Interfirm Cultural Compatibility and Communication in Supply Chain and Operations Performance

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Sociotechnical systems (STS) theory in the intraorganizational context takes a cultural and behavioral view on supply chain relations and emphasizes the foundational role of cultural compatibility in supply chain integration. Drawing from the STS rationale, we suggest that interfirm cultural compatibility can facilitate interfirm communication, which contributes to supply chain and operations performance. We use structural equation modeling method to analyze data from 687 manufacturing facilities and find that interfirm communication mediates the relationship between interfirm cultural compatibility and partner performance. Out of the four customer performance outcomes tested, the effect of cultural compatibility on three outcomes (order delivery, lead time, and sales forecast error in two years) are mediated through interfirm communication. Cultural compatibility impacts sales forecast error in two months directly. Our findings shed light on the processes whereby interfirm cultural compatibility can impact supply chain performance and provide empirical support for STS theory regarding interorganizational relationships.

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I. INTRODUCTION

Collaboration among supply chain partners bears paramount importance to firm success in the modern, complex global operational environment. A large body of research has identified interfirm communication as a key success factor for effective supply chain collaboration (Cheng, 2011; Hudnurkar, Jakhar, & Rathod, 2014). Interfirm communication in the context of supply chain relations entails such important practices as sharing information on proprietary technology, market forecast, and organizational events that could affect a partner's performance. For example, manufacturers actively exchange information with their suppliers and distributors about the market forecast, product development, and technological innovation so that they can speed up response to market changes as well as competitive development of new products (Clemons & Row, 1992). Suffice to say, the effectiveness of interfirm communication can yield strategic advantages. Interfirm communication fosters organizational learning and builds value-enhancing relationships along the supply chains that increasingly span across national boundaries. Its

benefits include reduced inventory and supply chain cost, more competitive pricing, increased material flow and visibility, faster delivery and order fulfillment rate, enhanced channel coordination, and improved partner relationships and customer satisfaction (Paulraj, Lado, & Chen, 2008).

While a large body of research has identified the benefits associated with interfirm communication, less has investigated the collaborative processes that lead to such practices and benefits. Paulraj et al. (2008) contend that more research guided by theoretical frameworks is needed to advance theory building and empirical testing of interfirm communication effectiveness in supply chain management. These authors conceptualize interorganizational communication as a relational competency drawing from the relation-based view of the firm (Dyer & Singh, 1998). Their empirical study shows that interfirm communication mediates the relationship between three antecedents (long-term orientation, network governance, and information technology) and buyer and supplier performance. Their research highlights the need for examining the extent to which interfirm communication mediates the links among key antecedents and outcomes within the context of buyer-supplier collaboration.

Interfirm communication is a behavioral phenomenon that is vital to the on-going management of supply chain relations. While many studies examined interfirm communication in the technological context, fewer studies investigated the factors that affect intercommunication from a behavioral perspective. In this study, we suggest that interfirm cultural compatibility is a key antecedent to interfirm communication and its subsequent influence on customer and supplier performance. In the context of supply relationships, cultural compatibility refers to the fit or congruence of two collaborating firms' cultures (McAfee, Glassman, & Honeycutt Jr, 2002). It can influence the extent to which partners are willing and able to materialize the benefits of collaborative practices. Successful supply chain collaboration requires building and maintaining close long-term relationships among partners beyond the life of a contract. Cultural compatibility captures the norms, values, and visions shared among supply chain partners and as such, provides an essential mechanism that guides interfirm communication behavior. Cultural congruence promotes interfirm cooperation that focuses on the systematic development of ongoing and collaborative business relationships. For example, cultures with differing norms around risk-taking, communication, or client interactions
can inhibit knowledge transfer between professional service firms (Empson, 2001), and barriers to knowledge transfer require firms to invest more resources and personnel in the integration process of strategic alliances (White & Siu-Yun Lui, 2005). Therefore, cultural compatibility has the potential to enhance or impede the effectiveness of communication among supply chain partners.

Our primary research question in this study concerns the role of cultural compatibility in interfirm communication and supply chain performance. We develop our hypotheses based on the premise that cultural and behavioral coherence ought to precede communication practices for the latter to be effective. We build our argument based on sociotechnical systems (STS) theory of supply chain relations. While STS theory historically is used to explain intraorganizational phenomena (Trist & Bamforth, 1951), recent literature extends the rationale of STS theory to interorganizational phenomena, such as supplier integration (Kull, Ellis, & Narasimhan, 2013). STS theory in the interorganizational context takes a cultural and behavioral view on supply chain relations and addresses the extent to which cultural integration forms the basis of sustainable supply chain integration. This theoretical perspective

shifts the focus of interfirm collaboration from the technical domain to the behavioral domain. It provides a robust theoretical framework for explaining how interfirm communication effectiveness largely depends on cultural and behavioral integration between firms. While economic gains such as cost reduction and delivery efficiency serve as an initial motivation for firms to engage in collaborative communication, the effectiveness of such efforts can only come to fruition if firms can achieve an aligned mindset based on shared values, norms, and coordinated goals and visions.

Similar to the relational view of strategic management (Dyer & Singh, 1998), STS theory places a premium on behavioral phenomena. Thus, by understanding the cultural phenomenon in relate to interfirm communication, we seek to gain a better understanding of the behavioral importance within the context of supply chain management. Kull et al. (2013) raise attention to behavioral constraints as plausible causes for failure of supply chain integrations. They emphasize that people place high values on their social position/status that could be threatened by integration practices. Supply chain integration practices are particularly problematic for companies with unique mindsets that are in conflict with those of their partners. Therefore, to minimize potential problems associated with supply chain integration, firms need to be proactive to develop socialization mechanisms, foster social bonds between employees from partner firms, align organizational values and goals, and provide information and orientation to prepare employees for integration challenges (Kull et al., 2013).

Therefore, we propose that cultural compatibility precedes interfirm communication, which, in turn, improves performance with customers and suppliers. In the firm-customer dyad, our outcome variables include order lead time, on-time delivery, and expected forecast error in both short term (three months) and long term (three years). In the firm-supplier dyad, we test the effect of cultural compatibility on interfirm communication and supplier's delivery delay. In the following sections, we review the literature on STS theory, interfirm communication, and supply chain performance to develop our theoretical model and hypotheses. We then validate our empirical model and constructs and conduct an explicit mediation analysis using structural equation modeling and bootstrapping. We also conduct a robustness check to verify the empirical rigor of our analysis. Lastly, we discuss our findings and implications.

