influencing all the other supplier integration activities, we deleted them. After deleting the two items, the reliability of supplier integration activity increased to 0.798. In the following test, we used another six activity items in order to develop each integration strategy with customer integration activity items.

The test results indicated that the reliability of customer integration activity was 0.841. We found the reliability of "require supplier(s) to manage or hold inventories of materials at your site (e.g., vendor-managed inventory, consignment stock)" to be significantly lower than other customer integration activity items. In order to avoid this activity item influencing all the other customer integration activities, we deleted it. After deleting the item, the reliability of customer integration activity increased to 0.850. In the following test, we used another seven activity items to develop each integration strategy with supplier integration activity items.

We also tested the indices of competitive performance, and the test results indicated that the reliability of competitive performance was 0.910. No matter which performance index was deleted, the reliability of competitive performance would not significantly change, therefore all 20 competitive performance indices were retained.

For the results of content validity, we measured the mean, standard deviation, and carried out an independent *t-test*. Content validity is suitable for subjective and judgmental testing ([32]). In the test results for integration activity, all integration activity items for suppliers and customers showed significant results. In the test results for performance, all indices of competitive performance also showed significant

results. All test results for content validity are shown in Tables 2 and 3.

In addition to content validity, in order to develop each integration strategy construct, we further tested construct validity for all supplier and customer integration activity items. The 20 indices of competitive performance were clustered into 5 kinds of competitive performance. IMSS provides 20 performance indices, including 7 cost performances indices, 4 quality performances indices, 4 delivery performances indices, 4 flexibility performances indices, and 1 innovation performance index. Cost performance includes unit manufacturing cost, procurement lead time, procurement costs, labor productivity, inventory turnover, capacity utilization, and overhead costs. Quality performance includes manufacturing conformance, product quality and reliability, employee satisfaction, and environmental performance. Delivery performance includes time to market, customer service and support, delivery speed, and delivery dependability. Flexibility performance includes product customization ability, volume flexibility, mix flexibility, and manufacturing lead time. Innovation performance includes product innovativeness. In order to ensure the different performance indices were correctly clustered into different performance groups, we also tested construct validity using factor analysis, and the results are shown in Tables 2 and 3.

Table 2: Validity of content and construct in integration activity

Supplier				**Integration activity**	Customer			
Mean	**S.D.**	**Sig.**	Loading		Loading	**Mean**	**S.D.**	**Sig.**
2.89	1.18	0.000**	0.670	Share inventory level knowledge	0.726	2.60	1.27	0.000**
		Deleted		Share production planning decisions and demand forecast knowledge	0.748	3.08	1.22	0.000**
3.09	1.18	0.000**	0.600	Order tracking/tracing	0.716	3.21	1.26	0.000**
		Deleted		Agreements on delivery frequency	0.714	3.45	1.23	0.000**
2.65	1.14	0.000**	0.742	Dedicated capacity	0.754	2.56	1.29	0.000**
2.4	1.27	0.000**	0.758	Require supplier(s) to manage or hold inventories of materials at your site (e.g. Vendor Managed Inventory, Consignment Stock)		Deleted		
2.73	1.21	0.000**	0.716	Collaborative Planning, Forecasting and Replenishment	0.753	2.64	1.25	0.000**
1.72	1.00	0.000**	0.680	Physical integration of the supplier into the plant	0.628	1.78	1.12	0.000**
			0.785	Cronbanch's α	0.846			
			2.910	Eigenvalue	3.638			
			48.501	Percent of variation	51.974			

