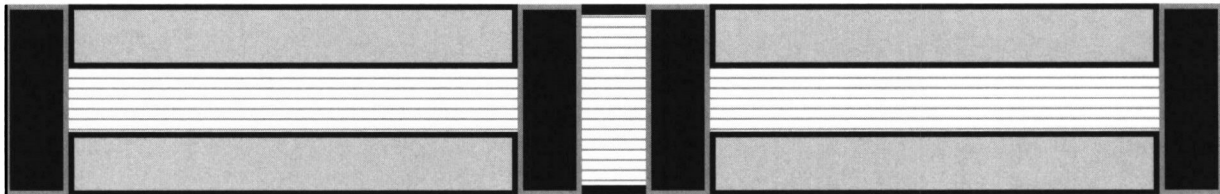


Supply Chain Integration and Organizational Success

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Introduction

Supply chain management is widely accepted today as the concept that links the operating side of a business with its suppliers and customers, ideally in a seamless chain of product and information flows. The integration of companies and processes, within a firm and across firms, is suggested as a better way to achieve supply chain success. The purpose of this paper is to ascertain whether companies perform better on various cost and customer performance measures when they have identified themselves as high performers on supply chain integration compared with their competitors.

The paper begins by reviewing the literature on supply chain integration, its definition, and studies that evaluate a strategy to integrate supply chains. The importance of integration for better supply chain performance will be discussed. Next, we present our study that used a multi-country survey instrument to identify companies describing themselves as successful at supply chain integration. Based on supply chain literature, firms that are members of well-integrated supply chains should have better results in meeting customer demands than their competition.

Literature Review

It is quite common today for descriptions of supply chain management to include the term 'integrated' or 'integration' in discussing how relationships should be built across companies. While there is no precise definition of supply chain integration, both practitioner and academic literature make common use of the term. As defined by Ellram and Cooper (1993), supply chain management is "an integrating philosophy to manage the total flow of a distribution chan-

nel from supplier to ultimate customer." Monzcka and Morgan (1997) stated that "integrated supply chain management is about going from the external customer and then managing all the processes that are needed to provide the customer with value in a horizontal way." Lummus and Vokurka (1999) in a summary definition of supply chain management offered that "... supply chain management coordinates and integrates all of these activities into a seamless process." They also discussed the total integration required for managing the supply chain.

Supply chain integration. Several authors within the field of supply chain management have proposed definitions for integration (Kahn and Mentzer, 1998; O'Leary-Kelly and Flores, 2002; Vickery, et al., 2003). In his 2004 study of factors that enable and inhibit integration, Pagell (2004) proposes the following definition: Integration is a process of interaction and collaboration in which manufacturing, purchasing, and logistics work together in a cooperative manner to arrive at mutually acceptable outcomes for their organizations.

Naylor et al., (1999) stated that the goal of an integrated supply chain is to remove all boundaries to ease the flow of material, cash, resources, and information. Van Donk and van der Vaart (2005) suggested that removing barriers (or boundaries) can be achieved by developing integrated activities in a number of areas (scope) and with a certain intensity (level) in each area. They looked at four logistical areas as dimensions of scope including flow of goods, planning and control, organization, and flow of information. The level of integration was measured by the extent of integrative activity developed.

The following sections outline the literature

support for the importance of supply integration and the performance measures that might indicate the benefits of integration.

The importance of supply chain integration.

Integration appears to be viewed from many perspectives. There is widespread support for the concept of integration backwards from customers to suppliers (Trent and Monczka, 1998; Frohlich and Westbrook, 2001; Ragatz, et al., 2001; Narasimhan and Das, 2001; Morgan and Monczka, 1996). Purchasing serves as an integrating mechanism and plays a key role in aligning supplier performance with the firm's competitive priorities.

Integration has also been viewed from the downstream side of the supply chain (forward integration), including the flow of material from manufacturers and logistics providers to end customers. This concept has been studied from both the logistics and customer perspectives by several authors. Romano (2003) proposed that logistics processes are a key area for integration between firms. Christopher and Towill (2002), Childerhouse and Towill (2002) and Lee (2002) all focused on customer integration through reductions in demand uncertainty and development of market-specific strategies.

Integration is not only important between firms, but also within companies. Research along two dimensions indicates its importance. The first is the integration of processes within and across firms through the use of information flows. Vickery et al. (2003) suggest that integrated information technologies are key to supply chain integration. They included both inter-firm electronic data exchange, but also intra-firm through Material Requirements Planning (MRP) systems. Other research on supply chain integration involves social interaction within and between firms. Cousins and Menguc (2005) found that increased levels of interaction, through communication, regular meetings, and other team activity improved supply chain integration.

