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SUPPLY CHAIN COLLABORATION AND LOGISTICAL SERVICE PERFORMANCE

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ABSTRACT

Collaboration with external supply chain entities influences increased internal collaboration, which in turn improves service performance. This relationship may be the key to helping managers understand how best to facilitate behavioral change. The implication is that collaborating with customers and suppliers is a first step toward effective collaboration within the firm.

ABOUT THE AUTHORS

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SUPPLY CHAIN COLLABORATION AND LOGISTICAL SERVICE PERFORMANCE

The supply chain management philosophy stresses that maximizing service to customers of choice at the lowest total cost requires a strong commitment to close relationships among trading partners. The philosophy requires a movement away from arm's-length interactions toward longer term, partnership-type arrangements to create highly competitive supply chains.¹ It is generally believed that increased collaboration among supply chain participants leads to lower total cost and enhanced service performance.² Ideally, collaboration begins with customers and extends back through the firm from finished goods distribution to manufacturing and raw material procurement, as well as to material and service suppliers. Thus, integration is needed both internally (intraorganizationally) and externally (interorganizationally).³ Although cost savings from reduced operational duplication and redundancy are important, the focus of this research is the relationship between collaboration and service improvement.

Both the popular press and academic research focus on the importance and frequency of collaborative action, and the role of collaboration in overall business performance.⁴ Much of this work is of prescriptive, whereas our study develops and tests measures to examine empirically the relationships between internal and external supply chain collaboration and logistical performance. Post hoc analyses offer further insights.

BACKGROUND

Best practice logistics embraces the concepts of cost-to-cost and cost-to-service tradeoffs that allow simultaneous improvement in economic performance and service quality. Within the firm, a high degree of operational integration is required, ranging from procurement of raw

materials, to delivery of products and services to end-users, to the return of unusables and disposables from customers.⁵ In the last decade, the concept of world-class logistics has expanded outside the boundaries of the firm to include customer and supplier integration. Top firms are developing extremely close relationships with selected clients and are placing significantly more emphasis on improved working arrangements with suppliers. The motivation is the desire to extend the effective control of the enterprise. The needs and capabilities of material suppliers, service suppliers, and especially customers are incorporated into strategic planning as firms view operations in terms of supply chain interactions and strategies.

The challenge of coordinating operations across all facets of a business has become known as supply chain management (SCM). Copacino highlights the importance of integration in his definition of SCM:

"The new vision of supply chain management links all the players and activities involved in converting raw materials into products and delivering those products to consumers at the right time and at the right place in the most efficient manner."⁶

Other definitions are similar. For example, Stein and Voehl describe the "systematic effort to provide integrated management to the Supply Value Chain in order to meet customer needs and expectations, from suppliers of raw materials through manufacturing and on to end-customers."⁷

As Cooper, Lambert, and Pagh note it is "the integration of business processes from end user through original suppliers that provides products, services, and information that add value for customers. Supply chain management is not just another name for logistics. It includes elements that are not typically included in a definition of logistics, such as information systems integration and coordination of planning and control activities."⁸ Larson and Rogers merged various ideas into the following definition: "Supply chain management is the coordination of activities, within and between vertically linked firms, for the purpose of serving end customers at a profit."⁹

Bowersox, Closs, and Stank define SCM as “a collaborative-based strategy to link interorganizational business operations to achieve a shared market opportunity.”¹⁰

SCM is generally considered to involve integration, coordination, and collaboration across organizations and throughout the supply chain. The concept includes the broad array of activities needed to plan, implement, and control sourcing, manufacturing, and delivery processes from the point of raw material origin to the point of ultimate consumption.

Logistics is viewed as a value-adding supply chain process. Logistics customer value is generally created through effectiveness, efficiency, and/or differentiation.¹¹ Therefore, a primary goal of SCM is to create or enhance value provided to the end-customer. Ideally, a firm should attempt to fulfill a customers’ orders and simultaneously meet all their expectations -- delivering 100% of the exact items and quantities ordered on time, damage free, and with errorless invoicing. Although perfection is an admirable goal, it is not always achievable at reasonable cost. The focus should be on creating as much value for the end-customer as is profitable, and doing this requires coordinated effort among all firms in the entire supply chain.

