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Supply Chain Integration and its Effect on Performance: A Multi-Country Study

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ABSTRACT

Supply chain performance is critical to enhanced organizational competitiveness and success. To analyze the impact of individual supply chain related factors on a firm's supply chain performance data was collected on various supply chain measures of 287 organizations in Brazil, Korea and India. The paper presents the results of the empirical study. Hypotheses are proposed and results of regressions are presented. We also develop a composite variable, Supply Chain Competency, which is an overall measure of the quality of a firm's supply chain and analyze its effect on supply chain performance.

1. INTRODUCTION & LITERATURE SURVEY

Few firms or nations can ignore the forces of globalization and electronic commerce that permeate businesses today. As companies strive to create better value for their customers, managers are beginning to realize the important role logistics and supply chain management play for better management of commercial transactions.

Mentzer (2001) defines a supply chain as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer. In this article, we use the following definition of supply chain management as developed by the members of The Global Supply Chain Management Forum (at the Ohio State University) in 1994 and modified in 1998: "Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services, and information

that add value for customers and other stakeholders." The emphasis on both physical supply (inbound) and physical distribution (outbound) sides is not merely on the immediate suppliers and customers, but often on suppliers' suppliers and customers' customers. The interfaces both upstream and downstream in the supply chain are frequently enabled these days by information and communications technology which provide instant access to each other's business and manufacturing systems. Suppliers gain access to manufacturers' production plans and can reduce their reliance on uncertain forecasts. Manufacturers obtain early warning about possible disruptions of supply due to unforeseen events faced by the suppliers and can reschedule their plans and avoid costly disruptions. These and other similar uses of the information technology ensure a smooth flow of information pertaining to order, product design and development, market intelligence, production scheduling, payments and other information for managing coordination among the various actors in the supply chain.

Supply chain management thus consists of the entire set of processes, procedures, the supporting institutions, and business practices that link buyers and sellers in a marketplace. To be effective, a supply chain has to link the members of the network and the functions to ensure uninterrupted flow by matching supply and demand flows. Coordinating these flows in a network requires integration of supply chain partners to ensure unhindered flows at each of the many buyer-supplier interfaces in a supply chain network. Experts believe supply chain integration involves efficient management of information and closer organizational collaboration among supply chain partners.

Several studies in the past have looked at various aspects of supply chain management on performance (Bagchi and Skjoett-Larsen, 2003; Fawcett and Magnan, 2002; McAdam and McCormack, 2001; Frohlich and Westbrook, 2001; Olhager and Selldin, 2003; Ragatz, Handfield and Scanell, 1997). Many authors recommend teams as a means to manage processes that transcend traditional functional barriers (Katzenbach and Smith, 1993; Teare, Ingram, Scheuing, Armistead, 1997; Telleria, Little, MacBryde, 2002). Process organization and cross-firm teams are a means to achieve integration among functions and organizations (Christopher, 1998). Ostroff (1999) claims that better organizational coordination takes place when there are avenues for information exchange and coordination at all levels of hierarchy. Streamlined inter-organizational processes ensure effective diffusion of shared cultural values across the supply chain, the lack of which often proves to be an insurmountable obstacle to logistics integration. Although, there are indications that successful integration might result in more efficient logistics operations (Closs and Savitskie, 2003; Tan, 2002¸ Daugherty, Ellinger and Gustin, 1996), some empirical evidence (Fawcett and Magnan, 2002) raises questions about the implementation of the vision of an integrated supply chain in practice.

The practice of SCM, as enumerated here, is characterized by supplier involvement, length of supplier relationship, use of information and communications technology, and logistics integration. Acting in unison, we believe, these four supply chain competency variables lead to better supply chain performance. These supply chain competency variables are discussed later in the paper.

A survey of the literature (Christopher, 1998; Stewart, 1995; Mapes, New, and Szwejczewski, 1997; Davis, 1993, Van Hoek, 2001, etc) indicates that while a variety of measures have been used to determine supply chain performance there is a broad overlap in the measures used. For the purpose of our research we have defined Supply Chain Performance as a function of its flexibility (volume and scheduling flexibility), on-time delivery, delivery reliability, quality standards, order lead time and order fill rate.

2. RESEARCH HYPOTHESES

Based on discussion above from the SCM literature, this study examines the effect of supply chain factors on supply chain performance measured by seven commonly used performance indicators. The research model of this study is illustrated in Figure 1.

Insert Figure 1 here

These supply chain factors are hypothesized to have direct effect on performance. The network of relationships among the variables in the model and the rationale for the proposed linkages are elaborated below.

Supplier Involvement: Supply chain management demands close working relationship with suppliers. There are many instances where companies have failed to accomplish desired results in markets where qualified suppliers are rare. Close relationship cannot happen in a vacuum and can only happen only with appropriately qualified suppliers. It requires the availability of qualified suppliers who also subscribe to the integrated supply chain management concept and who will take time to let such partnerships take root and flourish. Close supplier involvement requires long-term commitment from the supplier

and appropriate technological preparedness to become an equal partner and a willingness to nurture the relationship through challenges. Supplier development is thus an important criterion for the success of integrated supply chain management. It needs proactive initiative and involvement of the focal organization and "give and take" from both partners. As outsourcing intensifies, companies have started relying on suppliers not just for commoditized products, fabricated parts and sub-assemblies but there is also an increasing reliance on them for the design and development of component parts. More companies are realizing that early supplier involvement has the potential of decreasing design and manufacturing costs, reducing time to market, reducing risks associated with supply disruption as well as enhancing customer value. A high degree of supplier involvement suggests optimization of the resources and capabilities of the entire supply chain. Supplier involvement therefore, is relevant as a factor in determining the overall competency of the supply chain. Therefore, we hypothesize as follows.