The work of Frohlich and Westbrook (2001) is the most comprehensive evidence of supply chain integration as a specific strategy followed by manufacturers. They show evidence of the level of integration and the direction of that integration (toward suppliers or toward customers). They also demonstrate that those firms that are outward-facing, choosing to act on supply chain integration, had the highest level of performance improvements. The outward-facing group grasped the importance of supply chain integra-

tion and also incorporated it into their operation. Pagell (2004) goes one step beyond the Frohlich and Westbrook model of arcs of supply chain integration to prescribe actions that facilitate or hinder integration. He found that organizational structure that encourages the flow of goods and services, cultures that encourage openness and teamwork, mechanisms that improve open communication (specifically through cross-functional teams and job rotation based on proximity), well-designed measures and reward systems, and consensus between functional and strategic goals are all important to the integration of operations, purchasing, and logistics.

Integration and performance measures. The previous research on supply chain integration described in this paper suggests that better integrated supply chains leads to better performance. Other authors have also suggested this (Lee et al., 1997, Narasimhan and Jayaram, 1998, Lummus et al., 1998). Frohlich and Westbrook's study (2001) is one of the few attempts to test the relationship between supply chain integration and performance. They suggested three groupings of measures that should all show improvement as a company becomes more integrated with their supply chain partners. The groups included marketplace measures such as market share and profitability, productivity measures such as average unit manufacturing cost and delivery lead time, and nonproductivity measures such as customer satisfaction and on-time delivery. Their analysis of 322 global manufacturing companies provided evidence that integration in the supply chain differentiates performance.

Purpose of the Study

The purpose of this study is to ascertain whether firms perform better on various cost and customer performance measures when they have identified themselves as high performers on supply chain integration compared with their competitors. Companies appear to understand what it means to have an integrated supply chain, although previous research does not empirically validate that better integrated supply chains results in better performance. The results of this study will be used to show that, indeed, companies that are part of better integrated supply chains do perform better than companies that are not.

As with Frohlich and Westbrook's work (2001), this study uses measures of productivity

such as production costs, total product costs, supply chain costs, manufacturing throughput time and order fulfillment speed, along with nonproductivity measures such as delivery speed and delivery as promised to evaluate whether companies in well-integrated supply chains are really performing better than competitors not in such chains. This study also considers the important issue of flexibility in well-integrated supply chains. Companies in well-integrated supply chains should be more flexible, as evidenced by delivery flexibility and flexibility to change output volume and product mix. Companies that are integrated with their supply chain partners should perform better on these measures than their competitors that are not integrated with their supply chain partners.

Research Methodology/Data Collection

This study used data collected as part of the third round of manufacturing research conducted by Global Manufacturing Research Group (GMRG). Early in the 1980s, this group of researchers recognized that manufacturing, even though important to the U.S. economy, was being outsourced around the world, thereby reducing the opportunity to assess relevant data in the U.S. The decision was made to utilize survey methodologies to collect data not only from U.S. manufacturers but also from similar manufactures wherever the membership of the group would permit. A number of researchers

pooled their survey data from multiple countries. Survey questions cover the areas of manufacturing activities such as sales forecasting, production planning and scheduling, shop floor control, purchasing and materials management, and manufacturing performance. The first survey, structured around qualitative and quantitative data, was written and administered in the 1980s. Second and third rounds refined many of the questions and extended the research to additional countries. Data from the third round became available in 2005. The survey questionnaire has been previously validated in many studies published in *Decisions Sciences, Journal of Operations Management, International Journal of Production Research*, etc. Details about the development and the administration of the survey are available in Vastag and Whybark (1994) and Whybark (1997). The third round of data collection follows the same methodology used for the earlier rounds.

The data from the GMRG third round results included information from 325 manufacturing firms in Canada, Hungary, Italy, Lebanon, Taiwan, and the United States, the initial regions of data collection in this round. These regions were thought to be diverse enough for this study, but it was recognized that they would not represent all global firms.

Participants agreed to complete a detailed survey describing both manufacturing issues and overall company performance. Table 1 provides

Table 1. Frequency Distribution for Sales

Category By Sales Dollar	Number of companies	% of Total
\$0-under \$50,000,000	184	64.8
\$50,000,000-under \$100,000,000	21	7.4
\$100,000,000-under \$500,000,000	16	5.6
\$500,000,000-under \$1,000,000,000	17	6.0
\$1,000,000,000 or more	46	16.2
Total	284	100.0

Note: 41 respondents did not report sales

Table 2. Number of Employees by Country

	Canada	Hungary	Italy	Lebanon	USA	Taiwan	Total
0-49	10	0	23	6	4	12	55
50-99	25	0	9	7	16	18	75
100-499	50	43	6	5	24	15	143
500-999	4	17	2	1	1	6	31
1,000+	1	7	0	1	0	12	21
Total	90	67	40	20	45	63	325

details on firm size as indicated by sales volume. Table 2 provides further information on firm size through numbers of employees in each country. The total number of firms from each country is also identified.