Adversarial attitudes have long dominated business relationships, but SCM entails a new perspective. Managers identify operational tradeoffs with customers and suppliers in order to reduce supply chain duplication and eliminate non value-adding work. Thus, leading logistical practice has shifted from an exclusively internal focus to collaboration across the full range of supply chain participants.¹²

Growth of information technology and communication capabilities such as the Internet and e-commerce enhance the ability to integrate the chain. With these tools, firms can forge relationships that yield dramatic performance benefits in terms of end-customer satisfaction and reduced cost due to the elimination of operational duplication and resource waste.¹³

Integration and Collaboration

The need for integration in the physical distribution of product is not a new concept. In the 1970s, Lambert, Robeson, and Stock coordinated distribution activities viewed as a process to be managed.¹⁴ More than a decade, Staude called for a systems approach to integrate both inter-and intradepartmental efforts.¹⁵ Within a supply chain setting, integration extends beyond the firm to encompass channel participants. They must be willing to work together, but that is not enough to ensure integration. Investments in the relationship and/or resource sharing may be required as well. It has been suggested that effective integration involves mutual understanding, a common vision, shared resources, and achievement of collective goals.¹⁶

Simply stated, integration focuses efforts, whether from a corporate wide or functional perspective. Such focusing is especially critical for logistics operations, which span a number of boundaries. Research confirms that logistics integration is linked to increased efficiency and productivity.¹⁷ More integrated firms perform better than less integrated firms.

Initial investigations of integrated logistics focused on internal applications, that is, interrelationships and trade-offs within the firm.¹⁸ Today, functional integration is typically viewed within a much broader context. Recent work emphasizes the importance of achieving integration not only across internal operations but also with customers and material and service suppliers.¹⁹ Both intra- and interorganizational coordination are needed.²⁰

Research usually focuses on one of three perspectives of integration: as a series of interactions, as collaborative behaviors, or as a composite of the two.²¹ Each viewpoint provides insights, but in this study we concentrate on the collaborative dimensions of integration. Collaboration is a process of decision making among interdependent parties. It involves joint ownership of decisions and collective responsibility for outcomes.²² Schrage defines it as “an

affective, volitional, mutual shared process where two or more departments work together, have mutual understanding, have a common vision, share resources, and achieve collective goals.”²³ Key dimensions are a cross-department (or organization) scope, a commitment to working together, and some common bond or goal.

Managers who adopt a collaborative perspective work to build an *esprit de corps* across departments or organizations in order to unite efforts and achieve collective goals through synergy. Although individuals (or organizations) must relinquish some control, complete control over an ineffective process is not nearly as exciting as shared control over a dynamic and value-added process. The success of collaboration depends upon the ability and willingness of managers to build meaningful relationships and create trust.²⁴

At an operating level, collaboration requires significant change from standard business practice, particularly in the area of information exchange. It entails “sharing of data, operating plans, and even some financial information.”²⁵ A new initiative called collaborative planning, forecasting, and replenishment; (CPFR) is an excellent illustration of the scope of collaboration in many of today’s best practice firms.²⁶ Trading partners jointly develop long-term demand projections rather than rely upon separate, independently generated forecasts. The estimates are constantly updated, based upon actual demand and market changes. The result is a better match between supply and demand through the use of realistic, informed, and detailed estimates.²⁷

Research Hypotheses and Conceptual Model

Managers confront many and varied obstacles to a seamless flow of products, services, and information from sourcing, to manufacturing, to distribution to end-customer. Most managers strive to integrate these processes in order to increase value by reducing waste, excessive work delays, and redundancy. The objective is the lowest total landed cost without

sacrificing superior service. Data collected by the Supply Chain Council indicates that excellent supply chain performance can lower cost b up to 7% and enhance cash flow by more than 30%.²⁸ Collaboration, as a critical element of integration, contributes to these performance improvements.²⁹

Cost effectiveness is highly desirable and is a building block in gaining competitive advantage. Business success derived from cost orientation, however, is usually short term at best. The managerial tools and techniques used to achieve lower costs are typically easy to imitate, which means that performance differences gained from such programs are difficult to sustain. A firm will only outperform competitors if it can establish a preservable difference. Customized logistical service is an opportunity for a supplier to become an integral part of a customer's business.³⁰ Collaboration helps firms tailor service offerings to the specific requirements of customers of choice by identifying their long-term requirements, expectations, and preferences.³¹ A company that seeks to attain a competitive edge through external collaboration also must become more focused internally, so that it may better respond to customer expectations and accommodate customer needs. The relationship between collaboration and logistical service performance is the focus here.