II. LITERATURE AND HYPOTHESES

Firms establish, maintain, and enhance transactional relationships in the supply chain to achieve financial return through mutual exchange and fulfillment of promises (Paulraj et al., 2008). Despite its potential benefits, interfirm collaborations face numerous challenges. These challenges mainly center on behavioral aspects of collaboration such as confidentiality and accuracy of information shared, lack of trust among partners, ambiguous incentives, and insufficient capabilities that allow companies to effectively utilize the shared information (Khurana, Mishra, & Singh, 2011).

According to STS theory, organizations are an interlinked, systems-based mixture of people, technology, and their environment. STS theory posits that a firm encompasses three general subsystems. The technical system creates a structure that is embedded in technology, equipment, and knowledge, within which organizational members produce outputs and oversee the operational process. The social system is comprised of people and their attitudes, beliefs, relations, cultures, norms, politics, behaviors, and emotions. The environmental system includes the contextual forces surrounding the social and technical systems (Kull et al., 2013). A supply chain is a sociotechnical system as it entails all three

components, and its performance is driven by the alignment between these three subsystems. The STS view draws attention to the relationship between human behavior and technological process and asserts that successful supply chain activities need to adapt to changing cultures and economic conditions. Kull et al. (2013) indicate that the incompatibility of the sociocultural systems often results in behavioral constraints in supplier integration. During the supply chain integration process, unless the social elements are synchronized with the technical system, performance will not be effective.

Furthermore, interfirm communication is a relational competency that fosters supply chain collaboration. Collaborative communication will subsequently allow partner firms to explore and exploit their internal resources and market opportunities and thus, improve performance (Paulraj et al., 2008). Fig. 1 depicts our research model.

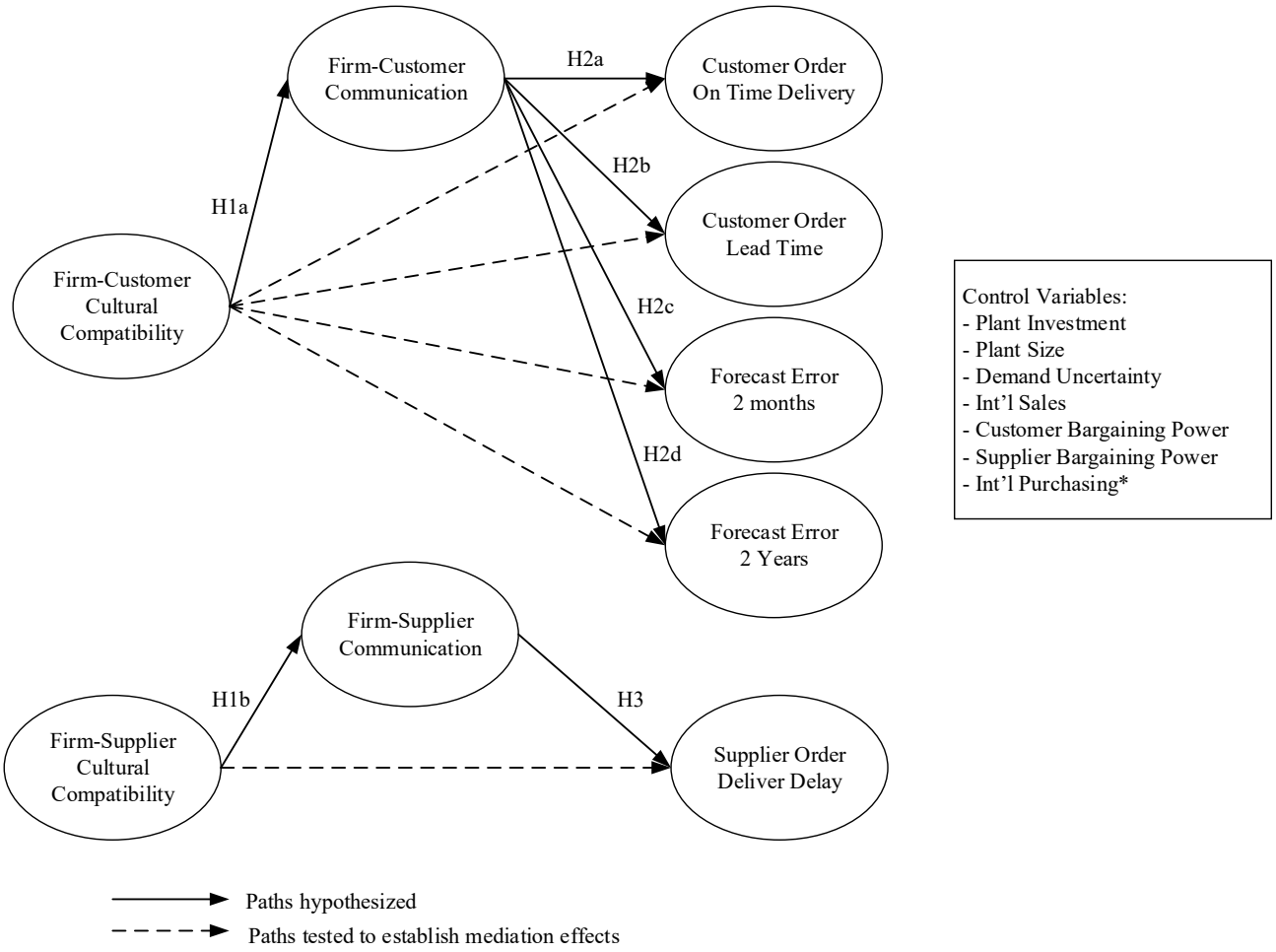

FIGURE 1. HYPOTHESIZED MODEL.