** Significant at the p<0.01 level
* Significant at the p<0.05 level

Table 3: Content validity, construct validity, and reliability in performance

Competitive performances	Cost	Quality	Delivery	Flexibility	Innovation	Mean	S.D.	Sig.
Procurement lead time	0.781					2.60	0.84	0.000**
Unit manufacturing cost	0.724					2.73	0.82	0.000**
Labour productivity	0.717					2.94	0.79	0.000**
Procurement costs	0.691					2.64	0.86	0.000**
Capacity utilization	0.668					2.81	0.88	0.000**
Inventory turnover	0.655					2.72	0.84	0.000**
Overhead costs	0.653					2.51	0.82	0.000**
Product quality and reliability		0.798				3.04	0.85	0.000**
Employee satisfaction		0.762				2.56	0.85	0.000**
Manufacturing conformance		0.762				2.95	0.87	0.000**
Environmental performance		0.757				2.74	0.80	0.000**
Delivery speed			0.862			2.97	0.91	0.000**
Delivery dependability			0.805			2.98	0.91	0.000**
Customer service and support			0.728			2.95	0.87	0.000**
Time to market			0.709			2.78	0.87	0.000**
Volume flexibility				0.789		2.99	0.88	0.000**
Mix flexibility				0.778		3.15	0.88	0.000**
Product customization ability				0.704		2.91	0.84	0.000**
Manufacturing lead time				0.617		2.82	0.85	0.000**
Product innovativeness						2.85	0.87	
Cronbanch's α	0.825	0.770	0.782	0.696				
Eigenvalue	3.427	2.370	2.424	2.103				
Percent of variation	48.964	59.247	60.608	52.583				

** Significant at the p<0.01 level

* Significant at the p<0.05 level

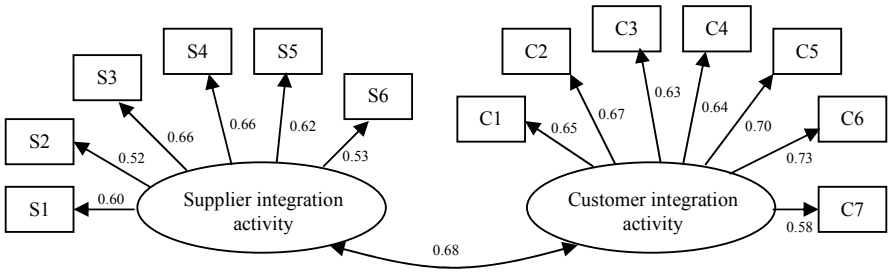
Through testing construct validity, we confirmed the cluster results of competitive performance. In terms of integration strategy, we confirmed that the supplier and customer integration activity items can be clustered into "supplier integration construct" and "customer integration construct" through construct validity. However, we could not further confirm that "supplier integration construct" and "customer integration construct" can be integrated and further developed through each integration strategy.

We used Confirmatory Factor Analysis (CFA) to check if the supplier and customer integration constructs could be integrated and developed through each integration strategy. The test model is shown in Figure 1. Through the CFA test process, we first confirmed the validity of the measurement model. As the results of the CFA in Table 4 show, the supplier and customer integration activity construct fits the measurement model. All coefficients are significant at the 0.01 level of significance. From the standardized parameter estimate results, the supplier integration activity and customer integration activity can be combined and further

developed through each integration strategy. The test results are shown in Figure 1.

Table 4: CFA results

Construct and measurement items	Standardized item-construct loadings (All loadings significant at 0.01 level
Supplier integration activities	
S1: Share inventory level knowledge	0.567
S2: Order tracking/tracing	0.520
S3: Dedicated capacity	0.684
S4: Require supplier(s) to manage or hold inventories of materials at your site (e.g. Vendor Managed Inventory, Consignment Stock)	0.660
S5: Collaborative Planning, Forecasting and Replenishment	0.622
S6: Physical integration of the supplier into the plant	0.530
Customer integration activities	
C1: Share inventory level knowledge	0.652
C2: Share production planning decisions and demand forecast knowledge	0.672
C3: Order tracking/tracing	0.631
C4: Agreements on delivery frequency	0.642
C5: Dedicated capacity	0.698
C6: Collaborative Planning, Forecasting and Replenishment	0.727
C7: Physical integration of the supplier into the plant	0.579



χ^2 = 231.32 (df = 60), CFI = 0.915, GFI = 0.901 RMSEA = 0.08
90 % confidence interval of RMSEA = (0.070, 0.091)

Figure 1: Test result through CFA

3.3 The development of different supply-chain integration strategies

Following CFA, we further developed different supply-chain integration strategies. This study used the empirical methods of [15] in order to judge the scope and definition of different integration strategies from the 439 tested samples. First the factor score was used to judge the different integration structure and scope. The integration structure and scope distinguished the upper, middle, and lower quartiles of the supplier and customer integration parts. We classified each sample into either the upper, middle, or lower quartiles, as seen in the following figure.