Benefits emerge when partners are willing to work together, (2 understand other viewpoints, (3 share information and resources, and (4 achieve collective goals. The benefits are reduced resource duplication, greater relevance to customer needs, and flexibility in responding to unique customer requests and accommodating change. Research indicates that collaboration should lead to improved operational performance.³² Therefore, higher levels of internal and external collaboration are therefore expected to result in improved logistical service

performance.³³ One objective of this research is to determine empirically whether this relationship is supported.

H1: Internal collaboration has a positive influence on logistical service performance outcomes.

H2: External collaboration has a positive influence on logistical service performance outcomes.

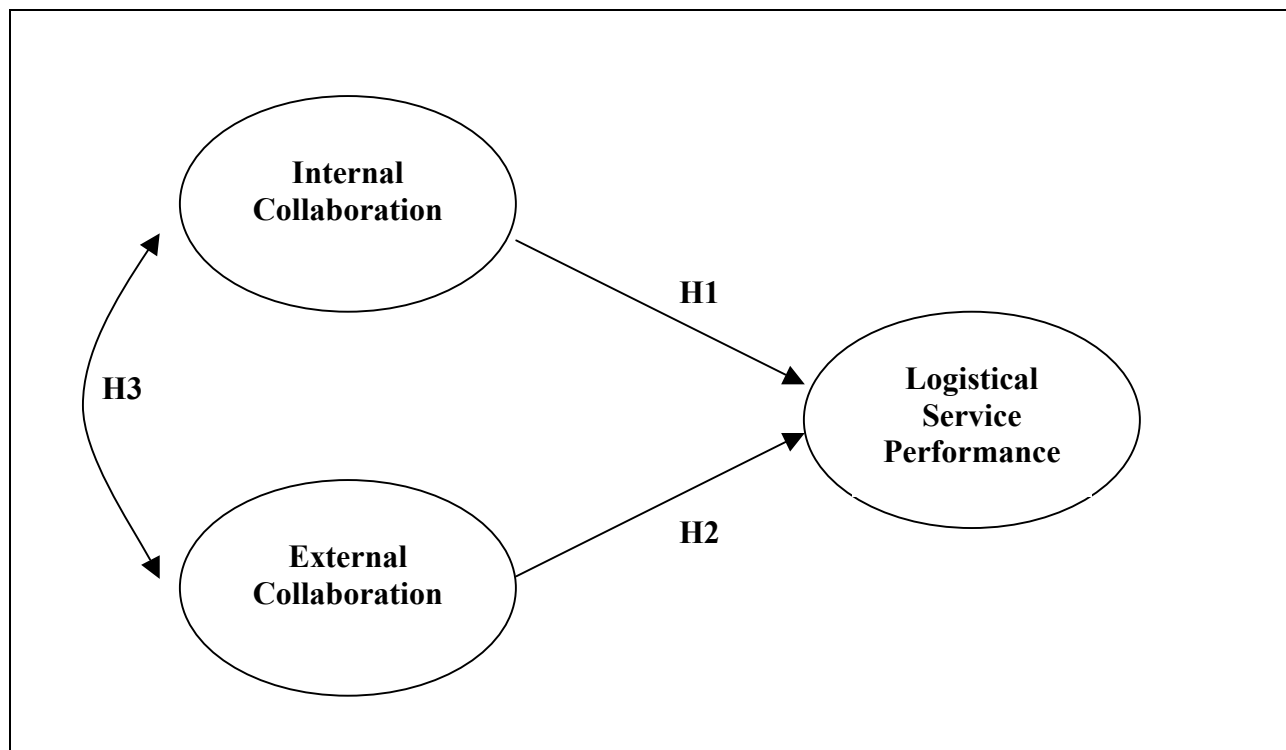
The next hypothesis relates to the interrelationship of internal and external collaboration. The literature suggests that firms must achieve a relatively high degree of collaboration among internal processes before initiating supply chain arrangements.³⁴ Evidence also suggests that the inability to integrate fully within the firm's logistics operations is a leading cause of strategic alliance failure. Breakdowns in internal operations inhibit delivery of promised performance levels.³⁵

Interviews we conducted in preparation for this research raise concerns regarding this relationship. Many firms reported more meaningful collaboration with suppliers and/or customers than with other functional areas within the firm. Although the specific relationship between internal and external collaboration is not well defined, research suggests that they should positively influence each other.³⁶

H3: Internal collaboration and external collaboration are positively related.

Figure 1 depicts the theoretical constructs and the hypothesized relationships.

FIGURE 1
CONCEPTUAL MODEL



RESEARCH METHODS

First, we will describe development of measures and the sample design. Second, the procedures used to analyze the data will be discussed.