2.1 Cultural Compatibility and Interfirm Communication

Interorganizational collaboration seeks to enhance market competitiveness through mutually beneficial relationships. Interfirm communication provides the critical mechanism to arrange resources and coordinate the norms and goals of different partners. From the perspective of STS theory, for technical systems to be effective, it is essential that social system is developed to accommodate and enable the changes of the technical system. Synergistic integration between the technical and social subsystems enables firms to deal with the competition and uncertainty from their operating environment and therefore, giving rise to superior performance (Kull et al., 2013).

In managing supply chain relations, organizations continually face the challenge of managing the "people" who operate the systems and react to the demands of the systems. In many cases, the technological, administrative, informational, and logistics systems needed for the supply chain collaborative effort are readily available and can be implemented within a planned time period. However, many supply chain initiatives fail due to a poor personal relationship and the resulting underperformance. Managers often assume that the personal relationships within and between organizations will fall into place once the technical systems are established. However, managing relationships among the various individuals is often the most difficult part of the supply chain initiative (Kull et al., 2013). Without positive social relationships, other systems cannot function effectively (Terpend, Tyler, Krause, & Handfield, 2008).

Given the dynamic nature of the multidimensional systems involved in supply chain communication, firms and managers have options in designing organizational processes to enhance performance outcomes. Cultural values underlie business norms and practices such as customer focus and team empowerment and therefore have a strong influence on relational based management practices such as interfirm communication. Differences in organizational culture can create different values and norms and lead to a conflict of interest. Conversely, shared values and vision instill a sense of collective identity, foster trust, long-term orientation, and thus provide the foundation for high-quality interfirm communication (O'Reilly III, Chatman, & Caldwell, 1991). Firms that share similar values and visions are more likely to establish a long-term view in their collaboration, as well as to provide the appropriate support and resources to sustain their collaboration. Min and Mentzer (2000) argue that supply chain partners need compatible corporate philosophies for successful supply chain management implementation. They propose that the set of values and beliefs about the importance of customers should guide firms to achieve customer satisfaction through inter-functional coordination. Importantly, when supply chain partners share compatible marketing values, they become more willing to be cost efficient and to focus more on customer service, both of which can lead to customer satisfaction and firm profit.

Paulraj et al. (2008) explain that interfirm communication extends organizational learning beyond the boundary of the individual firms toward that of the supply chain. The development of interfirm collaboration requires that firms adopt a collaborative managerial mindset for building strategically complementary capabilities. Thus, firms that emphasize cooperation among supply chain partners may achieve greater economic benefits compared to those that espouse traditional arm length transaction model. Frequent, in-depth exchange of information on strategic, proprietary, and market knowledge may also foster greater confidence, build cooperation and trust, reduce dysfunctional conflict, and lead to increased behavioral transparency, all the while reducing information

asymmetry. Exchange partners who share similar organizational norms and missions are also more likely to rely on norms of trust, long-term orientation, and mutuality in their interactions. These types of behavioral pattern facilitate the exchange of knowledge and ideas for mutual gains (Dyer & Singh, 1998).

Therefore, consistent with the proposition of interorganizational STS theory (Kull et al., 2013), we suggest that cultural compatibility provides a social condition that enables and enhances collaborative communication.

Hypothesis 1a: Firm-customer cultural compatibility is positively associated with firm-customer communication.

Hypothesis 1b: Firm-supplier cultural compatibility is positively associated with firm-supplier communication.

2.2. Interfirm Communication and Supply Chain and Operations Performance

Interfirm communication binds firms together in supply chain relations (Cheng, 2011). As a relational competency, it enables supply chain partners to effectively interact and exchange information and thus facilitate firms to identify market opportunities and solve problems together (Ulaga & Eggert, 2006). Zhou and Benton Jr (2007) find that while investment in information technology provides the essential resources to share information on demand/supply forecast and technological development among manufacturers, the effectiveness of technological systems largely depends upon the ability of these companies to communicate with each other. Carr and Pearson (1999) show that systematic and active exchange and sharing of meaningful, timely, and sensitive information between firms, customers, and suppliers are vital to developing effective interorganizational relationships. Studies have shown that communication improves supply chain performance in various aspects, such as mitigating conflict (Kim & Frazier, 1997), lowering operating costs (Cannon & Homburg, 2001), enhancing interfirm cooperation (Anderson & Narus, 1990), improving service quality (Mentzer, Flint, & Hult, 2001), customer outcomes (Jap, 1999), and production and delivery accuracy (Davis-Sramek, Germain, & Iyer, 2010). In sum, the coordination and integration of information via interfirm communication contribute to the bottom line for the supply chain partners.

Effective interfirm communication enables firms to generate intelligent market information, which compels them to disseminate and respond to the market trend. When firms collaborate and share knowledge with others, they can achieve the advantages beyond what could be achieved in arm's length transaction (Crook, Ketchen Jr, Combs, & Todd, 2008). Through their connections, companies can utilize each other's unique creativity and knowledge and improve their business process (Zhou & Benton Jr, 2007). These interactions and learning can strengthen partner relationships. Davis and Golicic (2010) find that a firm's ability to support the organization-wide collection, dissemination, and use of market information yields comparative advantages in supply relationships. This is because market information is heterogeneously and asymmetrically distributed across firms. In this regard, firms' ability to acquire and manage information enjoy an information advantage, which has the potential to provide an efficiency-effectiveness advantage in supply chain relationships (Davis & Golicic, 2010).

Close interfirm relationships are also sources of information outside the firm. When a firm communicates with its customers, it can closely monitor customers' current and future needs and to make sure that these needs are met. When a firm communicates with its suppliers, it can identify the influences of the suppliers on customers' needs and preferences. For example, Ouyang (2007) show that sharing customer

demand information across the supply chain can reduce the bullwhip effect, a distribution channel phenomenon in which forecasts yield supply chain inefficiencies. Martínez-Olvera (2008) suggests that information sharing can facilitate order fulfillment in a seamless way. Sohn and Lim (2008) show that proper information sharing policy and forecasting method have a significant impact on supply chain performance, especially where the product life cycle is short.

Given its well-documented advantages, we hypothesize that interfirm communication will enhance the firm's ability to fulfill their customer order, forecast market needs, as well as to strengthen their supplier's ability to serve the firms.

Hypothesis 2: Firm-customer communication is positively associated with customer order fulfillment in term of (a) on-time delivery and (b) lead time; and negatively associated with (c) short-term sales forecast error and (d) long-term sales forecast error.

