

Supply Chain Management: A Survey of Current Practice in the US

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ABSTRACT

Over the past decade, purchasing has evolved from a clerical function to becoming an integral part of the corporate strategic planning process in firms striving to achieve competitive success. Purchasing is one component of a broader approach to materials and distribution management known as Supply Chain Management (SCM). This research examines the development and impact of SCM on contemporary business practice. Results of a survey on the use of SCM are presented which provide empirical evidence to support findings cited in the literature. Survey results demonstrate the relationships between factors cited in the literature as being elements of effective SCM such as company practices in customer relations and purchasing, and corporate performance. In many cases, these relationships suggest a direct and positive relationship between effective SCM practice and corporate performance.

Key Words: Supply chain management, purchasing, supplier integration, supplier certification.

1. Supply Chain Management Defined

During the 1980s, manufacturers utilized Just-in-Time (JIT), Total Quality Management (TQM), and other programs to improve manufacturing efficiency. Today, as customers become even more sophisticated and require highly specialized and customized products to meet their needs, the push for mass customization and flexibility is gathering momentum. Producers of standardized, mass produced items are examining how manufacturing practices can be modified to reduce lead times. Make-to-order and assemble-to-order manufacturers are also under increasing pressure to meet smaller lot size and shorter delivery lead time requirements. As a result, mass customization strategies that emphasize flexibility, low cost, high quality and efficient small batch production are rapidly gaining ground.

To respond to these challenges, many organizations have upgraded their purchasing function from mere order placing to an integral part of the corporate planning process. These organizations recognize the benefits and potential competitive advantage associated with integrating the purchasing process into strategic planning. Integrating purchasing and supply management with other key corporate functions allows a closely linked set of production processes to be formed. This allows organizations to deliver products and services to both internal and external customers in a more timely, effective manner. To further exploit the competitive advantage associated with integrated processes, organizations are now also adopting a strategic approach to managing other elements of the supply chain. Companies are forming strategic alliances with suppliers instead of acquiring sources of supply or purchasing. Furthermore, they are viewing suppliers as partners as opposed to adversaries.

The literature is replete with buzzwords describing this new phenomenon; integrated purchasing strategy, supplier integration, buyer-supplier partnerships, supply base management,

strategic supplier alliances, supply chain synchronization and supply chain management. While each addresses elements of the phenomenon, typically focusing on immediate suppliers of an organization, supply chain management (SCM) encompasses the entire value chain. SCM addresses materials/supply management from the supply of raw materials to its end of life (and possible recycling or re-use) (Baatz, 1995). It focuses on how firms utilize their suppliers' processes, technology, and capability to enhance competitive advantage (Farley, 1997).

While in principle SCM addresses the supply process throughout the value chain, a practical approach to SCM is to consider only strategically important suppliers in the value chain. When all strategic suppliers in the value chain 'integrate' and act as a single entity, performance is enhanced throughout the system of suppliers. Figure 1 presents a simplified SCM paradigm with two alternative perspectives of SCM and how it enhances business results. This figure illustrates the evolution of supply chain management from the previously disparate functions of transportation and purchasing, with a focus on integration, visibility, cycle time reduction, and streamlined channels. A key facilitating mechanism in the evolution of supply chain management is a corporate vision which drives change throughout a firm's internal and external linkages.

[Insert Figure 1 about here]

Most of the literature on SCM follows the purchasing and supply perspective. According to this perspective, SCM is synonymous with the supplier base integration that evolved from the traditional purchasing and materials management function. It is a management philosophy that extends traditional intra-enterprise activities by embracing an inter-enterprise scope, bringing trading partners together with the common goal of optimization and efficiency (Harwick, 1997). In effect, SCM creates a virtual organization composed of several independent entities with the

common goal of efficiently and effectively managing all the entities and operations of the organization.

A customer driven corporate vision and effective SCM produce a competitive edge in different ways. Their short term objective is primarily to increase productivity and reduce inventory and cycle time, while the long term, strategic objective is to increase customer satisfaction, market share and profits for all members of the virtual organization. To realize these objectives, all strategic partners must recognize that the purchasing function is the crucial link between the sources of supply and the organization itself, with support coming from overlapping activities from sourcing to product design and delivery. For example, the involvement of purchasing in concurrent engineering or value analysis/engineering is essential to selecting components that ensure that the requisite quality is designed into the product. SCM seeks improved performance through better use of internal and external supplier capabilities and technology. This can in turn elevate inter-company competition to inter-supply chain competition (Morgan and Monczka, 1996).