Development of Measures

The questionnaire designed for the 1995 World Class Logistics Research at Michigan State University³⁷ is the basis for our instrument. The measures were developed from a pilot survey completed by almost 3,700 respondents in North America, Europe, and the Pacific Rim. Subsequent refinements through in-depth interviews with 111 top logistics firms established a tool for assessing logistical proficiency across a range of integrative and collaborative elements.³⁸

During summer 1997, we completed case studies of 26 firms to broaden the measures into a supply chain perspective.³⁹ Items to assess logistical process performance also were developed. The case study group of fifteen manufacturers, six wholesalers/distributors, and five retailers represented firms from the automotive, chemical, consumer durable, food manufacturing and wholesaling, health care, mass merchant, food and general retailing, and paper industries.

A set of questions was then developed and tested. These are listed in Table 1. For most items, respondents were asked to indicate agreement based on a five-point scale where 1 = strongly disagree, 5 = strongly agree. Items regarding logistical service performance used a slightly different scale where 1 = worse than competitors, 5 = better than competitors.

Sample Design

In late 1998, a survey population was selected from the Council of Logistics Management (CLM) membership list. Given the strategic focus of the research, it was decided to mail questionnaires to the senior logistics or supply chain executive in each firm based in North America (Canada, Mexico, and the United States) in the categories of manufacturing, wholesale/distributing, and retailing. They were chosen because of their frequent interaction with key customers and supply chain partners regarding logistical processes and performance outcomes. Furthermore, executive compensation and promotions are highly dependent on achieving established logistics service goals. Therefore, these executives are likely to understand and assess the logistical service of their firm compared to competitors. Due to the competence and awareness of senior logistics and supply chain executives, their perceived evaluation is reasonably credible.

TABLE 1
QUESTIONNAIRE ITEMS

<i>Internal Collaboration (IC)</i>	
IC1:	My firm maintains an integrated database and access method to facilitate information sharing.
IC2:	My firm effectively shares operational information between departments.
IC3:	My firm has adequate ability to share both standardized and customized information internally.
IC4:	My firm provides objective feedback to employees regarding integrated logistics performance.
IC5:	My firm's compensation, incentive, and reward systems encourage integration.
<i>External Collaboration (EC)</i>	
EC1:	My firm effectively shares operational information externally with selected suppliers and/or customers.
EC2:	My firm has developed performance measures that extend across supply chain relationships.
EC3:	My firm experiences improved performance by integrating operations with supply chain partners.
EC4:	My firm has supply chain arrangements with suppliers and customers that operate under principles of shared rewards and risks.
EC5:	My firm has increased operational flexibility through supply chain collaboration.
EC6:	My firm benchmarks best practices/processes and shares results with suppliers.
<i>Logistical Service Performance (LSP)</i>	
LSP1:	The ability to reduce the time between order receipt and customer delivery to as close to zero as possible.
LSP2:	The ability to meet quoted or anticipated delivery dates and quantities on a consistent basis.
LSP3:	The ability to respond to the needs and wants of key customers.
LSP4:	The ability to provide desired quantities on a consistent basis.
LSP5:	The ability to modify order size, volume or composition during logistics operation.
LSP6:	The ability to accommodate delivery times for specific customers.
LSP7:	The global judgment regarding the extent to which perceived logistics performance matches customer expectations.

One questionnaire was sent to each firm or strategic business unit (SBU). The total sample was 2,680 firms, from which 306 fully validated responses were received. Nine CEO/presidents, 13 senior/executive vice presidents, 70 vice presidents, 4 senior/executive directors, and 186 directors/managers completed the questionnaire. Twenty-four respondents

declined to provide their title. The industry breakdown is as follows: appliances, furniture, and hardware -- 14 firms; building/lumber, mining, metals -- 27 firms; chemicals and petroleum -- 23 firms; clothing and textile -- 12 firms; computers and electronics -- 16 firms; food processing and distribution -- 58 firms; health/beauty aids and pharmaceutical -- 38 firms; motor and transportation -- 40 firms; mass merchandising and retail -- 23 firms; office equipment and supplies -- 17 firms; and other or missing value -- 38 firms.

The 11.5% response rate may be related to the length and comprehensive nature of the questionnaire as well as the confidential nature of the information requested. Anonymity was guaranteed, but it is likely that some executives doubted this assurance. Also, senior executives have little free time and typically are inundated with surveys. The 306 usable responses provide sufficient data to confirm the general conceptual framework.