Hypothesis 3: Firm-supplier communication is negatively associated with supplier order delivery delay.

2.3. Mediating Role of Interfirm Communication

Scholars note that the way cultural norms and values affect behavior and performance is often indirect, contingent, and complex (Schein, 2004). So far, we have argued that shared interorganizational cultural norms and visions can serve as the catalyst for supply chain partners to develop and maintain meaningful interfirm communication. STS theory provides the rationale for this claim. Interfirm collaboration requires firms to align their strategic goals, share proprietary information and technological knowledge, and market demand forecast, all in an effort to transform strategic factors and information into mutually beneficial competency for market performance.

Cultural norms affect firm performance indirectly by functioning as a control mechanism that regulates collaborative behaviors through the alignment of values and goals of multiple constituencies. It is less likely that compatible cultural mindsets between firms will directly lead to technical performance, such as order fulfillment and sales forecast. Shared values and norms facilitate performance by creating an environment and guidelines for supply chain partners to communicate, a practice that enables them to subsequently adapt to the expectation of their market. When the norms for firm behavior support the needs of collaborative communications that partners are trying to implement, congruence between the social and technical systems will likely encourage acceptance of the implementation of collaborative practices.

To this end, the communication process in a triadic supply chain is embedded in its social context. Cultural values serve as an informal control mechanism for behaviors and generate a possible "pass-on" effect across partner firms (Liu, Ke, Wei, Gu, & Chen, 2010). Communicative practices channel the effects of cultural values and norms into operational efficiency and relational performance. In this regard, interfirm communication plays a mediating role in the path between cultural congruence and supply chain performance.

Hypothesis 4: Firm-customer communication mediates the relationship between firm-customer cultural compatibility and (a) customer order on-time delivery, (b) customer order lead time, (c) short-term sales forecast error, and (d) long-term sales forecast error.

Hypothesis 5: Firm-supplier communication mediates the relationship between firm-supplier cultural compatibility and supplier order delivery delay.

III. METHODS

3.1. Sample and Data

Our empirical data are from a subset of a worldwide survey conducted by the Global Manufacturing Research Group (GMRG). GMRG is a multinational research collaboration consists of researchers in operations and supply chain management. Its goal is to improve manufacturing supply chain effectiveness through the development of theory and dissemination of results (www.gmrg.org). GMRG scholars initially randomly choose sample firms from a given geographical area. Once the facilities agreed to participate, their directors or managers were asked to complete the survey based on their knowledge about the strategies and practices in their facilities (Whybark, Wacker, & Sheu, 2009).

The GMRG survey instrument has been developed and enhanced by leading scholars in operations and supply chain management over the last 20 years (Whybark et al., 2009). Prior studies analyzing GMRG data have reported acceptable measurement validity as well as translation equivalence of the questionnaire in different languages (Schoenherr, Power, Narasimhan, & Samson, 2012; Power, Klassen, Kull, & Simpson, 2015). The key informants were facility directors or managers who were knowledgeable about the strategic aspect of interorganizational exchange relationships. The average time the respondents had worked in their facilities was 12 years. Organizational leaders have extensive knowledge regarding the strategies, practices, and performance of their organizations and, as such, are uniquely qualified to provide comprehensive information as well as detailed insights across their entire organizations (Hambrick & Mason, 1984). The approach of surveying the manufacturing firms' executives to study supply chain relations has been widely adopted in the field of supply chain and operations management (cf. Ketokivi & Schroeder, 2004).

The GMRG 5th round survey (2012-2014) consists of five modules, including core operations, supply chain management, facility culture, innovation, and sustainability. We used a subset of data from the core and sustainability modules that include the variables of our interest. Out of the 765 total data points tabulated by the GMRG survey center for the core and supply chain management module, we obtained a useful data set including 687 firms after deleting cases with missing values. The unit of analysis of this study is the manufacturing facility. The number of employees in the facilities ranges from 30 to 15,000, with an average of 1,121 employees.

3.2. Measures

Five objective measures are used to measure supply chain and operations performance. Firm performance with its customer demand is measured by two variables: the percentage of total customer orders delivered in full and on time, and the average order lead time (from order to delivery) expressed in days. Firm production performance is measured by two variables: the expected forecast error (in percentage) in the next two months for the most important product line, and the expected forecast error (in percentage) in the next two years for the total sales for the plant. Supplier's performance is measured by the percentage of the plant's purchase orders that suppliers deliver late. Regrettably, only one measure is available in the survey for supplier performance that is comparable to those toward the customers. Descriptive statistics analysis detected various levels of skewness and kurtosis in the sample data. As such, data with positive skewness was transformed using log functions and squared root, and data with negative skewness was transformed using cubed function. Retest

showed normal distribution for all five outcome variables.

Interfirm communication practice is a three-item scale that measures the extent the plant and its main customers (1) exchange proprietary information, (2) inform each other about events affecting the other party, and (3) regular exchange of supply and demand forecast.

Interfirm cultural compatibility is reported as being best measured at the practices level (as opposed to with national culture measured at the values level) (Naor, Linderman, & Schroeder, 2010). Cultural compatibility is a two-item scale that measures the extent the plant and its main customer and suppliers share similar visions/philosophies for that business relationship. The measures for these four latent constructs are based on seven-point Likert-type scale.

Due to the length and multiple modules of the GMRG survey, the number of reflective measurement items for some scales was limited to two, to ensure parsimony of the instrument and adequate sample size (e.g., Denison & Mishra, 1995). Concerning the two-items measures, while they are not ideal, Little, Lindenberger, and Nesselroade (1999) demonstrate that when two indicators of a construct are theoretically equivalent selections from the domain of possible indicators, they can lead to the accurate recovery of the true construct centroids needed to be measured. Practically, researchers have found two-item scales to be useful in large-scale, complex questionnaires (Kathuria, Anandarajan, & Igbaria, 1999). We will discuss the limitation of this measure in our discussion section later.

3.3. Control Variables

We included *seven* control variables in our analysis to partition their potential variance in our predictive variables. These variables have been suggested in the literature to potentially affect the supply chain performance.