A seven-point Likert scale was used to measure respondents' perception of the extent to which their supply chain was integrated compared with their competitors (with 1 = far worse than competitors and 7 = far better than competitors). A seven-point Likert scale was also used to measure how the firm compared with its competitors on the following performance indicators:

- Production costs
- Total product costs
- Supply chain costs
- Order fulfillment speed
- Delivery speed
- Delivery as promised
- Delivery flexibility
- Flexibility to change output volume
- Flexibility to change product mix
- Manufacturing throughput time

The respondents were also asked approximately how many calendar days into the future the company promised delivery, and what that time frame would have been two years ago. Of orders delivered to customers, respondents were

asked what percentage were delivered after the promised date, both today and two years ago.

Analysis and Results

Supply Chain Integration. In response to the question, "How does the company compare with its competitors (1 = far worse than competitors, 7 = far better than competitors)" for supply chain integration, the mean response was 4.67. This is above the midpoint of the scale (or 4). We also looked at the distribution of responses by country, which are shown in Table 3. In general, firms in Lebanon rated their supply chain integration (5.40) higher than the other countries included in the sample. Firms in Italy (4.15) and the United States (4.14) rated the extent of supply chain integration lower than other countries. Italy and United States were statistically significantly lower than other countries (at $p < 0.01$).

To determine the performance results related to supply chain integration, we split the firms into three groups. The firms that rated a 6 or 7 were designated the top performers (on supply chain integration), the middle group rated a 5, and the low performers a 1, 2, 3, or 4. The top-performer group included 68 firms (22% of the total), the middle group 111 firms (36%), and the low performers 131 firms (42%).

Next, we compared the 10 different performance-indicator responses of the top supply chain integration firms to those of the low-integration firms. We calculated the differences and found that there were statistically significant

Table 3. Supply Chain Integration by Country

Rating*	Canada	Hungary	Italy	Lebanon	Taiwan	USA	Total	% of Total
7	3	1	1	2	3	0	10	3.2
6	14	17	3	7	14	3	58	18.7
5	29	31	9	8	23	11	111	35.8
4	28	13	12	3	16	20	92	29.8
3	10	4	5	0	4	9	32	10.3
2	0	0	1	0	3	1	5	1.6
1	0	0	2	0	0	0	2	0.6
Total	84	66	33	20	63	44	310	100.0
Mean	4.67	4.97	4.15	5.40	4.79	4.14	4.67	
(missing)	6	1	7	0	0	1	15	

* How does the company compare with its competitors (1=far worse than competitors, 7=far better than competitors)?

Table 4. Performance

Performance characteristic *	Top performers	Low performers	Difference	t-test	p-value
	n = 68	n = 131			
Supply chain integration	6.15	3.63	2.52	35.73	<0.0001
Production costs	4.97	4.19	0.78	4.65	<0.0001
Total product costs	4.97	4.22	0.75	4.46	<0.0001
Supply chain costs	5.28	4.28	1.00	6.67	<0.0001
Order fulfillment speed	5.75	4.61	1.14	7.30	<0.0001
Delivery speed	5.82	4.68	1.14	7.59	<0.0001
Delivery as promised	5.81	4.80	1.01	6.13	<0.0001
Delivery flexibility	5.63	4.85	0.78	5.23	<0.0001
Flexibility to change output volume	5.60	4.76	0.84	5.42	<0.0001
Flexibility to change product mix	5.38	4.92	.046	2.66	0.0043
Manufacturing throughput time	5.21	4.57	0.64	3.38	0.0005

* How does the company compare with its competitors (1=far worse than competitors, 7=far better than competitors)?

Table 5. Delivery Performance

	Top performers	Low performers	Difference	t-test	p-value
Approximately how many calendar days into the future has the company promised delivery?					
Current	10.65	28.51	17.86	2.11	0.0183
Two years ago	18.42	32.64	14.22		
% improvement	42%	13%			
On average, what percentage of the company's orders is delivered to customers after the promised date?					
Current	11.20	19.26	8.06	2.14	0.0166
Two years ago	16.76	22.66	5.90		
% improvement	33%	15%			

differences between the two groups for each of the 10 performance measures (all with $p < 0.01$) (see Table 4).

We also looked at two customer-related delivery performance measures to determine if there were differences between the top and low performers on "How many calendar days into the future has the company promised delivery?" and "What percentage of the company's orders is delivered to customers after the promised date?" On average, the top performers (on supply integration) promise delivery within 11 calendar days and the low performers in 29 days. The percentage of orders delivered to customers after the promised date is 11% for the top performers and 19% for the low performers. For both of these measures the top performers excelled at a statistically significant level ($p < 0.05$) (see Table 5). The top performers also showed

greater improvements over the past two years on each of these measures; 42% to 13% improvement on promised delivery dates and 33% to 15% improvement of the percentage of orders delivered to customers after the promised date.