According to the transportation and logistics perspective, SCM is synonymous with integrated logistics systems. Its origin can be traced to an effort for better managing the transportation and logistics function (Turner, 1993, MacDonald, 1991). Corporate vision of a holistic approach to logistics and the use of time phased inventory replenishment tools such as Distribution Resource Planning (DRP) and Manufacturing Resource Planning (MRP II) provide improved visibility and reduced demand uncertainty. Improved visibility affects the entire value chain by providing better customer service, replacing inventory with information, reducing transportation costs and consolidating distribution centers, thereby enhancing corporate performance. While this research focuses primarily on the purchasing and supply perspective of

SCM, there is little doubt that effective logistics systems are a vital component of a successful SCM strategy.

As the 21st century approaches, many manufacturers and retailers have embraced the concept of SCM with the hope of reducing costs by cutting inventory and improving efficiency throughout the value chain. Additional challenges to successful SCM include how supplier strength and technology can be exploited to support new product development (Morgan and Monczka, 1995), and how direct store delivery or cross docking can be achieved without the need for inspection by the buyer (St. Onge, 1996). Facilitating the evolution of SCM is the rapid development of SCM software for client/server environments in recent years, such as version 10 of Oracle's Cooperative Applications software which includes a completely integrated SCM and electronic commerce component. This system enables users to integrate the package into their suppliers' and customers' existing and future SCM systems (King, 1996, Semich, 1994).

2. Conditions Conducive to Supply Chain Management

Supply chain management allows organizations to realize the advantages of backward vertical integration while overcoming its disadvantages. However, certain conditions must be present for successful SCM adoption. The single most important prerequisite is a change in the corporate cultures of all members of the value chain to make them conducive to SCM (Farley, 1997). The traditional culture that emphasizes seeking good, short term, company focused performance conflicts with the objectives of SCM. SCM focuses on positioning the virtual organization to realize consistently high performance and profitability in a way that all contributors in the organization's value chain benefit. This requires greater coordination of the roles and responsibilities of members of the organization as well as greater cooperation. Effective SCM rests on the twin pillars of trust and communication (Grieco, 1989). Procurement

professionals may have the necessary expertise in the critical functions of their own enterprise, but may not fully understand how it affects the entire value chain. Proponents of SCM will not dispute that a buyers' market is an ideal time to develop long term strategies with key suppliers. They look at a buyers' market as a time when they have leverage over key suppliers and can assert themselves in defining various aspects of the relationship, particularly with respect to cost, quality, certification of processes, acquisition and sharing of new technology and production competence. Working cooperatively with suppliers, savvy procurement professionals move beyond mere cost reduction into the domain of real manufacturing efficiency, utilizing concepts and techniques such as value analysis, materials standardization and early supplier involvement (Porter, 1994). Supplier evaluation measures must be modified accordingly to encourage long term commitment and cooperation instead of focusing on lowest unit cost as in the old adversarial relationship paradigm.

Superior logistics is another key to successful SCM adoption. When coupled with a state of the art information system such as electronic data interchange (EDI), the transportation system becomes the warehouse. Instead of physically accumulating orders in a warehouse, orders can be consolidated in the computer and carriers can be coordinated for JIT delivery. Successful application of JIT principles in SCM requires agreements that strengthen buyer-supplier cooperation so that supply strategy is directly linked to the firm's overall strategy (Polakoff, 1992, Romero, 1991). However, JIT purchasing does not mean pushing back inventories on suppliers (Adair-Heeley, 1988), rather it emphasizes reduction in inventory levels throughout the value chain.

According to a study of 300 US purchasing personnel (Carter and Narasimhan, 1994), explicit supply management strategies and goals are required for successful SCM adoption. In

addition, business planning processes must give explicit recognition to purchasing and supply chain requirements. A formal purchasing performance evaluation system linked to rewards and recognition must also be in place to encourage risk taking.

3. Survey Details and Profile of Respondents

A survey was carried out to elicit information on how companies manage practices that the literature suggests are important components of effective SCM. These practices are purchasing, quality management, and customer relations. In addition, the survey sought information on company performance and the impact that competition has had on the companies in question. The survey population consisted of members of the American Society for Quality Control (ASQC). The membership of ASQC provides a good sampling frame for US companies across a broad spectrum of industries. ASQC records identified 3,000 quality directors and vice presidents. From this membership, 1,469 manufacturing firms in the automotive, chemical, computer, construction, consumer products, defense, electronics, industrial products, medical device, packaging, pharmaceutical, paperboard, semiconductor, and telecommunications industries were identified. The survey instrument was sent to quality directors or vice presidents of these companies. Two mailings and one follow-up reminder resulted in a response rate of 21.3% (313 surveys returned). Statistical analysis of the data showed that non-response bias was not significant.