Plant size is associated with operational strategy and capability and it's controlled for all five performance variables. Larger organizations tend to be more complex than small firms, but they can also have more resources to support supply chain practices. Size can also be a proxy for similarity, which can affect the scope and complexity of collaboration. Plant size is measured by the number of employees (Paulraj et al., 2008) and log-transformed to normalize data distribution.

Plant investment can provide organizations with capital resources necessary to enhance supply chain performance (Power et al., 2015). As such, it is controlled for on-time delivery for customers, customer lead time, and supplier delivery delay. The measure for plant investment consists of five items for investment made to improve manufacturing lead time, scheduling product processes, process technologies, process integration, and information automation. These five items were measured on a seven-point Likert-type scale.

International sales and international purchasing: International customers and suppliers may increase the complexity of communication, delivery, and forecast performance (Schroeder, Anderson, & Cleveland, 1986). Therefore, we controlled the percentage of international sales for customer delivery and market forecast; and the percentage of international purchasing for supplier delivery delay.

STS theory emphasizes that firm performance is partially subject to their competitive environment. Environmental uncertainty heightens the need for firms to collaborate and improve performance. Firms build and maintain interorganizational networks as a coping mechanism to control uncertainty (Podolny, 1994). Specifically, *demand uncertainty* refers to the instability of market preferences and expectations. It requires firms to have good adaptation abilities and flexibility when working together. We controlled the effect of demand uncertainty for the firm's

ability to reduce forecast error in two-month and two-year in the future (Danese & Kalchschmidt, 2011). *Bargaining powers of customers and bargaining powers of suppliers* can influence the dynamics of interorganizational relationships and drive the firm's performance (Porter, 2008). We controlled their effects on the customer and supplier performance, respectively. Table 1 lists descriptive statistics and bivariate correlations for the variables in our model.

TABLE 1. DESCRIPTIVE STATISTICS AND CONSTRUCT CORRELATIONS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1																
2	.54**															
3	.13**	.14**														
4	-0.01	0.05	-0.01													
5	-.14**	-.10**	-.17**	0.04												
6	-.08*	0.01	-.13**	.08*	.65**											
7	.71**	.42**	.12**	-.08*	-.14**	-.09*										
8	.39**	.65**	.10**	0.06	-0.07	0.01	.58**									
9	-.09*	-0.00	-.38**	.09*	.17**	.12**	-0.05	0.00								
10	.48**	.29**	.10*	-.08*	-.12**	-.14**	.47**	.29**	-.08*							
11	0.03	.14**	0.04	.25**	0.03	0.04	-0.00	.10**	0.05	.08*						
12	-0.02	-0.03	-0.04	.08*	.11**	.13**	0.03	0.01	.08*	-0.01	-0.01					
13	0.05	.12**	0.03	0.05	0.03	0.03	0.04	.08*	0.05	-0.05	0.02	.27**				
14	0.05	0.06	-0.05	0.07	0.01	0.01	0.05	.10*	.13**	.11**	.09*	.24**	.28**			
15	0.01	.07*	-0.03	0.00	-0.01	0.03	0.02	.08*	.11**	.09*	.25**	-0.03	0.03	0.07		
16	.08*	.06	.22**	.16**	.01	-.01	.03	.12**	-.21**	.19**	.20**	-.13**	-.02	.08	.12**	
Mean	4.43	3.88	85.52	1.08	2.48	2.77	4.31	3.92	3.22	4.01	31.80	4.16	4.88	4.30	37.69	4.97
s.d	1.32	1.07	18.14	0.60	0.87	0.87	1.29	1.04	1.85	0.93	32.87	1.46	1.35	1.43	32.74	1.67

1-Customer Culture; 2-Customer Communication; 3-Delivery on time cubed (raw percentage values for mean and s.d); 4-Order lead time; 5-Forecast error in two months (log); 6-Forecast Error in two years (log); 7-Supplier culture; 8-Supplier communication; 9-Supplier delivery delay (square root); 10-Investment; 11-IntlMarket percentage; 12-Demand uncertainty; 13-Customer bargaining power; 14-Supplier bargaining power; 15-International purchasing; 16-Plant size (log)
**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level

3.4. Data Analysis

Structural Equation Modeling (SEM) was employed for data analysis using software SPSS and AMOS 24. The SEM approach allows simultaneous and holistic testing of the hypothesized relationships while accounting all other paths in the model. This approach also reduces the chances of type I error and exhibits greater statistical power than the Ordinary Least Square (OLS) approach.

Our SEM analysis followed the two-step approach recommended by Anderson and Gerbing (1988). First, a Confirmatory Factor Analysis (CFA) was conducted to validate a measurement model with five latent constructs that include the four main constructs hypothesized in the model and one control variable measuring plant investment. CFA analysis determined construct validity, including construct reliability, convergent validity, discriminant validity, and overall model fit (Shah & Goldstein, 2006).

Second, a full SEM model analysis was used for hypotheses testing. For mediation analysis, we employed the explicit procedures recommended in recent OM and SCM literature (Malhotra, Singhal, Shang, & Ployhart, 2014; Rungtusanatham, Miller, & Boyer, 2014). Bootstrapping was used to test the specific indirect effect, sign, and significance of multiple mediating paths hypothesized in our model (Preacher & Hayes, 2008).

3.4.1. Common Methods Variance (CMV)

Given that the survey was completed by single respondents representing each facility, and that five constructs in our model were measured with perceptual measures, our data was subject to the threat of CMV (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Three

procedures were used to reduce and test the impact of CMV. First, the predicting and criterion variables were embedded in two different modules across many pages in the GMRG survey. Respondents were assured full confidentiality and asked to complete the questionnaires only if they had sufficient knowledge about those areas. This procedure could reduce a respondent's propensity to maintain response consistency (Podsakoff et al., 2003). Second, Harman's single factor procedure indicated that no one single factor accounted for more than 32.51% of the total variance. Third, we used the Common Latent Factor (CLF) test that was more sensitive to CMV than Harman's one-factor test (Podsakoff et al., 2003; Kortmann, Gelhard, Zimmermann, & Piller, 2014). In this model, measurement items were allowed to load on their theoretical constructs as well as on the common factor. Model fit for the CLF model (CMIN/DF = 2.32, CFI = .985, SRMR = .0289, RMSEA = .044, PCLOSE = .85) did not significantly improve from the default model (CMIN/DF = 2.53, CFI = .98, SRMR = .0428, RMSEA = .047, PCLOSE = .70). In addition, the five performance measures in our model were objective data. Therefore, although the perceptual measures were subject to CMV, our tests suggested that the CMV was well below the levels that would bias the results of our study (Fuller, Simmering, Atinc, Atinc, & Babin, 2016).