Hypothesis 1: Supplier involvement has a positive effect on supply chain performance.

Length of Supplier Relationship: Given complex supply networks, collaboration among the members of the supply chain undoubtedly poses a logistical challenge. However, the biggest impediment to collaboration arises from the lack of complete trust between participating organizations. Trust promotes collaboration, reduces "second guessing" among members and consequently reduces safety stocks held by them. The importance of trust and its lack thereof leading to opportunism is well established in the transaction theory of Williamson (1975). Firms internalize transactions to control such opportunism according to the theory of internalization. Even when the transaction is not internalized,

firms tend to shield themselves from potential opportunism by limiting access to information. Longer supplier relationship contributes to development of trust between business partners and is likely to reduce opportunism. It is no surprise that the Japanese auto industry which possibly best exemplifies SCM is characterized by long term relationship between the auto manufacturers and their suppliers. Trust generated by long term relationship and a spirit of openness has often led to close partnership among customers and suppliers culminating in increased business for the supplier including in some cases sole sourcing and buying leverage and better prices for the customer—a win-win relationship for both. This leads to our second hypothesis.

Hypothesis 2: Length of supplier involvement positively affects supply chain performance.

Information Technology: A reliable information and communication infrastructure paves the way for timely and efficient information exchange among partners. For example, using electronic data interchange (EDI) technology, manufacturers can provide real time information about their production needs by giving vendors access to the production planning and control system and vendors can arrange deliveries without the need of paper transactions. Similarly, timely payments can be arranged using EDI. Reduction of payment delays lowers the cost of doing business significantly, makes supply chains more efficient, and gives the users competitive advantage. Judicious use of information technology may lead to benefits such as reduced cycle time from order to delivery, reduced inventory, increased visibility of transactions, better tracking, and reduced transaction costs. These benefits translate into enhanced customer service and

competitive advantage for all participants in the supply chain. Information integration permits management to examine the operations of the organization in totality and not in a fragmented, functionally isolated manner. The participants in a supply chain can be linked by information technology for such logistics activities as inventory management, order fulfillment, production planning, and delivery planning and coordination. Integration often requires coordination of disparate functions among supply chain partners in geographically dispersed locations. It may involve sharing of design and manufacturing data among suppliers, focal manufacturer, and customers. Suppliers and customers may be invited to participate in focal company product design teams to capture pertinent upstream and downstream issues in the product/process designs to reduce costly design and/or process changes later (Karoway, 1997, Lee, 2004). Information integration makes inventory and production visible throughout the supply chain creating a more congenial climate for collaborative planning and forecasting. Supply chain members, as a result, face less uncertainty, can reduce inventory buffers by postponing costly value-adding operations and provide better customer service with more flexible response to customer demand. To sum up, IT is a great enabler since it facilitates information sharing which promotes collaboration and integration cutting across organizational boundaries. So, our third hypothesis is:

Hypothesis 3: Use of information technology in supply chains positive affects supply chain performance.

Logistics Integration: In their seminal work, Lawrence and Lorsch (1986) defined integration as, “the quality of the state of collaboration that exists among departments that

are required to achieve unity of effort by the demands of the environment". In a supply chain the collaboration goes beyond the firm and encompasses external entities that are players in a supply chain. Logistics integration in this study refers to the extent the logistics activities of supply chain members, both upstream and downstream, are linked together with that of the focal organization. Integration ensures management of the entire process across the supply chain as one unit where each member of the supply chain focuses on what it does best leaving the rest to others (Prahalad & Hamel, 1994; Hammer, 2001, Cox, 1999). For effective collaboration in an integrated supply chain, often there are multiple communications between people at various decision levels across the partner firms in the supply chain. Thus, technical personnel from both the buyer and the selling organizations may be in constant touch. Similarly, production planners at the supplier may be in close contact with purchasing personnel at the buying company. Collaboration can also occur in product design and development and joint investment in technology and other capabilities. Collaboration helps to optimize supplier involvement and better management of the supplier base not only to facilitate better flow of materials but also to fully realize the benefit of outsourcing through increased involvement in joint product development and other allied activities (Davis, 1993). Logistics integration, more than any other variable, is a measure which captures the essence of SCM which is to focus on the entire supply chain rather than on individual firms. Ragatz et al. (1997) did a study of 60 U.S. companies about supplier integration in new product development. The responses indicated that supplier integration has led to significant performance improvements and competitive advantage for the firms. While direct cross-functional, inter-company communication was the most extensively used technique in successful

supplier integration, it was only when all tools, technology, processes, and people work together in unison that companies derive the most advantage. Other authors (Narasimhan and Kim, 2002; Tan, 2002) have also studied the effect of supply chain integration on performance and found that Logistics Integration was the most important of all supply chain factors as far as its impact on performance is concerned. Thus, we hypothesize that:

Hypothesis 4: Among the constituent factors of supply chain competency, logistics integration has the greatest positive effect on supply chain performance.

While we have discussed the importance of the individual variables to SCM and its impact on performance, we submit that the aggregate effect of these variables, namely, Supplier Involvement, Length of Supplier Relationship, Use of Information technology, and Logistics Integration is best captured by a holistic variable which we refer to as Supply Chain Competency. Supply chains are multi-dimensional in nature determined as they are by different constituent factors and a single integrative variable such as Supply Chain Competency made up of different constituents would best represent the overall quality of a firm's supply chain. Therefore, we propose that a multidimensional construct, Supply Chain Competency, will influence performance.

Hypothesis 5: Supply Chain Competency has a positive effect on supply chain performance.