The companies from whom a response was obtained varied in size from 12 to 256,000 employees with a mean of 5,228 employees. Approximately 22.5% of the companies employed fewer than 100 employees while another 14.7% of the companies employed between 101 and 200 employees. Approximately 9.2% of the companies employed more than 8,000 employees. Annual sales (1993) of the companies ranged from \$1 million to \$ 65 billion with a mean of

approximately \$ 900 million. About 82% of the firms' sales were in the United States and Canada. Seventy-nine percent of responding companies had documented quality plans but only twenty-four percent were ISO 9000 certified. While the investment and lead time associated with receiving ISO 9000 certification are likely reasons for the current low percentage of certified companies, increasing emphasis on SCM and intensifying global competition may lead to an increase in the percentage of firms with either ISO 9000 or other certification of their processes.

4. SCM Practices

The survey instrument contained ten questions that addressed purchasing practices (Appendix I, questions B). The questions examined the extent to which companies were involved with ten related areas of supply base management, supplier development and customer-supplier integration. Responses indicated that suppliers' technical support and test capabilities are widely used by respondent firms (Table 1). This finding supports the fact that manufacturers are integrating their suppliers' knowledge into new product and process design.

Decentralized purchasing of materials, allowing individual plants to source low volume, low cost materials, supplier certification of product, and annual price negotiations on key items are also widely practiced. The widespread use of decentralized purchasing of materials seems to suggest that it may be a practical solution when combined with corporate purchasing of products and services that are used across divisions. The latter allows the firm to utilize a supplier's economies of scale and results in a reduction of prices through volume discounts. Certification of the supplier's product was found to be statistically more important than certification of the supplier's process. This is surprising in that it contradicts earlier findings (Inman and Hubler, 1992). The least frequently used practice is the use of commodity management teams to set supplier performance goals.

[Insert Table 1 about here]

A key element of supply chain management involves downstream integration of customers, as well as the management of upstream suppliers. Seven questions (Appendix I, questions C) asked respondents about the relative importance of various customer management practices in their companies. High ratings on these questions imply that firms are aware of their dual roles as buyers and suppliers in the value chain. Attempts to improve performance, encourage trust, and effective communication foster long term cooperation and strategic alliances. Responding firms are confident in their ability to evaluate customer complaints (Table 2). While it is encouraging that the firms paid attention to customer complaints, it may also signal an overly confident attitude of the supplier. This could have a potentially disruptive effect if customer perceptions do not match those of suppliers. Responses also show that firms are confident of their ability to monitor and provide support to their external customers, either by following up with customers for feedback, enhancing customer support or predicting key factors affecting customer relationships. This is a clear sign that these firms are creating an environment conducive for successful SCM. The ability to predict customer's future expectations may be an indication that buyers and suppliers are working together to set mutually acceptable standards and expectations¹.

[Insert Table 2 about here]

¹ Analysis of variance ($\alpha = 5\%$) showed that firms rated their ability to manage customer relations practices (mean response of 4.9254 on the seven questions) higher than the sophistication of their purchasing practices (mean response of 4.1296 on the ten questions).

5. How Tracking Purchasing Performance Makes a Difference

To investigate whether the tracking of purchasing performance has any value, respondents were asked whether they monitored any of six supplier related performance measures observed in the literature (Appendix I, questions D). If they did, they were also asked to estimate the magnitude and direction of changes in each measure over the last three years. This makes it possible to identify if there is a relationship between, for example, tracking the number of suppliers, and changes in the number of suppliers used or on-time delivery performance. Multiple linear regression was used to study the relationships between the supplier evaluation variables and supplier performance (Table 3).

[Insert Table 3 about here]

Over 70% of respondents indicated that they tracked on-time delivery, 69.6% tracked the percent of acceptable materials, and 63.9% tracked the total number of suppliers used. The high percentage of firms tracking these measures could be attributable to the increasing acceptance of the JIT manufacturing philosophy. As firms continue to adopt the JIT manufacturing philosophy, suppliers are increasingly relied upon to deliver high quality products and materials on time. It is also likely that many firms will also reduce their supplier base and form strategic partnerships with a smaller pool of suppliers.