3.4.2. Measurement model fit

The overall model fit for the five-factor model was assessed using parsimonious (normed Chi-square), comparative (CFI), and absolute (SRMR, RMSEA, and PCLOSE) measures because each provided a different perspective concerning the model fit (Fornell & Larcker, 1981). All the fit measures were greater than the recommended cut-off points, confirming that our model adequately captured the relationships among the variables: CMIN/DF = 2.53, CFI = .98, TLI = .97, GFI = .97, AAGFI = .94, SRMR = .0428, RMSEA = .047, PCLOSE = .70.

3.4.3. Construct validity and reliability

For convergent validity, each indicator's estimated coefficient loaded significantly on its underlying construct at $p < 0.001$ level with all factors loading between 0.61 and 0.96. Average Variance Extracted (AVE) values for the four main latent constructs were between .58 and .82, well above the suggested ideal cutoff score of .5 (O'Leary-Kelly & Vokurka, 1998). The AVE for investment construct was slightly lower at .45 but within the acceptable range (Hair, Black, Babin, Anderson, & Tatham, 2005). It is a reasonable tradeoff between the slightly reduced item internal consistency and the ability of the construct's multidimensionality to better capture their theoretical connection with the other factors in our model (Little et al., 1999).

CFA results also provided support for discriminant validity. The Maximum Shared Variance (MSV) values were less than the AVE values, and the AVE values were above the Average Shared Variances (ASV) values. Also, the square roots of AVEs were larger than the inter-construct correlations in all instances.

Construct reliability was assessed with composite reliability (C.R.) and maximum reliability (MaxR) scores. Composite reliability scores for the five latent factors ranged from .80 to .90, suggesting adequate internal consistency (Fornell & Larcker, 1981). Table 2 lists the survey measures and the CFA results.

TABLE 2 SURVEY INSTRUMENT AND CFA RESULTS

Main Constructs	**Factors Loadings**
Interfirm Communication with Customers (C.R. = .80, MaxR(H) = .83, AVE = .58, MSV = 38.)	
To what extent are the following inter-firm communication practices performed with your plant's main customers? (1= not at all, 4 = some extent, 7 = great extent)	
C-Comm1: The plant and main customers exchange proprietary information.	.65
C-Comm2: The plant and main customers inform each other about events affecting the other party.	.87
C-Comm3: The plant and main customers regularly exchange information of supply and demand forecast.	.75
Interfirm Communication with Suppliers (C.R. = .81, MaxR(H) = .85, AVE = .59, MSV = .38)	
To what extent are the following inter-firm communication practices performed with your plant's main suppliers? (1= not at all, 5 = some extent, 7 = great extent)	
S-Comm1: The plant and main suppliers exchange proprietary information.	.61
S-Comm2: The plant and main suppliers inform each other about events affecting the other party.	.88
S-Comm3: The plant and main suppliers regularly exchange information of supply and demand forecast.	.79
Culture Compatability with Customers (C.R. = .90, MaxR(H) = .84, AVE = .81, MSV = .45)	
To what extent do your plant's main customers share similar visions/philosophies for this business relationship? (1 = not at all, 4 = some extent, 7 = great extent)	
C-Culture1: Main ***customers*** have a similar organizational culture (e.g., values) to the plant.	.84
C-Culture2: Main ***customers*** share a common vision for the business relationship with the plant.	.96
Culture Compatability with Suppliers (C.R. = .90, MaxR(H) = .91, AVE = .82, MSV = .45)	
To what extent do your plant's main suppliers share similar visions/philosophies for this business relationship? (1 = not at all, 4 = some extent, 7 = great extent)	
S-Culture1: Main ***suppliers*** have a similar organizational culture (e.g., values) to the plant.	.88
S-Culture2: Main ***suppliers*** share a common vision for the business relationship with the plant.	.93
Customer Performance: Please provide approximate values for the following measures for the past financial year for you plant:	
Lead time: Average customer lead time (from order to delivery) _____ days	
Delivery on time: Percentage of the total number of customer orders delivered in full and on time _____% of customer orders	
Considering your most important product line, what average percentage would be the *forecast error for 2 months* in the future? _____% of error	
For the total sales for this plant, what average percentage would be the *forecast error for 24 months* in the future? % of error	
Supplier deliverydelay: What percentage of the plant's purchase orders do suppliers deliver late? _____% of purchase orders	
Control Variables	
Size: Approximately how many employees work at the plant in total?	
Plant Investment (C.R. = .80, MaxR(H) = .80, AVE = .45, MSV = .18)	
Please indicate the extent of investment (money, time and/or people) in the following areas in the last two years:	
IV1: Manufacturing lead time reduction programs	.64
IV2: Planning/scheduling processes and methods	.68
IV3: Processing technologies (e.g., FMS, automation)	.68
IV4: Integrating manufacturing and design processes	.65
IV5: Plant information flows automation	.68
Please indicate your level of agreement with these statements on competitive environment (1 = not at all; 7 = great extent):	
Demand uncertainty: Demand for your products is difficult to predict	
Customer bargaining power: Your customers have significant bargaining power	
Supplier barning power: Suppliers of critical inputs have significant bargaining power	
International sales: For your plant's most important product line, what percent of sales come from: Export market _____%	
International Purchasing: What percentage of plant ownership is international? _____% of plant ownership	

3.5. Hypotheses Test

The SEM model fit indices show adequate model fit with the data: CMIN/DF = 186.63/81 = 2.3, CFI = .98, TLI = .97, GFI = .96, AGFI = .95, SRMR = .0533, RESEA = .044, PCLOSE = .897. Table 3 lists the results of SEM analyses for the hypothesized relationships.

The results of standardized estimates show that the paths from interfirm cultural compatibility to communication for both the firm-customer (β = .47, p < .01) and firm-supplier (β = .49, p < .01) dyad are positively significant, supporting hypotheses 1a and 1b.