3. METHODOLOGY

Data for the research was gathered through a structured questionnaire. A 7-point Likert-type survey instrument seeking information on the Supply Chain Competency and Supply

Chain Performance measures was prepared and pre-tested in Brazil prior to its finalization. The survey instrument is shown in Annexure A. The survey was carried out in three countries, Brazil, Korea and India. While the survey in Brazil was done in 2010, that in Korea and India were done in summer and fall of 2011 respectively. The selection of companies can best be described as convenience sampling. Thus, in the case of Brazil as the research team has special knowledge of and an interest in certain regions of Brazil, these states were automatically chosen. A total of 60 personal interviews were conducted during the summer and fall of 2010 in 4 states of Brazil namely, Sao Paulo (13 surveys), Parana (10 surveys), Santa Catarina (17 surveys), and Rio Grand do Sul (20 surveys). Survey data was similarly collected through personal interviews of 60 firms in India. In the case of Korea, the survey instrument was first translated in Korean before being mailed to 80 firms. A total of 67 completed questionnaires were received.

A wide spectrum of industries was represented among the respondents (Table 1). The respondents were senior managers in the logistics/supply chain management department of the organizations who had spent considerable time in their companies and had adequate knowledge of its operations.

Insert Table 1 here

4. DATA ANALYSIS

Survey responses were tested for discriminant and convergent validity. Discriminant validity was tested by factor analysis. In factor analysis linear composites are extracted of the original variables which exhibit like properties. These composites known as factors

represent central characteristics of the phenomenon being studied. The survey questions (3.4-3.17) resulted in four factors being retained using the proportion criterion. Annexure B indicates the loading of the survey questionnaire items on the factors for each country. In the case of all the three countries questions 3.4-3.6 load on one factor which we have labeled "Supplier Involvement". Questions 3.7-3.9 in the case of Brazil and India load heavily on a factor which has been labeled "Length of Supplier Relationship". In the case of Korea two other questions related to use of IT also load on this factor. The cross loading is probably explained by the fact that companies having long term relationship are more likely to invest in the use of IT with supply chain partners. Questions 3.10-3.13 for both Korea and India load together on a factor. We label this construct as "Use of IT". In the case of Brazil, however, while questions 3.10-3.12 load heavily together on the construct, question 3.13 loads also on another construct (Logistics Integration). Again, this is to an extent understandable since Logistics Integration is significantly affected by Use of IT. Questions 3.14-3.17 were hypothesized to load together on a construct "Logistics Integration" which it does in the case of all the countries. However, in the case of Brazil, question 3.17 which relates to the smooth flow of information and materials between suppliers firms and the focal organization also loads on Length of Supplier Relationship and Use of IT. To the extent that the level of Logistic Integration is related to the Length of Relationship with the suppliers and Use of IT, the cross loading of this questionnaire item is not surprising. To summarize, the questions predominantly loaded on the constructs as hypothesized except for a few exceptions. Given that these sub-constructs are not totally orthogonal i.e. there is some overlap between them, a certain measure of cross loading is inevitable. Barring these few instances, all the questionnaire

items (with minimal cross-loading) loaded on the factors as hypothesized confirming the discriminant validity of the survey instrument. This was also confirmed by an examination of the scree plot.

Convergent validity was tested by calculating the Cronbach alpha values. The Cronbach alpha values for questions relating to each of the sub-constructs are given below (Table 2).

Insert Table 2 here

All values are either over the threshold value of 0.7 or very near it which indicates an acceptable level of convergence among the items constituting the sub-construct.

To analyze the impact of the constituent variables of Supply Chain Competency on performance, multiple regressions with individual Supply Chain Performance variables as the dependent variables and the Supply Chain Competency variables as independent variables were carried out. The results are presented in Table 3A-3C.

Insert Table 3A-3C here

The regression results are discussed below.

Brazil: All regressions are significant except where the dependent variable is Order Lead Time. It is somewhat surprising that the regression against Order Lead Time turned out to be insignificant[1]. We can only make a conjecture as to why this is so. It is reasonable to

[1] In the case of Brazil we shall ignore this regression from discussion

assume that all the variables included in the model are *more* likely to impact performance metrics such as Flexibility, Timeliness of Delivery, and Order Fill Rate etc. than Order Lead Time. More than the other performance measures, Order Lead Time is likely to be dependent on hard factors such as technology, the manufacturing process and manufacturing capacity of the supplying organization as well as distance from the focal organization. To that extent it would be less susceptible to changes based on improved coordination and collaboration between the manufacturer and the supplier.

The results in Table 3A indicate that except for Logistics Integration, most of the other variables are insignificant. Logistics Integration is significant in all the regressions except against Order Fill Rate. Among the other variables Supplier Involvement is significant against Scheduling Flexibility, Quality Standards and Order Fill Rate while Length of Supplier Relationship is significant against Delivery Reliability and Order Fill Rate. Use of IT is not significant in any of the regressions.

Korea: Supplier Involvement is significant in two regressions, namely against Scheduling Flexibility and On Time Delivery while Length of Supplier Relationship is significant against Volume Flexibility, Scheduling Flexibility and Delivery Reliability. Logistics Integration is significant against all the Performance variables but as in the case of Brazil, Use of IT is not significant in any of the regressions.

India: Supplier Involvement is not significant in any of the regressions while Length of Supplier Relationship is significant against Volume Flexibility and Scheduling

Flexibility. Use of IT is significant only against Order Fill Rate. Logistics Integration remains significant in all the cases.