There is no statistical evidence to suggest that monitoring any of the supplier evaluation variables affects the number of suppliers used or total purchase costs (Table 3). Tracking on time delivery performance appears to result in improved timeliness of supplier deliveries. Similarly, improved supplier performance in delivering acceptable materials appears to result from tracking the percent of acceptable materials. Tracking the percent of single sourced items relates positively with increases in the use of single sourcing as does the tracking of the percent of

certified suppliers and total purchase costs. However, it cannot be positively concluded that monitoring either single sourced items, the use of certified suppliers, or total purchases costs leads to increased single sourcing since regression does not imply causation. It could be that firms started monitoring single sourced items when they realized that the numbers and costs of such items had increased significantly. Tracking the percent of certified suppliers also relates positively with increases in the use of certified suppliers.

6. How Supply Chain Management Affects Performance

To investigate whether SCM has a positive impact on firm performance, bivariate correlation analysis was used to identify relationships between the two elements of SCM discussed earlier, customer relations practices and purchasing practices, and nine measures of firm performance (Appendix I, questions A). For each element of SCM, the practices that respondents were questioned on were correlated with each of the nine measures of firm performance. These measures were validated against a set of financial indicators from a subsample of 75 companies listed on the Dunn and Bradstreet financial database. Correlation coefficients ranged from 0.15 to 0.45, and were all statistically significant thus there is no reason to suspect the validity of these 9 measures of firm performance.

Results suggest that purchasing practices that reflect supplier capabilities correlate positively and significantly with most performance measures (Table 4). Using supplier knowledge and skills, requiring supplier certification of products and processes, visiting supplier facilities regularly, sharing confidential information, and using commodity teams to set supplier goals all correlate positively with return on assets, growth in market share, sales, and return on assets. In addition, in some cases, they correlate significantly with market share, customer service, product quality, and competitive position. Only the use of suppliers knowledge and skills

yielded a significant positive correlation with production cost. This might be explained by the fact that a greater level of coordination with suppliers is needed. However, in the long run, one would expect production costs to fall. Decentralizing purchasing and allowing individual plants to source low volume and low cost items did not appear to have a significant relationship with any of the performance measures while an inverse relationship exists between notifying suppliers of new product designs and performance. Of the ten practices examined, regular visits to supplier facilities consistently had the greatest impact on performance. It is also interesting to note that while certification of supplier processes has a greater impact than certification of supplier products on market share and financial measures of performance, the reverse is true when evaluating customer service, product quality and competitive position.

[Insert Table 4 about here]

Correlation of customer relations practices with performance shows that with the exception of production cost, performance measures show significant positive correlation with the use of each of the seven practices examined (Table 5). The only practice to correlate significantly with production cost was enhancing customer support. This is likely due to increased after sales service and participation in customer's product design and development or other forms of early supplier involvement. The fact that production cost does not otherwise exhibit significant positive correlation with use of the practices is itself noteworthy, suggesting that using progressive customer relations practices to improve corporate performance does not lead to increased production cost. This is substantiated by the observation that the practices that consistently yielded the highest correlation with performance were enhancing customer support, predicting future customer expectations, and predicting key factors affecting customer relationships. These are all practices that emphasize a long term supply chain perspective in

relationships with customers, reinforcing the suggestion that maintaining communication and close contact with customers is critical for future success.

[Insert Table 5 about here]

7. Conclusion

Existing literature on SCM has suggested that a company's customer relations and purchasing practices all have an effect on the effectiveness of its SCM strategy and can positively impact performance in the market place. Results from this study empirically confirm these suggestions. Further, the results are consistent with theories and claims that have been made in the literature. Concurrent engineering, customer focus, strategic alliances, and quality driven production have all been extensively used to describe how companies should strive to manage production activities within the value chain. However, until now, no evidence has existed in the SCM literature to confirm whether or how they bear upon corporate performance.

The current research lays the foundation for further study of SCM. Questions that remain include what other factors differentiate companies that have effective SCM strategies from those that do not, and how will SCM strategies need to evolve as the competitive environment changes. Interest in SCM has risen significantly over the last decade. Further increases in competition coupled with empirical evidence of the positive impact of SCM are only likely to add to this interest as companies recognize the necessity of embracing all participants in their value chain in their supply management strategy.

