Vlerick Leuven Gent Working Paper Series 2009/03

SUPPLY CHAIN INFORMATION FLOW STRATEGIES:

AN EMPIRICAL TAXONOMY

EVELYNE VANPOUCKE

Evelyne.Vanpoucke@vlerick.be

KEN BOYER

ANN VEREECKE

Ann.Vereecke@vlerick.be

D/2009/6482/04

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EVELYNE VANPOUCKE
Vlerick Leuven Gent Management School
KEN BOYER
Ohio State University
ANN VEREECKE
Vlerick Leuven Gent Management School

Contact:
Evelyne Vanpoucke
Vlerick Leuven Gent Management School
Tel: +32 09 210 98 12
Fax: +32 09 210 97 00
Email: Evelyne.Vanpoucke@vlerick.be

ABSTRACT

Purpose - The paper identifies different information flow strategies to enhance integration in strategic alliances and studies these strategies with respect to contextual factors and the impact on performance.

Design/methodology/approach – The paper examines empirical data gathered from 56 manufacturing companies, describing 112 supply chain relationships. An empirical taxonomy is created based on cluster analysis.

Findings - Based on a parsimonious description of inter-firm information flows in the literature and our empirical findings, we identify 3 types of alliances: Silent, Communicative and IT intensive alliances. While Silent alliances have the poorest overall performance, substantial similarities are found between Communicative and IT intensive alliances. In particular, the analysis suggests that IT intensive alliances, albeit performing better on operational capabilities, are not performing better on relationship satisfaction compared to Communicative alliances. Additional analyses indicate that partners of an IT intensive alliance are substantially more interdependent and larger in size.

Research limitations/implications – This research presents a taxonomy of information flow strategies in a supply chain context. This research is not describing causality, since our data is not longitudinal in nature.

Practical implications – Managers need to selectively invest in IT according to an overall supply chain integration strategy, which also takes softer, less technological forms of integration into consideration.

Originality/value – This research provides insight into inter-firm information flows from a contingency perspective, recognizing heterogeneity of firms and supply chain practices.

Keywords - Integration, Information flow, IT supply chain applications, Strategic alliances

Paper type – Research paper

1. INTRODUCTION

Information sharing and collaboration with trading partners is seen as a company's top logistic challenge according to a poll of Supply & Demand Chain Executive's readers (Supply & Demand Chain Executive, 2005). This is confirmed by academic researchers who identify inter-firm information flows as an important factor of supply chain management (Chen and Paulraj, 2005; Carr and Kaynak, 2007). An important reason for this growing attention towards inter-firm information flows is the increasing amount of externalized activities (Cagliano, Caniato and Spina, 2005).

While the literature describes different mechanisms for integrating supply chains, such as information sharing (Lee, Padmanabhan and Whang, 1997; Vereecke and Muylle, 2006) and structural coordination (Vereecke et al, 2006), the focus of this paper is on the information flow, which forms the foundation for some advanced mechanisms of integration (Zhou and Benton, 2007). There has been an extensive literature stream on the value of information sharing in general. Recently, this topic has received increased attention in the specific context of inter-firm relationships. For example, Lee and Whang (2000) provide some real life illustrations of information sharing in a supply chain. There is also an extensive amount of literature on theoretical models quantifying and analyzing the effect of information sharing between partners in the supply chain (Chen, 1998; Gavirneni, Kapuscinski and Tayur, 1999; Chen, Drezner, Ryan and Simchi-Levi, 2000). All of these papers report some benefits to sharing information, although these benefits vary substantially across specific numerical examples. While valuable, much of the cited work is stylistic in the sense that it is modeling theoretical supply chains. Therefore, our aim is to assess actual supply chain practices.

Existing theory on information sharing in purchasing relationships has emerged from survey data explaining how frequently buyers and suppliers exchange information and what media are used to exchange this information (Carr et al, 2007). However, these studies do not distinguish between different contexts in which these relationships are formed. While there is general support for the relationship between information sharing, supply chain integration and performance improvement, there is quite a bit of uncertainty regarding the contingent nature of such relationships.

The work of Ketzenberg, Rosenzweig, Maruccheck and Metters (2007) demonstrated that although technology has made the sharing of information easier, managers should not assume that more information automatically implies better performance.