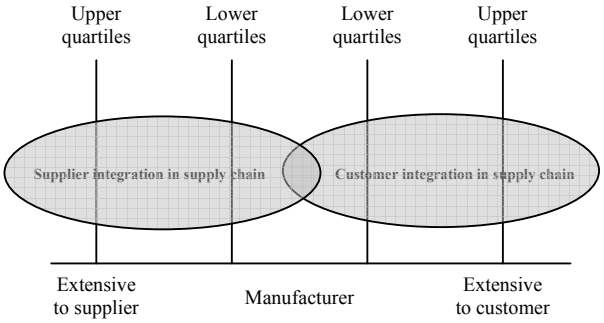


Figure. 2: Classification standard of supply-chain integration strategy

Through the judgment of integration structure and scope, this study found that seven integration strategies exist in the real world. We defined the different integration strategies as follows.

When integration structure and scope were limited to the lower quartile, we named this the “limited integration strategy”. When integration structure and scope were above the lower quartiles but fell below the upper quartiles with suppliers and customers, we named this the “incomplete integration strategy”. When the integration structure and scope extended to the upper quartiles for both customers and suppliers, we named this the “complete integration strategy”. When integration structure and scope reported extensive integration with suppliers, but customer integration was below the upper quartile, we named this the “complete supplier integration strategy”.

When there was extensive integration with customers but integration remained below the upper quartile for suppliers, we named this the “complete customer integration strategy”. When the integration structure and scope were above the lower quartiles but fell below the upper quartiles for suppliers and were in the bottom quartiles for customers, we named this the “incomplete supplier integration strategy”. When the integration structure and scope were above the lower quartiles but fell below the upper quartiles for customers and were in the bottom quartiles for suppliers,

we named this the “incomplete customer integration strategy”. All the results of the seven integration strategies are shown in Figure 3.