Discussion and Managerial Implications

The results paint a promising picture for the supply chain manager attempting to justify integration techniques within his or her company. These results may be even more important to the manager trying to convince other members of the supply chain that the techniques may improve the entire chain's competitiveness. While there is widespread support for the concept of integration backwards from customers to suppliers, companies have only anecdotal evidence to convince their suppliers that integration will really improve both companies' perfor-

mance. At the same time, integration on the downstream side of the supply chain to end customers contributes to improved delivery performance and delivery flexibility and should be used to develop market-specific strategies.

Integration can take many forms within and across companies. Technology is available to share demand information and operations plans with both customers and suppliers. This may take the form of linked computer planning systems or sharing access to each other's system via the Internet. Other kinds of integration may be as simple as communicating with suppliers any plans for new product introductions. While this study did not propose to identify integration methods, it did provide evidence that the methods are successful.

Although this study showed that a higher level of supply chain integration leads to improved performance and faster and more reliable delivery performance, it did not provide evidence of the impact of different aspects of integration, e.g., scope or extent or where in the supply chain the integration occurs. Also not evident are the possible interaction effects of different types of integration. Additionally, whether or not there is a specific sequence of integrations that leads to better performance was not apparent from the results of this study.

One of the interesting results from the study was that managers in the United States were the least likely (along with those in Italy) to think their supply chains were well integrated compared with all other countries. This could be due to U. S. managers' more extensive knowledge of available technology. If they are aware of the capabilities for integration through technology, but have not implemented them, they are not likely to view their supply chain as integrated. One might also speculate that U.S. companies have succeeded in the past without integrating with their supply chain partners. There are many other possible cross-cultural variables, e.g., individual reliance on informal vs. formal relationships. It would be interesting to understand how important they felt integration would be to their future success.

Limitations

There were several limitations to the study. Although the responses were from a number of countries, across many industries, and included firms of all sizes, the survey sample was not designed to represent the population of firms, countries, and industries. The sample set in-

cluded manufacturing firms for which respondents completed the survey.

The responses for supply chain integration and performance dimensions were self-reported. A consistent numerical scale was not used to quantitatively supply chain integration or performance measures. The perceptual methods may include biases, different interpretations, or different competitive comparisons.

Definitions were not provided for supply chain integration or performance metrics. The interpretation of each was left to each respondent, and there could well be differences in the meanings of each of these terms.

Conclusions

Supply chain integration is a key capability in meeting the demands of today's global customers. Based on a study of 325 manufacturing firms, the results show that firms that have done a better job of integrating their supply chains perform better on a variety of performance metrics. This includes internal performance metrics as well as delivery speed and reliability in meeting customer requirements.

The area of supply chain integration needs further exploration to determine the level and scope of supply chain integration and the resulting impact on various performance measures. This study used a broad self-reported measure of supply chain integration. Further research needs to be conducted on the different components of supply chain integration and performance. From these studies, firms could better determine the best approach to improving supply chain integration and, hence, performance and customer deliveries. The competitive nature of business today requires firms to further integrate their supply chains, as shown by the overall results of this study.

Dr. Lummus conducts research in supply chain strategies and the effects of demand management strategies in the supply chain. Dr. Vokurka's research focuses on supply chain management as well as on manufacturing strategy and performance improvement. Dr. Krumwiede's research interests include project management systems, value chain management, and operations issues involving environmental management.

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**Trust and Commitment: 46
Reciprocal and Multi-
dimensional Concepts in
Distribution Relationships**

Those who create products or services often do not distribute (sell) them. Their success may be in the hands of their distribution channel. The degree of mutual trust and commitment between the organizations is crucial to their mutual long-term success. This study of the many dimensions of trust and commitment — the two are not the same — and the evolutionary nature of their development reflects a survey of electronic components manufacturers, testing nine hypotheses. Managers should benefit from results showing the importance of proceeding step-by-step to build each level of the various types of trust and commitment.

Gregory S. Black

**Supply Chain Integration and 56
Organizational Success**

Much has been written about the importance of managing the supply chain if global companies wish to succeed. A key aspect of such management is integrating activities within and across companies in the chain. Organizations that achieve this should be expected to have higher levels of performance. Using data from the third round of Global Manufacturing Research Group results, this study analyzed several performance measures, including year-to-year-changes, to confirm that supply chain integration does improve performance. The study also found interesting variations among countries.

**Rhonda R. Lummus, Robert J. Vokurka, and
Dennis Krumweide**

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