An analysis of nonresponse bias was conducted.⁴⁰ The procedure requires that responses be numbered sequentially in the order in which they are received. Next, mean scores of the first quartile assumed to be most motivated to participate are compared to those of the last quartile assumed to be most similar to nonrespondents. No significant differences (at $p < .05$) in means were revealed, so there is no evidence of response bias

Analytical Techniques

To ensure valid and reliable conclusions, an analysis of the psychometric properties of the scales was conducted. The items were derived from the literature and refined on the basis of 26 case studies. These steps allowed for a thorough understanding of the concepts during the item generation stage. The final survey was reviewed and critiqued by professionals and academics in the field. Procedures such as these ensure constructs with high content and substantive validity.⁴¹

Unidimensional characteristics for each factor were assessed using principal components analyses and confirmatory factor analyses. The appendix outlines the results of tests for validity and reliability of the latent constructs. The measures demonstrated unidimensionally valid and reliable characteristics. The results of tests of hypotheses and overall model fit are presented in the following section.

RESULTS

A primary purpose of this research was to explore both internal and external collaboration. An additional purpose was to test how collaboration is related to firm performance. To this end, the theoretical framework illustrated in Figure 1 was subjected to an analysis using structural equations modeling via Lisrel 8.

Establishing an acceptable fit of the model to the data provides one explanation of the phenomenon. Results in Table 2 support a good fit. Because no single statistic is considered superior regarding assessment, a review of multiple fit indices is desirable.⁴² Although the chi-square statistic was significant (326.79, $df=130$, $p = .00$), a thorough examination of alternative indices yielded support for the hypothesized model ($GFI = .90$; $CFI = .92$; $IFI = .92$, $NNFI = .91$).

Hypothesis Tests

Individual hypotheses were assessed by reviewing the significance, magnitude, and direction of each parameter coefficient. Figure 2 is a visual portrayal of the results presented in Table 2.

Evidence suggests that internal collaboration is associated with higher levels of logistical service performance. This relationship is statistically significant

TABLE 2
OVERALL MODEL STATISTICS AND CONSTRUCT RELATIONSHIPS

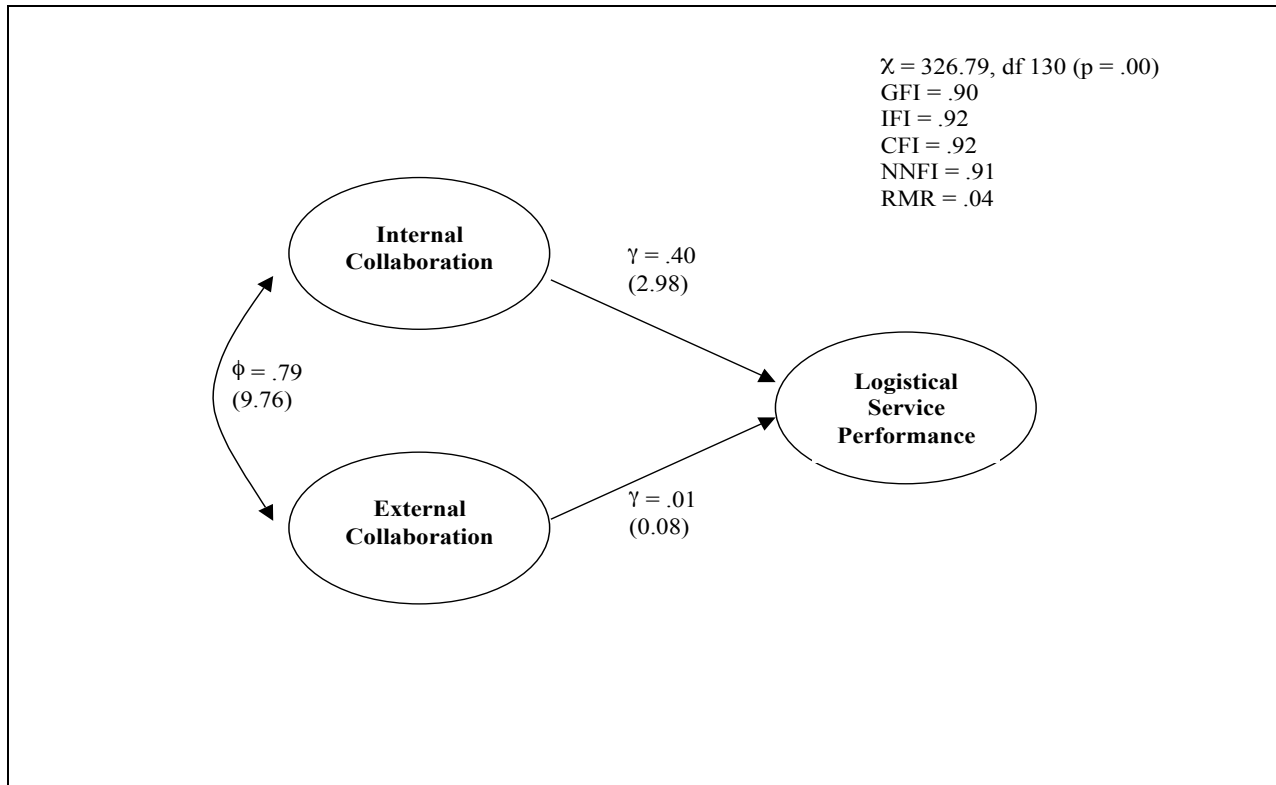
	Internal Collaboration		External Collaboration		Logistical Service Performance		
Internal Collaboration	--		$\phi = .79$ (7.69)		$\gamma = .40$ (2.98)		
External Collaboration	--		--		$\gamma = .01$ (0.08)		
	IC1	1.00	EC1	1.00	LSP1	1.00	
	IC2	.71 (11.00)	EC2	.80 (13.00)	LSP2	.74 (12.35)	
	IC3	.69 (10.82)	EC3	.76 (12.39)	LSP3	.67 (8.61)	
	IC3	.76 (11.82)	EC4	.69 (11.33)	LSP4	.67 (8.67)	
	IC4	.63 (9.95)	EC5	.79 (12.77)	LSP5	.52 (7.31)	
			EC6	.69 (11.33)	LSP6	.66 (8.53)	
					LSP7	.77 (9.38)	
χ^2	DF	P-VAL	GFI	CFI	IFI	NNFI	RMR
326.79	130	.00	.90	.92	.92	.91	.04