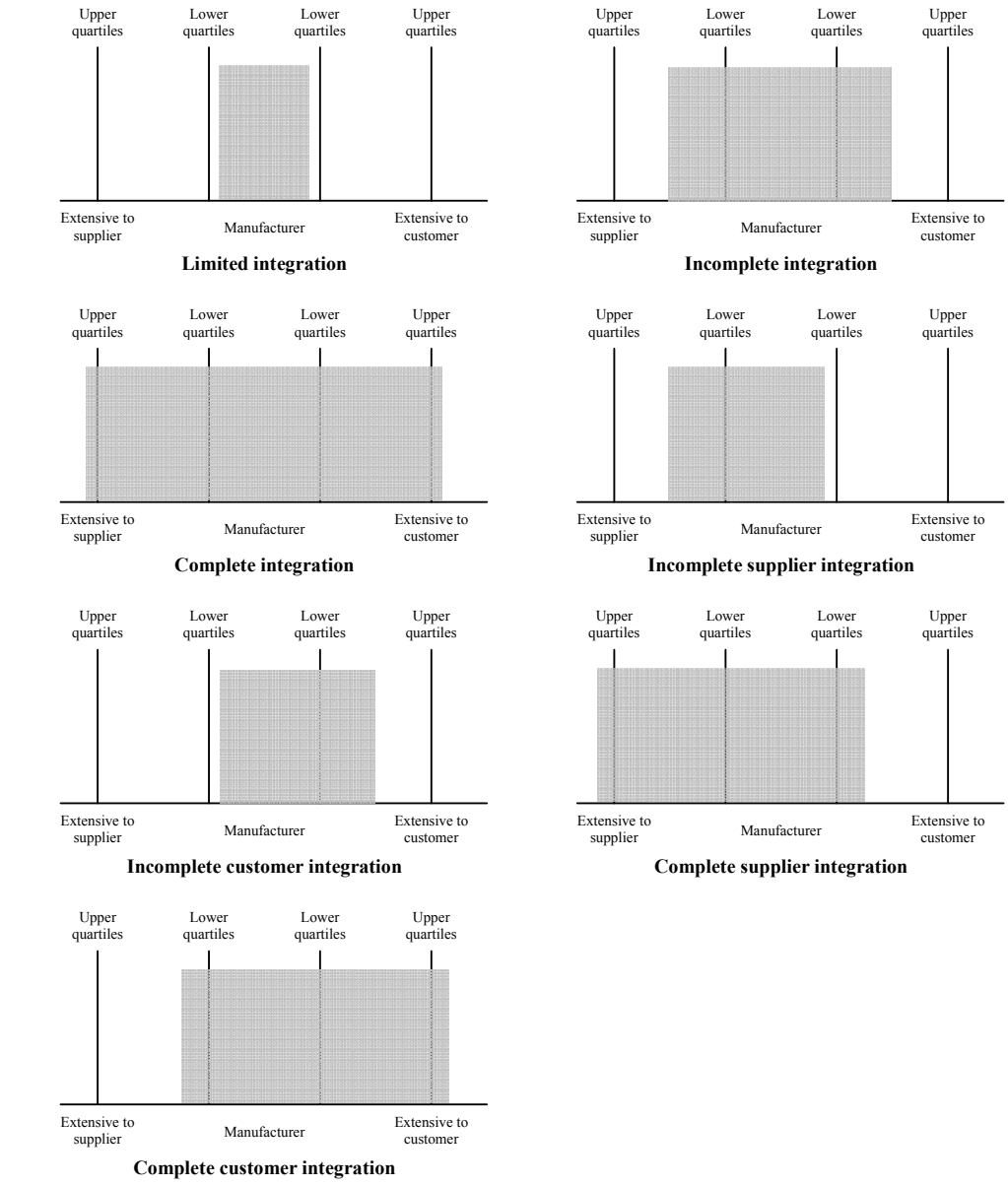


Figure 3: Different integration strategies

Furthermore, we further classified the sample groups into seven integration strategies. We adopted the factor score for each sample in order to simply classify the sample groups into different integration strategies. Based on the factor score results,

the distribution indicated 49 samples clustered in limited integration, 246 samples clustered in incomplete integration, 11 samples clustered in complete integration, 44 samples clustered in incomplete supplier integration, 57 samples clustered in incomplete customer integration, 8 samples clustered in complete supplier integration, and 24 samples clustered in complete customer integration.

In order to ensure the results of the classification were correct, discriminant analysis was adopted. As seen in Table 5, the results of the discriminant analysis of the factor scores indicated that the available classified results for limited integration were 98%, incomplete integration 62.2%, complete integration 100%, incomplete supplier integration 93.2%, incomplete customer integration 91.2%, complete supplier integration 100%, and complete customer integration 83.3%. All test results are shown in Table 5.

Table 5: Results of discriminant analysis

	Cases	Limited integration	Incomplete integration	Complete integration	Incomplete supplier integration	Incomplete customer integration	Complete supplier integration	Complete customer integration
Limited integration	49	48 (98.0%)	0	0	1 (2.0%)	0	0	0
Incomplete integration	246	1 (0.4%)	153 (62.2%)	2 (0.8%)	21 (8.5%)	31 (12.6%)	19 (7.7%)	19 (7.7%)
Complete integration	11	0	0	11 (100%)	0	0	0	0
Incomplete supplier integration	44	3 (6.8%)	0	0	41 (93.2%)	0	0	0
Incomplete customer integration	57	5 (8.8%)	0	0	0	52 (91.2%)	0	0
Complete supplier integration	8	0	0	0	0	0	8 (100%)	0
Complete customer integration	24	0	0	4 (16.7%)	0	0	0	20 (83.3%)

76% of original grouped cases correctly classified

3.4 Research methodology

A regression-based methodology was used to analyze and explore the research objective. The raw data were checked using general regression analysis. Based on the operationalizing variables of the different supply-chain integration strategies and

competitive performance definitions, a conceptual model was created (Figure 4). This will be further tested in the next section.