REFERENCES

- Adair-Heeley, C.B., JIT Purchasing: Seven Steps for Successful Implementation, *Production and Inventory Management Review & APICS News*, Vol 8 (12), December 1988, pp 22-23.
- Baatz, E.B., CIO 100 - Best Practices: The Chain Gang, *CIO*, Vol 8 (19), August 1995, pp 46-52.
- Carter, J.R., and Narasimhan, R., The Role of Purchasing and Materials Management in Total Quality Management and Customer Satisfaction, *International Journal of Purchasing & Materials Management*, Vol 30 (3), Summer 1994, pp 3-13.
- Farley, G.A., Discovering Supply Chain Management: A Roundtable Discussion. *APICS - The Performance Advantage*, Vol 7 (1), January 1997, pp 38-39.
- Grieco, P.L. Jr., Why Supplier Certification? and, Will It Work? *Production and Inventory Management Review & APICS News*, Vol 9 (5), May 1989, pp 38-42.
- Harwick, T., Optimal Decision-making for the Supply Chain, *APICS - The Performance Advantage*, Vol 7 (1), January 1997, pp 42-44.
- Inman, R.A., and Hubler, J.H., Certify The Process, Not Just The Product, *Production and Inventory Management Journal*, Vol 33 (4), Fourth Quarter 1992, pp 11-14.
- King, J., Supply and Demand, *Computerworld*, Vol 30 (6), February 5, 1996, pp 45.
- MacDonald, M.E., Integrate or Perish!, *Traffic Management*, Vol 30 (10), October 1991, pp 31-36.
- Morgan, J., and Monczka, R.M., Alliances for New Products, *Purchasing*, Vol 118 (1), January 12, 1995, pp 103-109.
- Morgan, J., and Monczka, R.M., Supplier Integration: A New Level of Supply Chain Management, *Purchasing*, Vol 120 (1), January 11, 1996, pp 110-113.
- Polakoff, J.C., Of Kites, Cranks, and Switches - And JIT Purchasing, *Corporate Controller*, Vol 4 (5), May/June 1992, pp 30-32, 64.
- Porter, A.M., Beyond Cost Avoidance, *Purchasing*, Vol 117 (8), November 24, 1994, pp 11-12.
- Romero, B.P., The Other Side of JIT in Supply Management, *Production and Inventory Management Journal*, Vol 32 (4), Fourth Quarter 1991, pp 1-3.
- Semich, J.W., Information Replaces Inventory at the Virtual Corp, *Datamation*, Vol 40 (14), July 15, 1994, pp 37-42.
- St. Onge, A., New Concepts in Supply Chain Management, *Modern Materials Handling*, Vol 51 (3), March 1996, pp 33.
- Turner, J.R., Integrated Supply Chain Management: What's Wrong With This Picture ?, *Industrial Engineering*, Vol 25 (12), December 1993, pp 52-55.