Therefore, they argue that future research should focus on the environment, coupled with the specific use of information, to determine the value of information sharing. In summary, the focus of the current work is to better understand the supply chain environment and the effects of contingencies on the choice of an information flow strategy.

Insert Figure 1 About Here

Figure 1 provides a model of the relationships tested in this paper. We start our analysis by looking at the foundations of supply chain integration, which we define as the information flow between partners. This is discussed in the next paragraph. Based on this classification, we empirically develop a taxonomy of supply chain information flow strategies. Next, we examine the choice of the information flow strategy. Finally, we examine performance factors which are believed to be improved by higher levels of information flows and thus influenced by the choice of the information flow strategy. These analyses will help us to better understand the impact of contingency factors on the link between supply chain integration and performance improvement.

2. INFORMATION FLOW STRATEGIES

Supply chain management takes a systems view regarding all processes needed to bring a product to the final customer. This view recognizes that the value creation process extends beyond the boundaries of the firm, and involves integrated business processes among the entities of the chain, such as suppliers, manufacturers, and customers (Porter, 1985). This requires the supply chain to be ultimately managed as one complete system (e.g. Currie, 2000) and asks for integration practices that strengthen linkages across individual firm functions as well as throughout the supply chain (Vickery, Jayaram, Dröge and Calantone, 2003).

Although, the literature posits that integration throughout the supply chain is highly beneficial, there is insufficient empirical evidence to support this 'one-size-fits all' assertion. Moreover, Harland, Caldwell, Powell and Zheng (2007) found that firms are not concerned with the integration of information in their supply chains. This strengthens the belief that integration might only be appropriate in certain types of supply chains or within certain parts of supply chains. We thus suggest a more complex, contingent approach to information integration in supply chains.

The domain of inter-organisational linkages in a supply chain spans both contractual and equity arrangements. Since we believe that the way in which partners are brought together (i.e. contractually or equity arrangements) may influence information flows, this study focuses only on strategic alliances based on nontraditional contractual arrangements. Based on the definition of Yoshino and Rangan (1995), strategic alliances, which are different from simple buy-sell contractual arrangement, require the following necessary and sufficient conditions: (1) independence of the parties, (2) shared benefits among the parties and, (3) ongoing participation in one or more key strategic areas, such as technology, products, markets, etc. In addition, we limit our definition of strategic alliances towards strategic alliances focusing on coordination of logistics, purchasing and/or operations activities. Consequently, we describe strategic alliances as "long-term cooperative relationships designed to increase the strategic operating capability of two individual firms, with the aim of achieving significant benefits to both parties. These alliances will last provided that they continue to offer significant value to each of the parties. Some of the main benefits of this type of relationships are the increase in the synchronization of the Supply Chain, the reduction of the total costs, improvement of quality and cycles, as well as a strong competitive position which exceeds any possible contribution from traditional relationships."

Similar to Zhou and Benton (2007), we describe the information flow as the foundation for integration in the strategic alliance. Based on on their definition, we describe this information flow by three characteristics: *level of Information sharing, Information quality* and *IT supply chain applications*. These characteristics provide a parsimonious description of three logical dimensions of the information flow, i.e. the volume, the content and the medium of the shared information.

In the following sections, we describe these information flows characteristics as defined by Zhou et al (2007). Next, we provide insights into a testable proposition regarding the use of information flows in a supply chain context.

2.1 Information sharing

Information sharing in the supply chain is the sharing of knowledge among partners to serve downstream customers effectively and efficiently. This knowledge includes information on the production status and the planning process, but also on changes in the business environment and the goals of the companies. More specifically, information needs to be shared at different levels. While operational integration is geared towards transaction efficiency improvements, integration at the strategic level requires shared or matching objectives (Lamming, Caldwell and Harrison, 2004). Information sharing is an important issue in supply chain management, particularly as a component of supply chain practices that have recently become popular, such as Vendor Managed Inventories (VMI) and Collaborative Planning, Forecasting and Replenishment (CPFR). To guarantee the success of these supply chain management practices, it is essential that the better-informed downstream member of the alliance shares its demand information with the less-informed upstream member (Lee et al, 1997). Also upstream partners may share information with their downstream partners about for instance production plans and future deliveries. These information flows between alliance partners may lead to a better coordination of the stock levels and to logistic superiority in the strategic alliance (Freedman, 1994).