To summarize, Supplier Involvement is significant in only a few instances in the case of Brazil and Korea but not in the case of India. Length of Supplier Relationship is similarly significant in a few regressions in the case of all the countries. Use of IT was not found to be significant. Thus, Hypotheses 1, 2 & 3 can only be partly supported or not supported at all. The results do however indicate the importance of Logistics Integration to Supply Chain Performance and Hypothesis 4 is clearly supported.

The regression results tend to suggest that most of the individual factors *per se* do not significantly affect individual performance measures. This is counter-intuitive considering that there exists a strong conceptual foundation for these relationships. *Prima facie* this could be because of the fact that the individual factors do not work in isolation but rather in conjunction with each other to generate a demonstrable effect on performance. To illustrate, Use of IT without the attendant necessary relationship with the suppliers would not generate a measurable change in performance. To put it differently, except for Logistics Integration, it is not possible to measure the individual effect of each factor since these factors are interlinked which necessitates a measurement of their joint effect rather than an individual effect on performance. Consequently, it would be worthwhile to come up with multi-dimensional formative construct of the influencing variables and to determine whether such a construct has a bearing on performance. We call this formative construct Supply Chain Competency (SCC).

To compute values of SCC, a principal component analysis (PCA) was employed on the sub-constructs/items. PCA is a data reduction technique that reduces the number of variables used. Consecutive factors are extracted that account for less and less of the total variability. The first principal component is the linear combination of the standardized original variables that has the greatest possible variance. One factor was retained in all cases based on eigen value criterion (eigen value represents the amount of variance that is accounted by a particular component). Next regressions were carried out between SCC and individual constituent variables of supply chain performance. The results are reported in Table 4A- 4C.

Insert Table 4A-4C here

Possibly for reasons outlined earlier the regression against Order Lead Time in the case of Brazil turned out to be insignificant. Except for this, in all other regressions SCC turned out to be significant. This was true in case of all the countries. The results of the regression with SCC present a much clearer picture of the influence of the determinants of supply chain taken as a whole rather than considered individually. SCC affects a broad array of performance measures ranging from Flexibility to Delivery Reliability and Timeliness as also Quality Standards and Order Fill Rate. The results therefore clearly support Hypothesis 5.

Next, as with the variable Supply Chain Competency, we came up with a single measure, Supply Chain Performance (SCP), which captures most of the variation of its constituent

factors, namely the different performance metrics. SCP is a comprehensive variable, derived as it is from a host of performance variables, and is indicative of the overall performance on a variety of dimensions. Regressions were then run between Supply Chain Competency (SCC) and Supply Chain Performance (SCP). In all cases SCC was significant at 1 % level against SCP (Table 5).

Insert Table 5 here

This suggests that Supply Chain Competency of an organization, a multi-dimensional measure of different influencing variables, significantly impacts its Supply Chain Performance as measured by a composite variable. The results thus provide further validation of Hypothesis 5.

5. MANAGERIAL IMPLICATIONS

Management of the supply chain is often cited as a strategic choice to achieve competitive success. The objective of the study was both to empirically study the effect of individual supply chain related variables on performance as also to come up with an integrated measure of Supply Chain Competency and determine its impact on performance as measured by supply chain metrics. The results of the different regressions validate the utility of a composite variable, Supply Chain Competency, as measure of different supply chain sub-constructs. Analyzing the results of multiple regressions with individual variables (Table 3) with the results of Table 4 which uses Supply Chain Competency as the independent variable, it is evident that more meaningful inferences can be drawn if a holistic variable which incorporates different dimensions of Supply

Chain Competency is employed. What this suggests is that an organization's supply chain ability cannot be evaluated along a particular dimension alone. An organization's ability along a particular dimension may not result in improved performance unless the organization is adept in other dimensions of competency also. For an organization to show measurable improvement in performance it must invest in a variety of competency factors and ensure they work together well. Thus, use of IT by itself may not be able to make a difference to supply chain performance. It is after all a tool to be utilized to facilitate transactions and collaborations. Used in conjunction with procedures and processes i.e. in an environment conducive to integration, however, it can generate dividend in terms of improved performance metrics.

While supply chains can be managed either in an integrated or a disintegrated manner, firms practicing SCM attempt to integrate their procurement and operations with their business partners as this is the key to improved results (Brewer and Speh, 2000). The results do bring out the value of integration. They indicate that the real driver of Supply Chain Competency is the level of Logistics Integration between the focal organization and its key suppliers. This is evident from the multiple regressions reported earlier. The empirical evidence from this study is not surprising given that supply chain management is essentially about linking processes and business partners. Closer organizational coordination and integration is the key to achieving enhanced supply chain productivity. The other variables, such as Length of Supplier Relationship, can be viewed as building trust which can assist in integration but which by itself does not determine Supply Chain

Performance. In essence, the other variables are enablers of integration. They are necessary but not a sufficient cause for improved Supply Chain Performance.

Having established the criticality of Logistics Integration to the composite variable of Supply Chain Competency and to Supply Chain Performance future research may well study the factors that are conducive to its realization. *A priori* it can be hypothesized that Logistics Integration would be dependent on a variety of factors related to the focal organization, the intensity of competition and the nature of the product. Integration may also be influenced by the organizational structure of the focal organization and intangible factors such as culture and history. The influences of these and other variables are probably best studied through a case study approach which is more suited to bring out the dynamics of interaction of a host of influencing agents. The most interesting aspect that we find is that despite some differences, the overall results are applicable in all the three countries.

The study has limitations. We have considered only about 187 responses from three countries. A larger sample base would add to its validity. Further, because of the limited sample size we have not been able to study variations across industry. *Prima facie* it seems likely that some industries would lend themselves to more supply chain practices than others. This has not been captured by the study.