Figure 1: Supply Chain Management Paradigm

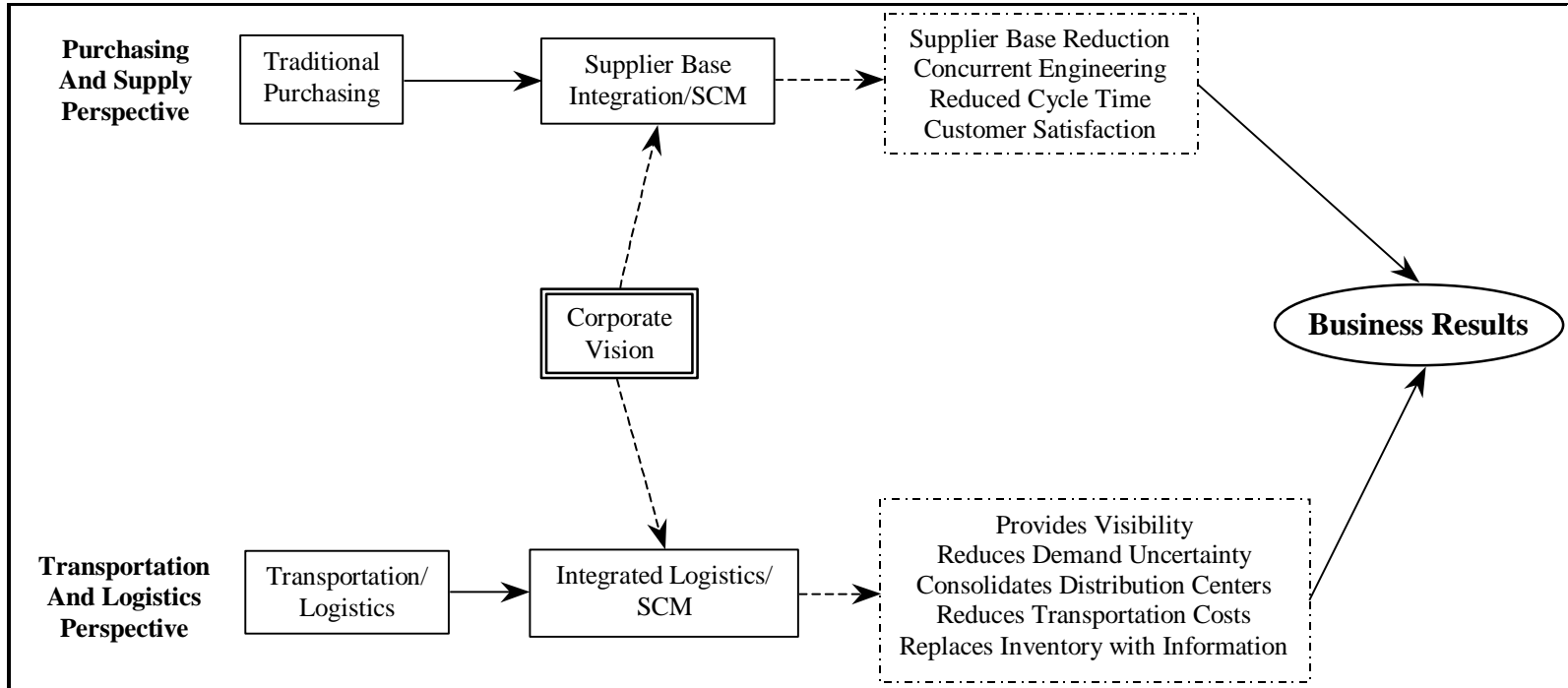


Table 1: Use of Specific Purchasing Practices

Analysis of Variance					
Source	D.F.	Sum Squares	Mean Squares	F-Ratio	F-Prob.
Between Groups	9	880.9193	97.8799	30.2966	0.0000
Within Groups	3054	9866.6417	3.2307		
Total	3063	10747.5610			

Firm's Purchasing Practices (Appendix I, Questions B)	Mean Response	Bonferroni Multiple Range Tests *
(6) Use Suppliers' Technical Support & Test Capabilities	4.9290	$\mu_6 > \mu_1, \mu_9, \mu_7, \mu_8, \mu_5, \mu_4$
(3) Individual Plants Source Low Volume, Low Cost Items	4.6623	$\mu_3 > \mu_1, \mu_9, \mu_7, \mu_8, \mu_5$
(2) Decentralized Purchasing	4.6569	$\mu_2 > \mu_1, \mu_9, \mu_7, \mu_8, \mu_5$
(10) Annual Price Negotiations On Key Items	4.5508	$\mu_{10} > \mu_1, \mu_9, \mu_7, \mu_8, \mu_5$
(4) Supplier Certification – Product	4.3160	$\mu_4 > \mu_1, \mu_9, \mu_7, \mu_8, \mu_5$
(5) Supplier Certification – Process	3.8013	$\mu_5 > \mu_1$
(8) Notify Suppliers of New Product Designs	3.7690	$\mu_8 > \mu_1$
(7) Visit Supplier Facilities Regularly	3.7190	$\mu_7 > \mu_1$
(9) Share Confidential Information	3.6742	
(1) Commodity Teams Set Supplier Goals	3.2098	

* $\alpha = 0.05$

Table 2: Use of Specific Customer Relations Practices

Analysis of Variance					
Source	D.F.	Sum Squares	Mean Squares	F-Ratio	F-Prob.
Between Groups	6	175.5160	29.2527	16.1867	0.0000
Within Groups	2166	3914.4067	1.8072		
Total	2172	4089.9227			

Firm's Customer Relations Practices (Appendix I, Questions C)	Mean Response	Bonferroni Multiple Range Tests *
(4) Evaluate customer complaints	5.3686	$\mu_4 > \mu_7, \mu_6, \mu_1, \mu_2$
(5) Follow-up with customers for feedback	5.1029	$\mu_5 > \mu_7, \mu_6$
(3) Enhance customer support	5.0645	$\mu_3 > \mu_7, \mu_6$
(2) Predict key factors affecting customer relationships	5.0226	$\mu_2 > \mu_7, \mu_6$
(1) Predict customer's future expectations	4.7871	$\mu_1 > \mu_7$
(6) Interact with customers to set standards	4.6839	
(7) Measure customer satisfaction	4.4452	