t-values are given in parentheses.

($\gamma = .40$, *t*-value = 2.98), and hypothesis 1 is supported. Internal collaboration improves delivery speed, dependability, responsiveness, flexibility, and overall customer satisfaction.

Interestingly, and counter to hypothesis, external collaboration does not lead directly to better outcomes in logistical service, as revealed in Figure 2 ($\gamma = .01$, *t*-value = .08).

FIGURE 2
RESULTS OF HYPOTHESIS TESTING



This result will be discussed further below.

Finally, internal and external collaboration are significantly correlated ($\phi = .79$, t -value = 7.69). So, hypothesis 3 is supported.

Further Analysis and Post Hoc Assessment

The lack of support for a relationship between external collaboration and logistical service performance but the significant correlation between external and internal collaboration suggests a relationship we did not anticipate. The results imply that external collaboration may influence internal collaboration and, in turn, indirectly affect a firm's logistical service. Further analysis was conducted to determine whether internal collaboration plays an intermediary role.

A three-step regression analysis was used to assess the potential mediating influence of internal collaboration on the external collaboration-service performance relationship.⁴³ First, the proposed mediator was regressed on the independent variable, external collaboration. If the model produces a significant relationship, then there is mediation among the variables. Second, the ultimate dependent variable, logistical service performance, was regressed on the independent variable. Again, a significant relationship indicates a mediating influence between the two. Third, service performance was regressed on both the proposed mediator and independent variable. If internal collaboration significantly predicts service performance, but the association between external collaboration and service performance (supported in condition two) is insignificant or is reduced in magnitude, then internal collaboration is said to mediate the relationship between the independent and dependent variables.

Table 3 presents the results of the three-step regression. Model one indicates the satisfaction of condition one, and the significant coefficients in model two support condition two. Model three reveals the reduced effect of external collaboration on logistical service performance when internal collaboration is included. Accordingly, the latter mediates their relationship. That is, if firms foster externally focused information, measurement, reward, and risk collaboration, can best influence logistical service performance outcomes through enhanced internal collaboration.

TABLE 3
RESULTS OF MEDIATOR MULTIPLE REGRESSION ANALYSES

Models:	1	2	3
Independent Variable	Dependent Variable: Internal Collaboration	Dependent Variable: Service Performance	Dependent Variable: Logistical Service Performance
External collaboration (<i>p</i> -value)	.63 (.00)	.28 (.00)	.15 (.04)
Internal collaboration (<i>p</i> -value)	--	--	.21 (.00)
Model F (<i>p</i> -value)	195.29 (.00)	25.01 (.00)	17.25 (.00)
R ²	.39	.08	.10

Note: Standardized beta coefficients are reported, with *p*-values in parentheses.