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Table 1
Industry wise composition of surveyed companies

	Brazil	Korea	India
Automobiles/Components	20	8	3
Fast moving consumer goods	7	5	8
Consumer Durables	22	7	0
Electrical equipment/machinery	9	25	2
Engineering goods	0	1	5
Chemicals/Pharmaceuticals	2	12	16
Other	0	9	26

Table 2
Cronbach's Alpha for reliability of Measures

	Supplier Involvement	Length of Supplier Relationship	IT	Logistics Integration
Brazil	0.794	0.819	0.639	0.680
Korea	0.859	0.925	0.755	0.922
India	0.849	0.663	0.832	0.841

Table 3A
Regression Results - Brazilian Companies

	Dependent Variables						
	Volume Flexibility	Scheduling Flexibility	On-Time Delivery	Delivery Reliability	Quality Standards	Order Lead Time	Order Fill Rate
Supplier Involvement	0.007 (0.082)	0.0131* (1.687)	0.043 (0.492)	0.116 (1.359)	0.176*** (3.238)	-0.094 (-1.235)	0.324** (2.191)
Length of Supplier Relationship	-0.096 (-0.836)	-0.118 (-1.165)	0.074 (0.655)	0.195* (1.751)	-0.034 (-0.482)	0.071 (0.719)	0.422** (2.196)
Use of IT	0.065 (0.336)	-0.128 (-0.747)	0.108 (0.561)	-0.196 (-1.035)	0.064 (0.531)	0.073 (0.436)	0.176 (0.539)
Logistics Integration	0.994*** (4.615)	0.965*** (5.097)	0.581*** (2.74)	0.412* (1.972)	0.618*** (4.645)	0.288 (1.55)	-0.323 (-0.897)
Intercept	0.112 (0.099)	1.032 (1.042)	1.127 (1.015)	3.078 (2.815)	0.975 (1.402)	3.734 (3.846)	1.446 (0.767)
R-Sq	0.37	0.42	0.25	0.19	0.53	0.10	0.18
Adj. R-Sq	0.32	0.38	0.19	0.14	0.50	0.04	0.12
F-Ratio	7.99***	9.964***	4.62***	3.41**	15.54***	1.547	3.01**
N	60	60	60	60	60	60	60

***p<0.01; **p<0.05; *p<0.1, figures in parentheses are t-statistics

Table 3B
Regression Results - Korean Companies

	Dependent Variables						
	Volume Flexibility	Scheduling Flexibility	On-Time Delivery	Delivery Reliability	Quality Standards	Order Lead Time	Order Fill Rate
Supplier Involvement	-0.003 (-0.037)	0.162** (2.046)	0.160* (1.768)	0.042 (0.496)	-0.022 (-0.228)	0.104 (1.186)	0.057 (0.699)
Length of Supplier Relationship	0.232** (1.945)	0.254*** (2.671)	0.080 (0.732)	0.249** (2.474)	0.184 (1.601)	0.073 (0.69)	0.095 (0.965)
Use of IT	0.063 (0.633)	-0.004 (-0.048)	-0.009 (-0.094)	-0.006 (-0.067)	-0.004 (-0.041)	-0.034 (-0.383)	-0.002 (-0.022)
Logistics Integration	0.420*** (2.878)	0.313*** (2.705)	0.521*** (3.923)	0.417*** (3.39)	0.442*** (3.153)	0.436*** (3.373)	0.577*** (4.803)
Intercept	1.197* (1.921)	1.130 (2.282)	1.516 (2.672)	1.872 (3.567)	2.207 (3.683)	2.503 (4.534)	1.619 (3.156)
R-Sq	0.4	0.5	0.46	0.48	0.36	0.36	0.51
Adj. R-Sq	0.36	0.46	0.43	0.44	0.32	0.32	0.48
F-Ratio	10.38***	15.24***	18.02***	14.03***	8.65***	8.635***	16.19***
N	67	67	67	67	67	67	67

***p<0.01; **p<0.05; *p<0.1, figures in parentheses are t-statistics

Table 3C
Regression Results - Indian Companies

	Dependent Variables						
	Volume Flexibility	Scheduling Flexibility	On-Time Delivery	Delivery Reliability	Quality Standards	Order Lead Time	Order Fill Rate
Supplier Involvement	0.014 (0.238)	-0.111 (-1.366)	-0.010 (-0.113)	-0.016 (-0.194)	0.012 (0.15)	0.118 (1.526)	-0.023 (-0.277)
Length of Supplier Relationship	0.172* (1.738)	0.324** (2.448)	0.196 (1.378)	0.031 (0.227)	-0.024 (-0.191)	0.008 (0.063)	0.030 (0.219)
Use of IT	0.067 (0.944)	0.139 (1.465)	-0.069 (-0.679)	0.149 (1.505)	0.079 (0.872)	0.035 (0.384)	0.285*** (2.906)
Logistics Integration	0.569*** (5.799)	0.427*** (3.257)	0.743*** (5.283)	0.347** (2.535)	0.473*** (3.786)	0.564*** (4.492)	0.334** (2.472)
Intercept	1.007 (1.365)	0.939 (0.953)	0.59 (0.558)	3.049 (2.965)	3.074 (3.271)	1.603 (1.698)	2.084 (2.049)
R-Sq	0.45	0.33	0.35	0.18	0.25	0.32	0.28
Adj. R-Sq	0.41	0.29	0.30	0.12	0.19	0.27	0.23
F-Ratio	11.3***	6.92***	7.46***	3.051**	4.545***	6.40***	5.42***
N	60	60	60	60	60	60	60