* $\alpha = 0.05$

Table 3: Multiple Regression of Change in Supplier Performance on Supplier Evaluation Variables

Percentage of firms tracking variable	Supplier Evaluation Variables (Independent Variables – Yes/No)	Supplier Performance: Change in the Number or Percent of					
		Suppliers	On-time Deliveries	Acceptable Materials	Single Sourced Items	Certified Suppliers	Total Purchase Costs
63.9 %	(Q1) Number of Suppliers	0.0089	-0.0804	0.0122	-0.0057	0.0756	-0.0223
70.6 %	(Q2) On-time Delivery	0.0438	0.2059 *	-0.0404	0.0280	-0.0290	0.0947
69.6 %	(Q3) Percent of Acceptable Materials	-0.0277	0.0110	0.1912 *	-0.0645	-0.0580	-0.0198
36.4 %	(Q4) Percent of Single Sourced Items	-0.1149	0.0369	0.0568	0.1342 *	-0.0055	-0.0918
50.2 %	(Q5) Percent of Certified Suppliers	-0.0181	0.0039	0.0565	0.1255 *	0.3018 *	0.0044
61.0 %	(Q6) Total Purchase Costs	0.0956	0.0533	-0.0076	-0.0896 **	-0.0009	0.1237
	Multiple R =	0.1953	0.2640	0.3089	0.4009	0.4239	0.2325
	R ² =	0.0382	0.0697	0.0954	0.1607	0.1797	0.0541
	Standard Error =	0.3399	0.2584	0.2680	0.2191	0.2862	0.2773
	F-Statistic =	1.3158	2.5095	3.4451	4.0535	5.5128	1.5998
	Significant F =	0.2516	0.0230 *	0.0029 *	0.0009 *	0.0000 *	0.1501

* significant at $\alpha = 5\%$

** significant at $\alpha = 10\%$

Note:

The independent variables, Supplier Evaluation Variables, are the binary variables (yes/no) part of questions D in Appendix I.

The dependent variables, Supplier Performance, are the “changes in magnitude” part of questions D in Appendix I.

Regression models are: $\text{Supplier Performance} = \beta_0 + \beta_1 Q1 + \beta_2 Q2 + \beta_3 Q3 + \beta_4 Q4 + \beta_5 Q5 + \beta_6 Q6 + \text{error}$

Table 4: Correlation of Purchasing Practices with Firm Performance

Purchasing Practices (Appendix I, Questions B)	Performance Measures (Appendix I, Questions A)								
	Market Share	Return on Assets	Growth - Market Share	Growth - Sales	Growth - ROA	Production Costs	Customer Service	Product Quality	Competitive Position
(1) Commodity Teams Set Supplier Goals	0.105	0.220*	0.184*	0.249*	0.244*	0.067	0.114*	0.055	0.157*
(2) Decentralized Purchasing	0.096	0.077	-0.008	0.055	0.010	-0.058	0.041	0.021	0.062
(3) Individual Plants Source Low Volume, Low Cost Items	0.112	0.084	-0.027	-0.026	-0.024	-0.012	0.041	0.051	0.080
(4) Supplier Certification – Product	0.147*	0.136*	0.139*	0.146*	0.151*	0.041	0.213*	0.226*	0.219*
(5) Supplier Certification – Process	0.095	0.243*	0.139*	0.167*	0.210*	0.025	0.141*	0.185*	0.129*
(6) Use Suppliers’ Technical Support & Test Capabilities	0.057	0.126*	0.181*	0.193*	0.119*	0.113*	0.092	0.098	0.181*
(7) Visit Supplier Facilities Regularly	0.274*	0.259*	0.247*	0.190*	0.212*	0.080	0.219*	0.210*	0.279*
(8) Notify Supplier of New Product Designs	0.002	0.061	-0.015	-0.011	0.080	-0.017	-0.115*	-0.062	-0.083
(9) Share Confidential Information	0.165*	0.233*	0.211*	0.179*	0.206*	0.052	0.123*	0.102	0.188*
(10) Annual Price Negotiation On Key Items	0.147*	0.168*	0.160*	0.112	0.126*	0.003	0.171*	0.168*	0.168*