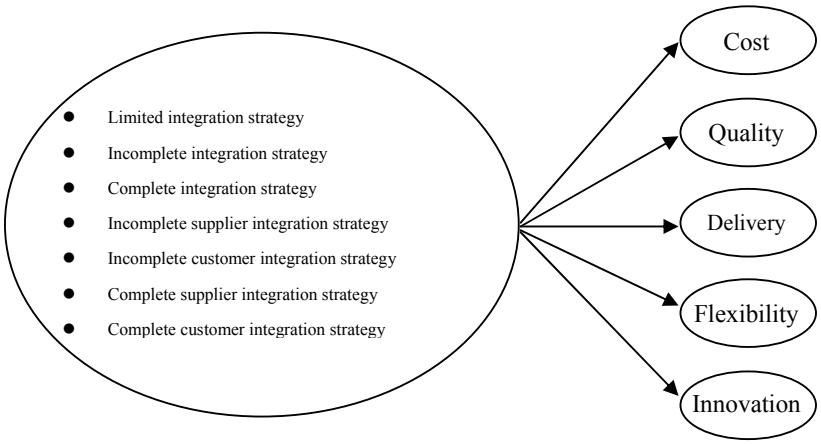


Figure 4: Conceptual model

4. Results and findings

4.1 Test results

The seven integration strategies were evaluated through regression analysis in order to judge the competitive performance of each of the different integration strategies. The regression test results are shown in Tables 6a and 6b. The test results indicated that the limited integration strategy can align significantly and achieve "procurement lead time" ($F = 4.070$, $p < 0.05$) and "labor productivity" ($F = 5.142$, $p < 0.05$) of cost performance, and "delivery speed" ($F = 5.070$, $p < 0.05$) of delivery performance.

The incomplete integration strategy can align significantly and achieve "procurement lead time" ($F = 7.685$, $p < 0.01$), "procurement costs" ($F = 4.069$, $p < 0.05$), and "overhead costs" ($F = 4.399$, $p < 0.05$) of cost performance;

“manufacturing conformance” ($F = 4.370$, $p < 0.05$), “product quality and reliability” ($F = 5.652$, $p < 0.05$), “employee satisfaction” ($F = 12.377$, $p < 0.01$), and “environmental performance” ($F = 9.600$, $p < 0.01$) of quality performance; “time to market” ($F = 5.949$, $p < 0.05$), “customer service and support” ($F = 6.629$, $p < 0.05$), “delivery speed” ($F = 6.783$, $p < 0.01$), and “delivery dependability” ($F = 6.919$, $p < 0.01$) of delivery performance.

The complete integration strategy can align significantly and achieve the best competitive performance: “unit manufacturing cost” ($F = 8.002$, $p < 0.05$), “procurement lead time” ($F = 6.594$, $p < 0.05$), “procurement costs” ($F = 11.376$, $p < 0.01$), “labor productivity” ($F = 26.267$, $p < 0.01$), “inventory turnover” ($F = 21.454$, $p < 0.01$), “capacity utilization” ($F = 7.253$, $p < 0.05$), and “overhead costs” ($F = 4.418$, $p < 0.05$) of cost performance; “manufacturing conformance” ($F = 15.393$, $p < 0.01$), “product quality and reliability” ($F = 8.836$, $p < 0.05$), and “employee satisfaction” ($F = 6.403$, $p < 0.05$) of quality performance; “time to market” ($F = 9.663$, $p < 0.05$) and “customer service and support” ($F = 11.363$, $p < 0.01$) of delivery performance; “volume flexibility” ($F = 12.233$, $p < 0.01$) and “manufacturing lead time” ($F = 5.238$, $p < 0.05$) of delivery performance; and “product innovativeness” ($F = 13.939$, $p < 0.01$) of innovation performance.

The incomplete supplier integration strategy can align significantly and achieve “environmental performance” ($F = 8.632$, $p < 0.01$) of quality performance. The incomplete customer integration strategy cannot align significantly and achieve competitive performance.