***p<0.01; **p<0.05; *p<0.1, figures in parentheses are t-statistics

Table 4A
Regression Results - Brazilian Companies

	Dependent Variables						
	Volume Flexibility	Scheduling Flexibility	On-Time Delivery	Delivery Reliability	Quality Standards	Order Lead Time	Order Fill Rate
Intercept	5.367 (36.82)	5.450 (41.02)	5.567 (41.88)	5.90 (44.09)	5.333 (59.34)	5.717 (48.56)	4.750 (20.44)
SCC	0.430*** (4.154)	0.407*** (4.316)	0.381*** (4.033)	0.276*** (2.906)	0.423*** (6.617)	0.128 (1.531)	0.403** (2.437)
R-Sq	0.23	0.24	0.22	0.13	0.43	0.04	0.09
Adj. R-Sq	0.22	0.23	0.21	0.11	0.42	0.02	0.08
F-Ratio	17.25***	18.62***	16.27***	8.444***	43.79***	2.341	5.94**
N	60	60	60	60	60	60	60

***p<0.01; **p<0.05; *p<0.1, figures in parentheses are t-statistics

Table 4B
Regression Results - Korean Companies

	Dependent Variables						
	Volume Flexibility	Scheduling Flexibility	On-Time Delivery	Delivery Reliability	Quality Standards	Order Lead Time	Order Fill Rate
Intercept	5.014 (52.396)	4.940 (65.24)	5.418 (61.483)	5.642 (68.29)	5.463 (58.39)	5.537 (65.08)	5.463 (66.52)
SCC	0.369*** (5.862)	0.366*** (7.355)	0.381*** (6.573)	0.356*** (6.559)	0.306*** (4.98)	0.291*** (5.203)	0.370*** (6.863)
R-Sq	0.35	0.45	0.40	0.40	0.28	0.29	0.42
Adj. R-Sq	0.34	0.45	0.39	0.39	0.27	0.28	0.41
F-Ratio	34.36***	54.09***	43.21***	43.02***	24.8***	27.07***	47.1***
N	67	67	67	67	67	67	67

***p<0.01; **p<0.05; *p<0.1, figures in parentheses are t-statistics

Table 4C
Regression Results - India Companies

	Dependent Variables						
	Volume Flexibility	Scheduling Flexibility	On-Time Delivery	Delivery Reliability	Quality Standards	Order Lead Time	Order Fill Rate
Intercept	5.333 (75.43)	5.167 (60.65)	5.417 (53.02)	5.60 (63.73)	5.850 (68.72)	5.233 (58.49)	5.033 (57.50)
SCC	0.266*** (4.449)	0.329*** (4.566)	0.226** (2.608)	0.205*** (2.761)	0.170** (2.364)	0.185** (2.445)	0.295*** (3.976)
R-Sq	0.25	0.26	0.11	0.12	0.09	0.09	0.21
Adj. R-Sq	0.24	0.25	0.09	0.10	0.07	0.08	0.20
F-Ratio	19.79***	20.85***	6.80**	7.625***	5.589**	5.976**	15.81***
N	60	60	60	60	60	60	60

***p<0.01; **p<0.05; *p<0.1, figures in parentheses are t-statistics

Table 5
Regression Results of SCP on SCC

	Dependent Variables		
	SCP (Brazil)	SCP (Korea)	SCP (India)
SCC	0.774*** (5.443)	1.044*** (8.58)	0.866*** (4.814)
R-Sq	0.34	0.53	0.29
Adj. R-Sq	0.33	0.52	0.27
Intercept	-8. 77e-16 (0.00)	-7.815e-18 (0.00)	5.367e-16 (0.00)
F-Ratio	29.62***	73.62***	23.17***
N	60	67	60