Regarding the effect of firm-customer communication on performance, interfirm communication is positively, significantly related to on-time delivery for customer order (β = .11, p < .05) and lead time (β = .13, p < .05), providing support for hypothesis 2a and 2b. Interfirm communication is negatively associated with 2-year forecast error (β = -.08, p < .10) but not with 2-month forecast error, providing support for hypothesis 2d but not 2c. On the supplier front, interfirm communication is not significantly related to supplier order delivery. As such, hypothesis 3 is not supported.

Among the control variables, investment is negatively related customer order lead time and supplier order delay. Firm size is positively related to customer on-time delivery and lead time, and negatively related to supplier order delay. Demand uncertainty increases both short term and long term forecast error, consistent with the suggestions in the literature.

Supplier bargaining power and international purchasing are both positively related to supplier deliver delay, indicating that as suppliers' bargaining power increases and as international purchasing increases, it is more likely that firms will experience delivery delay from their suppliers. In comparison, customer bargaining and international sales do not directly exert an effect on customer order performance.

3.6. Mediation Analysis

Following recommendations in recent SCM and OM literature (Malhotra et al., 2014; Rungtusanatham et al., 2014), we employed explicit statistical procedures to test our mediation hypotheses. Bootstrapping is used to test the specific mediating paths from interfirm culture compatibility to inter-firm communication to performance outcomes (Preacher & Hayes, 2008; Hayes, 2009). According to Zhao, Lynch, and Chen (2010, p. 204), "to establish mediation, all that matters is that the indirect effect is significant."

Scholars recommend a Bootstrapping procedure for mediation test due to its several advantages: 1) correct for the non-normality of the sampling distribution of a specific indirect effect; 2) accommodate models with multiple mediations processes in parallel series; 3) have the greatest statistical power to detect significant mediation processes while maintaining acceptable Type I error rates; 4) is more flexible than other methods in analyzing large samples (Rungtusanatham et al., 2014). Bootstrapping in this study implemented Shrout and Bolger (2002) bias-corrected methods. One thousand resamples with replacement were used to empirically represent the sampling distribution of the indirect effects. By this method, we determined the product of the constituent mediation pathways by estimating the indirect effect in the population sampled at a 95 percent confidence interval. The model parameters were estimated using the method of maximum likelihood.

The bias-corrected bootstrap confidence interval for the indirect effects of customer interfirm culture compatibility confirms its role as a mediator in firm-customer collaboration. Three out of the four mediating paths are significant. Furthermore, the explicit mediation analysis using Bootstrapping reveal different types of mediation between cultural compatibility and performance outcomes.

Applying Zhao et al. (2010) typology for mediations, interfirm communication exerts full mediation between cultural compatibility and on-time delivery to customers, and competitive mediation on lead time and two-year forest error. As shown in Table 3, competitive mediation occurs when the signs of the indirect effect and the direct effect point in opposite directions. Hence, we can infer that although interfirm communication is a mediator for the effect of cultural compatibility on lead time and two-year forest error, there is likely to be another mediator present in the theoretical framework (Zhao et al. 2010).

On the supplier side, except the direct effect of cultural compatibility on communication, no mediating or other direct effect was found on supplier order delay.

3.7. Robustness Check with Alternative Models

We tested two rival models to ascertain the underlining relationships hypothesized in our model. First, although research strongly suggests culture can drive social interactions, it does not rule out the possibility that information sharing facilitates the cultural values and mission to converge between partners. Therefore, we ran SEM for a reversed model that depicts interfirm communication as an antecedent to cultural compatibility. The fit indices of the reversed model (CMIN/DF = 2.43, CFI = .94, TLI = .93, GFI = .93, AGFI = .91, SRMR = .0554, RESEA = .0906, PCLOSE = .939) are worse than those of the proposed model (CMIN/DF = 1.99, CFI = .96, TLI = .95, GFI = .95, AGFI = .93, SRMR = .0554, RESEA = .038, PCLOSE = 1.0). The proposed model is also more parsimonious (AIC = 646.80, CAIC = 1050.66) than the reversed model AIC = 759.59, CAIC = 1152.39). Therefore, the empirical evidence confirms that the proposed model fits the data much better than the reversed model.

Second, communication is fundamentally a behavior construct as people communicate, not organizations (Paulraj et al., 2008). Extant literature in organizational culture suggests that cultural norms and values can moderate the strength between management practices and outcomes. Cultural values prompt behavioral patterns of organizational members, which can alter the strength of the relationship between interfirm communication practices and performance. Therefore, we tested an interactional model in which firm-customer cultural compatibility was posited to moderate the relationships between interfirm communication and the four customer performance variables, and firm-supplier cultural compatibility was posited to moderate the relationships between interfirm communication and supply delivery performance. The results showed that all four moderating variables were not significant. Hence, the moderation model received no empirical support. The robustness check provided further support for our hypothesized model.

TABLE 3: SEM RESULTS

Structural Path		Effect	SE	*t*-value	*p*-value	UCL[a]	LCL	Supported?
Firm to Customer								
CCul→CCom	H1a	.47	.042	11.46	.006			Yes
CCom→Delivery	H2a	.11	.046	2.40	.017			Yes
CCom→Lead Time	H2b	.13	.054	2.75	.023			Yes
CCom→2M Forecast	H2c	-.04	.057	-.79	.442			No
CCom→2Y Forecast	H2d	.08	.052	1.77	.09			Yes
CCul→CCom→Delivery	H4a	.05	.022	-	.018	.098	.009	Indirect-only mediation
CCul→CCom→Lead Time	H4b	.06	.026	-	.021	.115	.009	Competitive mediation
CCul→CCom→2M Forecast	H4c	-.02	.027	-	.449	.033	-.71	No mediation
CCul→CCom→2Y Forecast	H4d	.04	.025	-	.086	.089	-.007	Competitive mediation
CCul→Delivery		.06	.049	1.32	.164			Not significant
CCul→Lead Time		-.13	.044	-2.93	.004			Significant
CCul→2M Forecast		-.14	.056	-2.95	.019			Significant
CCul→2Y Forecast		-.13	.049	-2.71	.017			Significant
SCul→S-Delivery		-.06	.053	-1.39	.33			Not significant
Firm to Supplier								
SCul→SCom	H1b	.49	.038	12.30	.008			Yes
SCom→SDelivery	H3	.05	.049	1.03	.344			No
SCul→SCom→SDel	H5	.02	.024	-	.334	.072	-.023	No mediation
Control Variables			Estimates (β)					
Investment→delivery			.062					
Investment→lead time			-.10**					
Investment→suppliers delivery			-.12**					
Size→deliver on time			.19***					
Size→lead time			.16***					
Size→suppliers delivery			-.21***					
Intl sales→ delivery			.03					
Intl sales→lead time			.24**					
Customer power→delivery on time			.03					
Customer bargaining power→lead time			.04					
Demand Uncertainty →2M Forecast			.10**					
Demand Uncertainty →2Y Forecast			.13**					
Supplier power →supplier delivery			.11**					
Int'l Purchasing→ suppliers delivery delay			.10**					