When the complete supplier integration strategy is adopted, the cost performances of “procurement lead time” ($F = 3.978$, $p < 0.05$) and “procurement

costs" ($F = 3.938$, $p < 0.05$) can be aligned significantly and achieved. Regarding the complete customer integration strategy, majority competitive performance will be aligned significantly and achieved when firms adopt this strategy in the supply-chain operational environment. These performances include "unit manufacturing cost" ($F = 3.412$, $p < 0.05$), "procurement lead time" ($F = 5.065$, $p < 0.05$), "procurement costs" ($F = 5.653$, $p < 0.05$), "labor productivity" ($F = 6.793$, $p < 0.05$), and "overhead costs" ($F = 7.307$, $p < 0.05$) of cost performance; "product quality and reliability" ($F = 9.017$, $p < 0.01$) of quality performance; "time to market" ($F = 5.173$, $p < 0.05$), "delivery speed" ($F = 5.271$, $p < 0.05$), and "delivery dependability" ($F = 3.371$, $p < 0.05$) of delivery performance; and "product innovativeness" ($F = 4.297$, $p < 0.05$) of innovation performance.

Table 6a: Result of regression

Integration strategies	Limited integration			Incomplete integration			Complete integration			Incomplete supplier integration		
Performance	β	t-value	R^2	β	t-value	R^2	β	t-value	R^2	β	t-value	R^2
Cost performance												
Unit manufacturing cost	.188	1.315	0.035	.075	1.178	0.006	.686	2.829*	0.471	.037	0.242	0.001
Procurement lead time	.282	2.017*	0.080	.175	2.772**	0.031	.650	2.568*	0.423	.012	0.077	0.000
Procurement costs	.001	0.010	0.000	.128	2.017*	0.016	.747	3.373**	0.558	.020	0.128	0.000
Labour productivity	.314	2.267*	0.099	.070	1.092	0.005	.863	5.125**	0.745	-.151	-0.977	0.023
Inventory turnover	.134	0.926	0.018	.043	0.676	0.002	.839	4.632**	0.704	.057	0.369	0.003
Capacity utilization	.244	1.723	0.059	.111	1.740	0.012	.668	2.693*	0.446	-.120	-0.784	0.014
Overhead costs	-.099	-0.685	0.010	.133	2.097*	0.018	.574	2.102*	0.329	.313	2.110	0.098
Quality performance												
Manufacturing conformance	-.091	-0.625	0.008	.133	2.090*	0.018	.794	3.923**	0.631	.077	0.497	0.006
Product quality and reliability	.049	0.335	0.002	.150	2.377*	0.023	.704	2.972*	0.495	-.055	-0.354	0.003
Employee satisfaction	.083	0.569	0.007	.220	3.518**	0.048	.645	2.530*	0.416	.041	0.268	0.002
Environmental performance	.236	1.662	0.056	.195	3.098**	0.038	.405	1.328	0.164	.413	2.938**	0.170
Delivery performance												
Time to market	.254	1.778	0.064	.154	2.439*	0.024	.720	3.109*	0.518	-.187	-1.236	0.035
Customer service and support	.219	1.521	0.048	.163	2.575*	0.026	.747	3.371**	0.558	.109	0.710	0.012
Delivery speed	.312	2.252*	0.097	.165	2.605**	0.027	.549	1.972	0.302	.185	1.223	0.034
Delivery dependability	.220	1.528	0.048	.167	2.630**	0.028	.484	1.660	0.235	.094	0.610	0.009
Flexibility performance												
Product customization ability	.082	0.567	0.007	.035	0.547	0.001	.534	1.896	0.285	.005	0.033	0.000
Volume flexibility	.050	0.340	0.002	.097	1.521	0.009	.759	3.498**	0.576	-.202	-1.320	0.041
Mix flexibility	-.133	-0.918	0.018	.041	0.645	0.002	.399	1.307	0.160	.134	0.866	0.018
Manufacturing lead time	.224	1.576	0.050	.103	1.608	0.011	.607	2.289*	0.368	.053	0.341	0.003
Innovation performance												
Product innovativeness	.079	0.546	0.006	.106	1.665	0.011	.780	3.734**	0.608	.022	0.143	0.000

** Coefficient is significant at the 0.01 level (2-tailed).

* Coefficient is significant at the 0.05 level (2-tailed).