***p<0.01; **p<0.05; *p<0.1, figures in parentheses are t-statistics

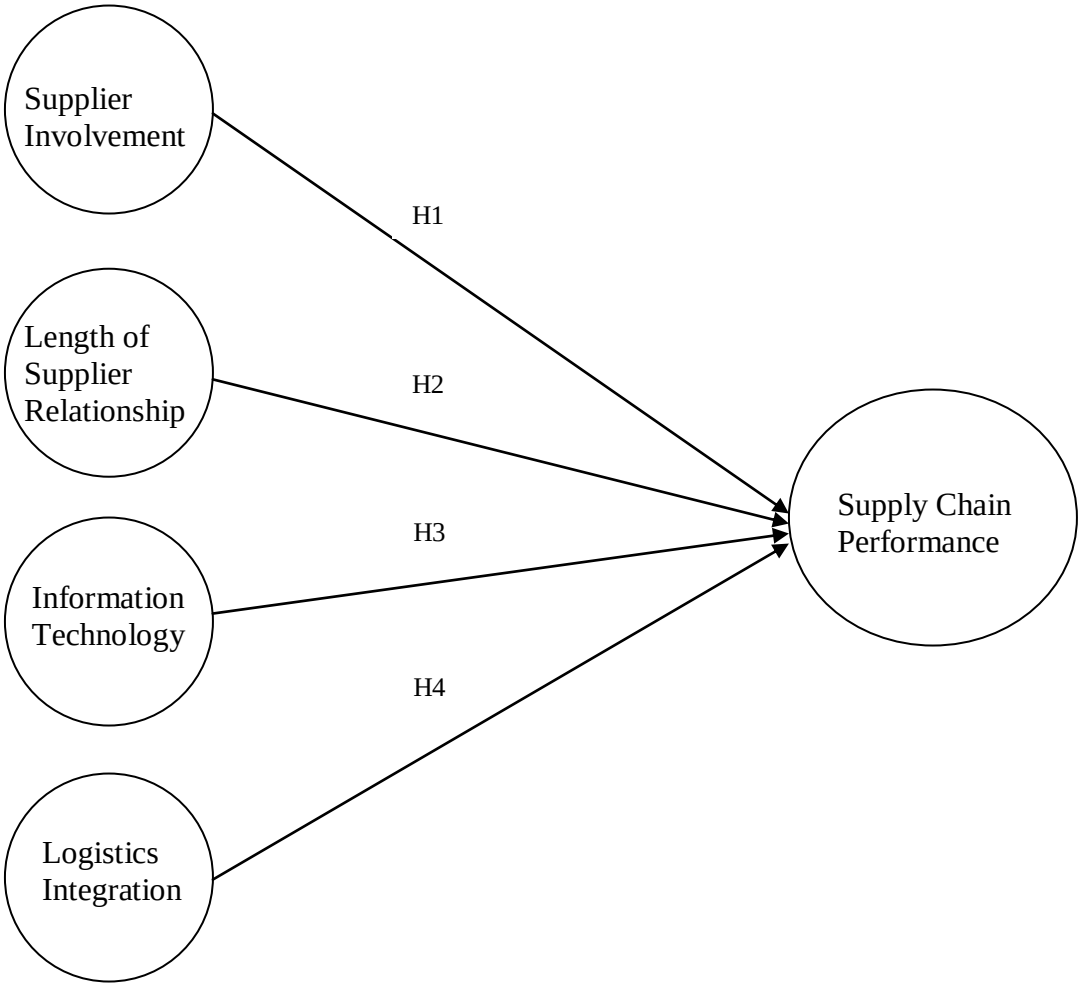

Figure 1: Supply Chain Factors and Performance

Annexure A

Research Survey

This survey is part of the research work being conducted by the School of Business at The George Washington University, Washington DC, USA and the Federal University of Santa, Catarina, Florianopolis and Universidade Federal do Paraná (UFPR), Centro Curitiba Paraná. This research project is jointly funded by the Governments of Brazil and United States under the US-Brazil higher Education Consortia program. The objective of the survey is to get information on items such as quality consciousness, customer orientation, technical capacity, and other related issues. This information from the survey will be used along with other hard data to determine the business environment/capability of countries.

The results of the survey would be used only for academic purposes. The responses will be treated in confidence and anonymity of respondents and their organizations is ensured.

Thank you for taking the time to respond to it.

General Information

Please provide the following information.

1.1 Name: _____

1.2 Designation: _____

1.3 Organization: _____

1.4 Country where you are located: _____

1.5 Email: _____

1.6 What is your company's product(s)?

_____

1.7 Please select an industry from the list below with which you have the MOST familiarity.

A. Automobiles/Automotive components B. Fast moving consumer goods

C. Consumer Durables D. Electrical Equipment/machinery E. Engineering Goods

F. Chemicals and Pharmaceuticals G. None/Other (pl. specify) _____

Part A

This part of the questionnaire relates to information on overall supply environment and technical skills in the country.

While responding to the survey items on a scale of 1-7, please bear in mind that you should select 7 if the country is comparable to the best in the world on that item.

Please respond to all the questions.

2.1. Most locally-owned manufacturers possess machinery, comparable to the best in the world.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

2.2. The technological capability of locally-owned manufacturing organizations matches the best in the world.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

2.3. Locally-owned organizations use the world's most efficient manufacturing processes.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

2.4. The technical competency of the engineering and technical personnel in locally-owned manufacturing organizations is comparable to the world's best

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

2.5. The level of quality consciousness in business organizations is at par with the best in the developed world.

Strongly Strongly

Disagree Agree

1 2 3 4 5 6 7

2.6. Locally-owned manufacturing organizations meet product quality standards as practiced in the most advanced countries.

Strongly Strongly

Disagree Agree

1 2 3 4 5 6 7

2.7. Awareness of quality issues in local firms exists to the same degree as in the best business organizations worldwide.

Strongly Strongly

Disagree Agree

1 2 3 4 5 6 7

2.8. Locally-owned manufacturing organizations strive to provide the best possible service to customers.

Strongly Strongly

Disagree Agree

1 2 3 4 5 6 7

2.9. Locally-owned organizations provide very reliable service to customers.

Strongly Strongly

Disagree Agree

1 2 3 4 5 6 7

2.10. Locally-owned firms in the country are highly responsive to customers' concerns.

Strongly Disagree — Strongly Agree

1 2 3 4 5 6 7

2.11. Customer satisfaction is emphasized by locally-owned firms in your country.

Strongly Disagree — Strongly Agree

1 2 3 4 5 6 7

2.12. The quality of science and technical education in the country is comparable to the best in the world.

Strongly Disagree — Strongly Agree

1 2 3 4 5 6 7

2.13. The quality of the country's science and engineering colleges is comparable to those in the most advanced countries.

Strongly Disagree — Strongly Agree

1 2 3 4 5 6 7

2.14. The educational system meets the need of a competitive economy.

Strongly Disagree — Strongly Agree

1 2 3 4 5 6 7

2.15. Employee training has a high priority in most companies.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

2.16. Local training organizations exist in sufficient numbers.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

2.17. Skilled/trained manpower is readily available in the country.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

2.18. Knowledge transfer between companies and universities is at par with the most developed countries.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

2.19. Locally-owned firms are technically competent to absorb new technology.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

2.20 The overall state of infrastructure (transport, communication, etc) in the country is comparable to the best in the world.

Strongly Disagree — Strongly Agree

1 2 3 4 5 6 7

Part B

This part of the questionnaire relates to your experience with your suppliers.

Using the following rating scale, circle the number that best represents your response to each item.