* significant at $\alpha = 5\%$

Table 5: Correlation of Customer Relation Practices with Performance

Customer Relations Practices (Appendix I, Questions C)	Performance Measures (Appendix I, Questions A)								
	Market Share	Return on Assets	Growth - Market Share	Growth - Sales	Growth - ROA	Production Costs	Customer Service	Product Quality	Competitive Position
(1) Predict customer's future expectations	0.154*	0.334*	0.376*	0.365*	0.335*	-0.033	0.345*	0.306*	0.346*
(2) Predict key factors affecting customer relationships	0.159*	0.351*	0.307*	0.316*	0.330*	-0.005	0.373*	0.307*	0.344*
(3) Enhance customer support	0.257*	0.301*	0.314*	0.341*	0.280*	0.115*	0.366*	0.315*	0.416*
(4) Evaluate customer complaints	0.131*	0.221*	0.219*	0.207*	0.229*	0.050	0.292*	0.338*	0.221*
(5) Follow-up with customers for feedback	0.158*	0.231*	0.226*	0.202*	0.223*	0.071	0.365*	0.253*	0.239*
(6) Interact with customers to set standards	0.162*	0.284*	0.269*	0.262*	0.324*	0.004	0.334*	0.316*	0.328*
(7) Measure customer satisfaction	0.177*	0.220*	0.216*	0.232*	0.294*	0.097	0.325*	0.260*	0.272*

* significant at $\alpha = 5\%$

APPENDIX I

A. Firm Performance Measures

Indicate the level of your firm's performance compared to major industry competitors.
[Likert scale of 1 (below average) to 7 (above average)]

1. Market share.
2. Return on total assets.
3. Average annual market share growth (over the past three years).
4. Average annual sales growth (over the past three years).
5. Average annual growth in return on total assets (over the past three years).
6. Average production costs.
7. Overall customer service levels.
8. Overall product quality.
9. Overall competitive position.

B. Use of Specific Purchasing Practices

Indicate the most appropriate response regarding your firm's practice for the following areas of supply chain management. [Likert scale of 1 (strongly disagree) to 7 (strongly agree)]

1. Commodity management teams set the levels of cost, quality and lead time for supplier performance.
2. Local plant managers are given authority to execute purchase orders and daily supply flows.
3. Low volume, low cost materials are handled by individual plant staff based on local needs.
4. Our company has a quality-assurance (certified) program for our supplier's specific product.
5. Our company has a quality-assurance program for our supplier's manufacturing process.
6. Our company takes advantage of supplier-provided technical support and test capabilities.
7. Our manufacturing personnel regularly visit our supplier's facility.
8. Suppliers receive changes to our specifications after we develop a new product design.
9. We share a great deal of sensitive information with our suppliers.
10. We undertake annual negotiations to establish the price for key-input items from our suppliers.

C. Use of Specific Customer Relation Practices

Rate your firm's ability to monitor and manage customer relationships in the following areas.
[Likert scale of 1 (poor) to 7 (excellent)]

1. Determination of future customer expectations.
2. Determination of key factors for building and maintaining customer relationships.
3. Enhancement of customers' ability to seek assistance.
4. Evaluation of formal and informal complaints.
5. Follow-up with customers for quality/service feedback.
6. Interaction with customers to set reliability, responsiveness, and other standards.
7. Measurement and evaluation of customer satisfaction factors.

D. Variables Used to Evaluate Supplier Performance

The following measures are used to evaluate supplier quality. Indicate your firm's use of these measures (Yes/No). Also, please estimate the magnitude (100+%, 75%, 50%, 25%, 10%, 5%, 0%) and direction (+ or -) of changes in each area over the last three years (or since your firm's quality plan has been implemented).

1. Number of suppliers.
2. On-time delivery of purchased parts.
3. Percent of incoming shipments acceptable.
4. Percent of single sourced items.
5. Percent of suppliers certified.
6. Total cost of purchased parts.

Biographical Data

Keah-Choon Tan is an assistant professor in the School of Business at Mesa State College. He received his Ph.D. in Production and Operations Management from Michigan State University. He holds a B.Sc. in Systems and Operations Management and an MBA. He is certified in Production and Inventory Management (CPIM) by the American Production and Inventory Control Society (APICS), and he is also a Certified Purchasing Manager (C.P.M.) and Accredited Purchasing Practitioner (A.P.P.) of the National Association of Purchasing Management (NAPM). Dr. Tan has published several articles in the areas of scheduling and supply chain management. His industrial experience includes that of an administrator for a large modern specialists hospital and comptroller for a public company.

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