Table 6b: Result of regression

Integration strategies	Incomplete customer integration			Complete supplier integration			Complete customer integration		
Performance	β	t-value	R^2	β	t-value	R^2	β	t-value	R^2
Cost performance									
Unit manufacturing cost	.003	0.023	0.000	-.218	-0.546	0.047	.366	1.847*	0.134
Procurement lead time	.040	0.295	0.002	.631	1.995*	0.399	.433	2.251*	0.187
Procurement costs	.206	1.560	0.042	.630	1.985*	0.396	.452	2.378*	0.204
Labour productivity	.063	0.464	0.004	.371	0.980	0.138	.486	2.606*	0.236
Inventory turnover	.177	1.336	0.031	.069	0.169	0.005	-.114	-0.524	0.013
Capacity utilization	.041	0.298	0.002	.522	1.501	0.273	.101	0.474	0.010
Overhead costs	-.119	-0.886	0.014	-.029	-0.071	0.001	.499	2.703*	0.249
Quality performance									
Manufacturing conformance	.037	0.276	0.001	.475	1.322	0.225	.379	1.880	0.144
Product quality and reliability	.165	1.239	0.027	.510	1.451	0.260	.539	3.003**	0.291
Employee satisfaction	.174	1.297	0.030	.287	0.735	0.083	.253	1.226	0.064
Environmental performance	.134	0.991	0.018	.072	0.176	0.005	.044	0.208	0.002
Delivery performance									
Time to market	-.033	-0.243	0.001	.069	0.169	0.005	.436	2.274*	0.190
Customer service and support	.015	0.114	0.000	.574	1.719	0.330	.242	1.167	0.058
Delivery speed	-.254	-1.950	0.065	-.347	-0.906	0.120	.440	2.296*	0.193
Delivery dependability	-.067	-0.492	0.004	-.146	-0.361	0.021	.365	1.836*	0.133
Flexibility performance									
Product customization ability	.044	0.326	0.002	.283	0.724	0.080	.169	0.802	0.028
Volume flexibility	.174	1.312	0.030	.445	1.217	0.198	.070	0.330	0.005
Mix flexibility	.118	0.880	0.014	.570	1.701	0.325	.111	0.514	0.012
Manufacturing lead time	.039	0.291	0.002	.050	0.122	0.002	.353	1.772	0.125
Innovation performance									
Product innovativeness	.056	0.414	0.003	-.003	-0.008	0.000	.408	2.097*	0.167

** Coefficient is significant at the 0.01 level (2-tailed).

* Coefficient is significant at the 0.05 level (2-tailed).

4.2 Findings

The test results can be used to test the research hypotheses. Hypothesis 1 states, "When manufacturers adopt a complete integration strategy, the best competitive performance will be achieved." By comparing the seven integration strategies, we found that the complete integration strategy can align significantly with majority competitive performance and surpass other six integration strategies. The test results and the related literature, such as [19], [27], and [28], show that when the integration structure is completely extended to suppliers and customers, uncertainty and variability is reduced. Therefore, when firms adopt the complete integration strategy in the supply-chain operational environment, the best competitive performance will be achieved. Therefore, hypothesis 1 cannot be rejected.

Hypotheses 2 and 3 state "When manufacturers adopt a supplier integration strategy in order to achieve competitiveness, majority competitive performance will be achieved" and "When manufacturers adopt a customer integration strategy in order to achieve competitiveness, majority competitive performance will be achieved." The test results showed that the complete supplier integration strategy aligned with the few lowest cost performance. However, the complete customer integration strategy can be used to achieve improved majority competitive performance. Therefore, hypothesis 2 is rejected, and hypothesis 3 cannot be rejected.

The above results also reveal that customer demand integration plays an important role in the supply-chain operational environment. Demand integration is defined as end customers triggering actions up the supply chain, as products and services are created as a result of customer demand ([29]). In fact, as customization becomes key in a competitive environment, firms must satisfy varied customer

requirements. However, how can customer demand be understood? More research needs to be carried out in order for manufacturers to establish an integration structure with customers.

In recent years, more and more researchers, such as [11], [17], [23], and [29], have all explored whether manufacturers can more effectively align and achieve competitive performance through customer demand integration rather than supplier integration. Our test results show that customer demand integration can more drive firms to align and achieve the majority competitive performance.

Hypothesis 4 states, “When the integration scope and structure of integration strategies is shortened, majority competitive performance will be difficult to achieve.” The test results showed that the integration scope and structure of the incomplete integration strategy was a little short, but extended to the supplier and customer. Although shorter than complete integration, this integration strategy can align and achieve good competitive performance when firms adopt this integration strategy in their supply-chain operational environment.