IMPLICATIONS AND CONCLUSIONS

The findings reveal that internal collaboration significantly influences logistical service performance, which implies that firms should promote cooperation and collaboration across internal processes to achieve logistical effectiveness. The lack of support for a direct link between external collaboration and service performance is an interesting and, on the surface, suggest that collaboration with customers and suppliers will not improve performance. Further investigation revealed, however, that collaboration with external supply chain entities influences increased internal collaboration, which in turn improves logistical service. Therefore, best practice firms focus on both.

The relationship between external and internal collaboration may be the key in facilitating behavioral change, that is, the shifting from traditional arms-length or even

adversarial attitudes to a partnership perspective that fosters cooperation and a freer exchange of information. Collaboration is needed both within and beyond the firm's boundaries. The benefits are synergistic. Collaborating and information sharing focuses more resources (human and financial) on business operations, which allows more informed decisions and reduces risks. The result is a win/win situation that should improve service performance.

External collaboration is essential. Boundary-spanning personnel from trading partners collect the necessary intelligence, such as information on order patterns, planned product promotions, and valuable service feedback. They also provide the contact that enables coordination of operations across business entities. To accomplish these tasks, they must be informed and educated; they need to know what questions to ask and what information to provide. It is critical that the information they pass on reach the right people within the organizations and mere delivery may not be adequate; they may have to "sell" the ideas internally, to convince the appropriate people to follow through. It helps if boundary spanners are politically empowered, so that managers from different organizations will be motivated to act on their information. Empowerment is often derived from metrics that encourage all managers to focus on total system performance rather than narrower results.

Internal collaboration is essential as well. It facilitates the close interactions that bring greater expertise to day-to-day operations, focusing efforts and targeting resources as needed. Often task forces or cross-functional teams are involved. Their cooperative decisions on the use of internal resources are supplemented with information from external collaboration, which ensures that internal processes are customer focused.

If the pattern is reversed, and internal collaboration drives external relationships, then performance improvements may not be achieved. A food service firm, for example, developed

an internal focus on improving basic delivery capabilities. These were measured by internally generated and jointly agreed operating parameters that totally ignored the perspective of the customer. One manager of a fast food restaurant received a delivery from the food service firm at lunchtime. The delivery truck blocked the restaurant parking lot, and the manager could see potential diners pulling away because they could not enter the lot. When told of the problem, the driver said he needed to complete his route on time. The food service firm was working toward an inappropriate and myopic performance goal that totally ignored the customer.

Viewed from another perspective, lack of a direct relationship between external collaboration and performance may stem from a breakdown in internal collaboration. In other words, external collaboration is a necessary but not sufficient condition for performance improvement. A firm can “drop the ball” internally after receiving positive input and direction from external partners. Thus, a positive relationship between external and internal collaboration fosters better performance.

Future research should explore ways in which managers can influence the behavioral change needed to facilitate collaboration. Two recommended methods are empowerment and cross-functional work teams.⁴⁴ When front-line managers and employees can use their own discretion, within policy guidelines, to make timely decisions, the firm can respond more flexibility and quickly to the needs of customers. Empowered employees have the authority and information necessary to do a job, and they are trusted to perform it without intense over-the-shoulder supervision. Cross-functional teams that manage day-to-day operations can work closely with customers to tailor responses to unique opportunities. Teams typically have representatives from sales, marketing, logistics, production, and accounting. The team is authorized to make tactical decisions and is held accountable for its performance.

We found that internal collaboration mediates the relationship between external collaboration and logistical service performance. In other words, if firms want to improve service performance through collaboration with external customers and suppliers, they need to enhance internal collaboration. Future research is needed to understand how managers can accomplish this. Also, what factors contribute to meaningful relationships with external partners, and is the relationship with customers or suppliers more meaningful?

Two important areas for future research involve methodological issues. First, satisfaction with service performance should be assessed from the customer perspective. Data collection on both sides of the buyer-seller dyad would alleviate concern about biased performance assessments by service providers. One methodology would be to ask sellers to evaluate their logistical offerings and also identify customers who would be willing to report on their satisfaction with the seller's services. This design also could explore customer loyalty as a performance outcome, which affects a provider's financial performance. Second, alternate operationalizations are possible. Measures of internal and external collaboration that capture joint problem solving, performance measurement, and cross-functional teaming should be developed, and constructs targeted at either suppliers or customers would enable comparisons. Finally, the logistical performance construct should include cost as well as service elements so that it can be examined using both objective and perceptual measures.