1 2 3 4 5 6 7

Strongly Disagree — Strongly Agree

3.1 The suppliers consistently meet our requirements on time

1 2 3 4 5 6 7

3.2 The suppliers consistently fill our orders accurately

1 2 3 4 5 6 7

3.3 The suppliers consistently meet our quality standards

1 2 3 4 5 6 7

3.4 Key suppliers are involved in product design and development

1 2 3 4 5 6 7

3.5 Key suppliers have input in the design of new products

1 2 3 4 5 6 7

3.6 There is a formal procedure for involvement of key suppliers in the production planning process

1 2 3 4 5 6 7

3.7 We have long term alliances (5 years or more) with our suppliers

1 2 3 4 5 6 7

3.8 We expect our relationship with key suppliers to last a long time (at least 5 years)

1 2 3 4 5 6 7

3.9 Suppliers see our relationship as lasting for more than 5 years

1 2 3 4 5 6 7

3.10 There are direct computer to computer links with key suppliers

1 2 3 4 5 6 7

3.11 Inter-organizational coordination is achieved using electronic links (EDI, XML, other web-based/internet links).

1 2 3 4 5 6 7

3.12 We use electronic transfer of purchase orders, invoices and/or funds

1 2 3 4 5 6 7

3.13 We use advanced information systems to track and/or expedite shipments.

1 2 3 4 5 6 7

3.14 Inter-organizational logistics activities are closely coordinated

1 2 3 4 5 6 7

3.15 Our logistics activities are well coordinated with the logistics activities of our suppliers

1 2 3 4 5 6 7

3.16 The inbound and outbound distribution of goods is well integrated with our suppliers and carriers.

1 2 3 4 5 6 7

3.17 Information and materials flow smoothly between our supplier firms and us.

1 2 3 4 5 6 7

3.18 How would you rate the performance of your major suppliers on volume flexibility?

1 2 3 4 5 6 7

3.19 How would you rate the performance of your major suppliers on scheduling flexibility?

1 2 3 4 5 6 7

3.20 How would you rate the performance of your major suppliers on on-time delivery?

1 2 3 4 5 6 7

3.21 How would you rate the performance of your major suppliers on reliability of delivery?

1 2 3 4 5 6 7

3.22 How would you rate the performance of your major suppliers on meeting quality standards?

1 2 3 4 5 6 7

3.23 How would you rate the performance of your major suppliers on order lead time?

1 2 3 4 5 6 7

3.24 How would you rate the performance of your major suppliers on order fill rate?

1 2 3 4 5 6 7

Thank you for participating in the survey.

Annexure B

Factor Analysis (Discriminant Validity) - Brazil

Survey Questionnaire Question #	Factor 1	Factor 2	Factor 3	Factor 4
3_4	0.00527	0.19678	0.81735	0.16274
3_5	0.04531	0.06899	0.93681	0.21492
3_6	0.05418	0.48412	0.51983	-0.12458
3_7	0.7835	0.13277	-0.00909	-0.0193
3_8	0.79771	-0.00905	0.04463	0.04504
3_9	0.79417	0.14286	0.05656	0.15227
3_10	0.04992	0.0705	0.02674	0.75395
3_11	0.01111	0.03856	0.11963	0.68837
3_12	0.29264	0.23075	0.25527	0.55643
3_13	0.13031	0.58866	0.25319	0.12334
3_14	0.30221	0.60755	0.15415	0.11098
3_15	-0.03162	0.65053	0.02564	-0.01965
3_16	0.11972	0.6402	0.07072	0.26122
3_17	0.44155	0.31383	0.00281	0.3396

Factor Analysis (Discriminant Validity) - Korea

Survey Questionnaire Question #	Factor 1	Factor 2	Factor 3	Factor 4
3_4	0.61090	0.61239	-0.07229	-0.32484
3_5	0.50670	0.66216	-0.06433	-0.35072
3_6	0.50832	0.55230	-0.39138	-0.15326
3_7	0.72646	-0.43178	0.31142	-0.20804
3_8	0.70225	-0.37846	0.44527	-0.28202
3_9	0.72710	-0.37910	0.22395	-0.32469
3_10	0.52677	0.446820	0.56747	0.26677
3_11	0.552150	0.48816	0.45110	0.32118
3_12	0.51228	-0.04657	-0.14320	0.50345
3_13	0.69001	-0.03587	0.08140	0.35350
3_14	0.77519	-0.23044	-0.34863	0.12438
3_15	0.83203	-0.10828	-0.30844	0.13973
3_16	0.84192	-0.21638	-0.19776	-0.04660
3_17	0.80769	-0.17425	-0.32622	0.0571

Factor Analysis (Discriminant Validity) - India

Survey Questionnaire Question #	Factor 1	Factor 2	Factor 3	Factor 4
3_4	0.04553	0.87098	0.12920	-0.28611
3_5	-0.04774	0.87974	-0.05746	-0.10421
3_6	0.11172	0.81735	0.13733	0.03767
3_7	0.21375	0.06980	-0.44429	0.75352
3_8	0.25640	0.43108	-0.28194	0.60567
3_9	0.54244	0.10711	-0.53182	0.17731
3_10	0.77636	-0.28270	-0.18607	-0.22250
3_11	0.72269	-0.32494	-0.41570	-0.13648
3_12	0.66183	0.08037	-0.24676	-0.35679
3_13	0.63935	0.31093	-0.39599	-0.28779
3_14	0.56647	-0.16671	0.51750	0.28003
3_15	0.59675	0.02179	0.62139	0.09438
3_16	0.59584	-0.09862	0.58294	-0.01090
3_17	0.40413	0.17319	0.69740	0.18398