n = 687

[a]Bootstrap upper and lower confidence intervals for the direct and indirect effects.

***p < .001, **p < .01, +p < .10

Model fit without control variables: CMIN/DF = 165.88/76 = 2.18, CFI = .98, TLI = .97, GFI = .97, AGFI = .95, SRMR = .0426, RMSEA = .042, PCLOSE = .947

Model fit with control variables: CMIN/DF = 488.29/247 = 1.98, CFI = .96, TLI = .95, GFI = .95, AGFI = .93, SRMR = .0519, RMSEA = .038, PCLOSE = 1.0

Zhao et al. (2010, p. 200) typology:

1. Complementary mediation: Mediated effect (*a x b:* mediator) and direct effect (*c:* independent variable to dependent variable) both exist and point at the same direction.
2. Competitive mediation: Mediated effect and direct effect both exist and point in opposite directions, overlaps with Baron and Kenny's (1986) partial mediation.
3. Indirect-only mediation: Mediated effect exists, but no direct effect, overlaps with Baron and Kenny's (1986) full mediation.
4. Direct-only nonmediation: Direct effect exists, but no indirect effect.

IV. DISCUSSION AND CONCLUSION

There is a considerable body of scholarly work exploring the various antecedents, including value congruence, of supply chain communication. There is an equally considerable body of research examining the impact of supply chain communication on firm performance. However, there is far less work linking the antecedents to performance via mediators (Paulraj et al., 2008). This paper proposes a mediating path from interfirm cultural compatibility to interfirm communication to supply chain performance outcomes based on STS theory. Our findings based on SEM analysis for the data collected from 687 manufacturing facilities provide considerable support for our conceptual model. Therefore, this study contributes to supply chain literature in several regards.

First, literature has documented the strategic significance of interfirm communication on supply chain effectiveness. We extend this line of research by identifying interfirm cultural compatibility as a key antecedent for interfirm communication effectiveness. Second, supply chain efficiency is a result of coordinated activities between the manufacturing firm and its supply chain partners. Our study takes an interorganizational level perspective in understanding the effectiveness of interfirm communication and its subsequent effect on customer and supplier performance. Third, we contribute to the rising behavioral supply chain research (Siemsen, 2011) by illustrating that shared cultural norms enable supply chain partners to communicate meaningfully and effectively in ways that add economic value. Scholars contend that IT effectiveness exists not in the technical infrastructure and information storage but in the knowledge that is possessed by individuals who process such information, as well as in a firm's ability to apply and transform the knowledge in various areas of operations management (Zhou & Benton Jr, 2007). Our study demonstrates the important role of the sociocultural elements of communication and cultural compatibility in firm performance.

The integration and coordination between manufacturing, relational, and social systems are essential for supply chain success. Prolific research has shown that organizational culture is intertwined with a wide range of features of organizational life. Nevertheless, research on the role of culture in supply chain practice is relatively lacking. Our study empirically links cultural compatibility to interfirm communication and then to supply chain performance. Therefore, when managing supply chain relationships, managers need to be tactical not only in deploying information sharing resources but also in encouraging and rewarding the social norms and interactions that can enhance the effectiveness of the adoption of technical systems. The emphasis is that cultural environment can systematically influence actions and performance in a supply chain context beyond an individual firm's policies and practices. The alignment between the two sets of values and goals can create value for partner firms in a way that is difficult for competitors to imitate and integrate into their manufacturing systems.

From a practical perspective, managers could benefit from knowing why they and their supply chain partners implement interfirm communication practices and how they can succeed in transforming interfirm communication into performance. Effective communication practices rely on the congruence of cultural values between partner firms. While firms can initiate technical systems for interfirm communication, its effectiveness will evolve in accordance with the aligned and shared

interorganizational cultural values. And reciprocally, communication practices can further enhance the cultural congruence by reinforcing shared values.

There are several limitations to this study which also suggest related opportunities for future research. First, our use of survey data does not allow us to draw causal conclusions regarding the pathway from culture to communication. Also, while the SEM analysis supported our proposed mediation model, it only suggests mediation but does not infer it. Future research using multi-method multi-trait study design and analyses would be able to yield more rigorous findings concerning the relationships studied here.

Second, cultural compatibility is a key construct in our model. The GMRG survey used a two-item holistic measure of this construct due to the restraint of the survey size. Organizational culture is a multidimensional construct (Schein, 2004). As such, the study of cultural compatibility that captures the multidimensional quality of the construct can yield a more fine-grained and unique understanding of this construct. Future studies that examine the compatibility of the multiple dimensions of organizational cultures between collaborative partners can yield more in-depth and fine-grained knowledge on the dynamics between these dimensions and the unique contribution of these cultural dimensions between firms in predicting partners' performance.

Third, while we are fortunate to have access to data from a wide range of manufacturers, we are limited to one measure for supplier performance, comparing to having four measures for customer performance. Nevertheless, by including both supplier and customer performance in this study, we made an attempt to study both upstream and downstream supply chain dyads simultaneously. While we do not have enough information to identify possible reasons for the lack of relationship between firm-supplier communication and supplier order delivery delay, we demonstrate that the association between culture and communication is symmetrically strong for both the upstream and downstream supply chain relations.

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