APPENDIX

Unidimensional characteristics for each factor were assessed using principal components analyses and confirmatory factor analyses. Table A1 contains the one-factor solutions for each construct. All principal component scores (with the exception of LSP5, order flexibility, at .59) meet or exceed .60.⁴⁵ Table A1 also addresses scale reliability. Cumulative reliabilities meet or exceed .81. The deletion of any one item would not improve the reliability of any particular scale.

TABLE A1
RELIABILITIES AND PRINCIPAL COMPONENT SCORES

Items	PC Scores	Item-To-Total Correlation	Alpha If Item Deleted	Cronbach Alpha For Scale
Internal Integration				.81
IC1	.76	.60	.77	
IC2	.80	.64	.75	
IC3	.79	.64	.75	
IC4	.73	.57	.77	
IC5	.66	.50	.80	
External Integration				.85
EC1	.74	.61	.83	
EC2	.80	.69	.82	
EC3	.78	.66	.83	
EC4	.73	.60	.84	
EC5	.80	.68	.82	
EC6	.72	.60	.84	
Logistical Service Performance				.82
LSP1	.70	.56	.80	
LSP2	.79	.67	.78	
LSP3	.68	.54	.80	
LSP4	.67	.53	.80	

LSP5	.59	.46	.81	
LSP6	.71	.59	.79	
LSP7	.74	.61	.79	

Confirmatory factor analyses using Lisrel 8 were conducted for each factor as a more stringent test of unidimensionality. Table A2 indicates that the constructs represent single concepts. The goodness of fit index (GFI) ranges from .89 for performance to .96 for external collaboration. Other incremental fit measures, such as the comparative fit index (CFI) and the incremental fit index (IFI), are also presented. Although .90 is a recommended level of fit, values lie between zero and one; therefore, higher index coefficients represent higher levels of goodness-of fit.⁴⁶ Table A2 reveals significant and large pattern coefficients (in the direction conceptualized) that support the convergent validity of the items representing each construct.⁴⁷

TABLE A2
CONSTRUCT UNIDIMENSIONALITY AND
ITEM LAMBDA FOR MEASUREMENT MODELS

CONSTRUCTS/ ITEMS	λ	T VAL.	χ^2	DF	P VAL	GFI	CFI	IFI	RMR
Internal Collaboration			48.76	5	.00	.94	.93	.93	.06
IC1	.73	13.80							
IC2	.82	16.19							
IC3	.81	16.09							
IC4	.65	12.00							
IC5	.56	9.93							
External Collaboration			38.93	9	.00	.96	.96	.97	.03
EC1	.71	13.53							
EC2	.79	15.93							
EC3	.77	15.23							
EC4	.69	13.20							

EC5	.80	16.03							
EC6	.69	13.01							
Logistical Service Performance			134.90	14	.00	.89	.86	.86	.05
LSP1	.68	12.75							
LSP2	.82	16.44							
LSP3	.64	11.65							
LSP4	.65	12.02							
LSP5	.50	8.73							
LSP6	.65	12.00							
LSP7	.73	14.05							

Following the recommendations of Fornell and Larcker,⁴⁸ and as a stringent test of discriminant validity, the average variance extracted estimates, with the exception of the comparison between internal and external collaboration, were greater than the shared variance between the two constructs of any two-factor models. Table A3 gives the results of the discriminant validity tests. In support of discriminant validity between internal and external collaboration, the parameter between the two was constrained to 1.00, and the resulting model chi-square was compared to the chi-square obtained when the parameter was free to vary.⁴⁹ The latter result ($\chi^2 = 168.00$, $df = 43$, $p = .00$) indicates a significantly better fit than the constrained model ($\chi^2 = 209.02$, $df = 44$, $p = .00$, χ^2 difference = 41.02, $df=1$).

TABLE A3
CONSTRUCT DISCRIMINANT VALIDITY

	Internal Collaboration	External Collaboration	Logistical Service Performance
Average Variance Extracted	.52	.55	.45
Shared Variance External Collaboration Internal Collaboration		.55 (.74)	.10 (.32) .14 (.38)
	Freed Parameter Model	Model $\phi = 1$	χ^2 Difference
External Collaboration & Internal Collaboration	$\chi^2 = 168.00$ df = 43	$\chi^2 = 209.02$ df = 44	41.02 df = 1

Note: Construct correlation coefficients are given in parentheses.

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