However, the integration scope and structure of the incomplete supplier integration strategy, the incomplete customer integration strategy, and the limited integration strategy are shorter than incomplete integration. We found it difficult for these three integration strategies to align and achieve improved competitive performance. Based on the above results, when the integration scope and structure of integration strategies shortens, majority competitive performance will be difficult to achieve. Therefore, hypothesis 4 cannot be rejected.

Aside from testing the hypotheses, we also reached some other interesting

conclusions. First, three integration strategies are effective: complete integration strategy, incomplete integration strategy, and complete customer integration strategy. Also, the test results indicated that four integration strategies are poor: limited integration strategy, incomplete supplier integration strategy, incomplete customer integration strategy, and complete supplier integration strategy. The supply-chain structure involves many independent firms, including upstream suppliers and downstream customers. Through the integration of different independent firms, supply-chain integration can help manufacturers possess powerful competitive ability. As [41] indicated, successful supply-chain integration can improve competitive advantage, creating improved competitive ability to achieve advanced competitive performance. However, as a result of resource limitations and the nature of the development environment, it is usually difficult for manufacturers to completely integrate all independent firms, and manufacturers usually develop other integration strategies in order to remain competitive. Even then, firms still have to avoid the adoption of poor integration strategies.

Second, we found that manufacturers are increasingly adopting customer demand integration. These results show that customer demand integration is becoming more and more important.

Third, over 50% of the sample manufacturers adopted incomplete integration strategies in the supply-chain operational environment. This result means that most manufacturers still find it difficult to completely extend the scope of the integration of the supply-chain operational environment. Perhaps manufacturers need more resources if they wish to completely extend their integration structure and scope to suppliers and customers.

Fourth, over 30% of the sample firms still adopt poor integration strategy. This means that more manufacturers should check their integration strategy and make alternative plans. Of course, these manufacturers may be limited in terms of their resources and development environment, and may have been forced to adopt a poor integration strategy.

5. Conclusion

This study investigated the practical performance of different supply-chain integration strategies. We clearly defined the different integration strategies and the level of competitive performance that they satisfied. Data were taken from the International Manufacturing Strategy Survey (IMSS).

The goal of integration is to improve manufacturing processes, leading to the greatest possible competitive performance that most competitors cannot easily match ([3] [15] [16]). In order to improve supply-chain integration, creating an integration strategy is the key to being competitive. Although most of the related literature indicated that the best integration strategy must have a structure and scope that completely extends to suppliers and customers, most firms are limited in terms of their resources and development environment, so it is difficult to establish the best integration strategy. Therefore, most firms must develop other integration strategies.

However, firms must understand which integration strategy will align and achieve with different levels of competitive performance. This study found that there are seven different integration strategies in the real world. We also found that the different integration strategies will align and achieve with different levels of competitive performance when the strategies are adopted and practiced. We were able to define

which integration strategies are effective, and which are poor.

The above findings present some important implications for research and managerial practice. In terms of research, when researchers try to explore the alignment relationship between integration strategy and performance for any industry, perhaps researchers should judge which integration strategy should be adopted in which industry, and explore why this strategy should be adopted. This study also has several important implications for managers. Managers can refer our findings in order to check whether their integration strategy can lead to improved performance, and to understand which integration scope and structure is effective.

As our results indicate, some issues should be further explored in future research. First, we found that the complete supplier integration strategy can only align with cost performances, while the complete customer integration strategy can align with and achieve more competitive performances. Although [40] found that it is difficult to align supplier integration with competitive performance, many other researchers believe that supplier integration can achieve specific competitive performances such as cost, quality, and innovation. Perhaps researchers need to explore which industries can effectively adopt the supplier integration strategy, and which industries can effectively adopt the customer integration strategy.

Second, although we found that the complete integration strategy is the best, over 50% of firms still adopted the incomplete integration strategy in the supply-chain operational environment. Future research can explore how and why in order to help firms improve their integration strategy.

Third, we found that over 30% of firms adopted a poor integration strategy.

Future research can explore the reasons why, and how to improve.

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