2.2 Information quality

Daft and Lengel (1986) found that the major problem in information processing in organizations is not the lack of data, but clarity of the data. Furthermore, Petersen (1999) concludes that while much has been written about supply chain integration, little empirical research has been conducted to determine whether information quality helps to create better performing supply chains. The literature describes Information quality as an important indicator of the clarity and usefulness of the information (Sum, Yang and Quek, 1995; McGowan, 1998).

It is measured by the degree to which the information shared between supply chain partners meets the needs of the different partners (Petersen, 1999). Researchers have identified important dimensions of Information quality. Neumann and Segev (1979), for instance, described high quality information as being accurate, frequently exchanged, recent and containing the appropriate content. Bailey and Pearson (1983) also described several dimensions of information quality as accurate, timely, precise, reliable, current and complete.

2.3 IT supply chain applications

Information technology (IT) plays a critical role in supply chain management activities (Kearns and Lederer, 2003), as it permits the sharing of large amounts of information between firms. More specifically, a high degree of system integration between two firms allows two proprietary systems to reduce technical barriers and incompatibility so as to communicate more effectively (Bowersox, Closs, Stank and Keller, 2000). The use of IT systems in inter-firm integration is supported by transaction costs economics, which generally posits that IT reduces transaction costs. (Coase, 1937; Williamson, 1996). However, in practice, new IT may result in higher transaction costs, caused by the higher cost of processing the information costs. If these coordination costs exceed the benefits of IT, the implementation of IT becomes expensive (Cordella, 2006).

Past empirical studies have evaluated the link between IT supply chain applications and integration. Earlier studies focused on the benefits of EDI and showed that it provides benefits to companies by providing speed of information flow and fostering value-added partnerships between supply chain organizations (Holland, Lockett and Blackman, 1992; Ragatz, Handfield and Scannell, 1997). A study by Stoeken (2000) showed that IT has a direct impact on coordination and leads to supply chain innovation. Furthermore, Shaw (2000) shows that emerging manufacturing technologies have an influence on supply chain activities and supply chain structures and that emerging web-based manufacturing technologies make information transmission among the supply chain partners easier. Jagdev and Thoben (2001) also indicate that standardized systems embedded in the processes result in buyer-supplier dyads going beyond passive information exchange by engaging in proactive collaboration. Vickery et al (2003) further showed a direct link between integrative information technologies and supply chain coordination for supplier firms in the car

industry. Finally, a recent study of Johnson, Klassen, Leenders and Awaysheh (2007) confirmed the relationship between IT supply chain applications and decreasing transaction costs. In summary, all these studies point to a positive link between the IT supply chain applications and performance.

Sanders (2007) points out that inter-firm integration requires shared planning, coordination and sharing of integrated databases between firms. She categorized information sharing support systems as supply chain planning systems, information exchange systems and database collaboration systems. These technologies are supply chain 'enablers', in that they can substantially reduce paperwork, improve communication and reduce supply chain cycle times if properly implemented. A primary requirement for efficient information flow integration is that the relationship is characterized by a willingness to share and receive information and work in a collaborative manner (Handfield and Bechtel, 2002).

2.4 Information flow strategies

As described above, a relevant classification dimension is based on the information flow characteristics: information sharing, information quality and IT supply chain applications. These characteristics provide a parsimonious description of the information flow. Drawing on the discussion offered in sections 2.1 – 2.3, we develop the following hypotheses:

Proposition 1: *Information is shared by manufacturing firms to integrate different processes along the supply chain; different information flow strategies can be identified according to the level of Information sharing, the Information quality and the IT supply chain applications used.*

Proposition 1 is evaluated by using cluster analysis to form an empirical classification of relationships based on the information flow strategy. This classification is then used to test several hypotheses related to context and performance. The hypotheses that will be tested are presented in the following paragraph.

3. CONTEXTUAL AND PERFORMANCE FACTORS OF SUPPLY CHAIN INFORMATION FLOW STRATEGIES

The process of validating our clustering requires that we assess it in the context of its nomological network, i.e. other related constructs (Shwab, 1980). More specifically, we will look at the contextual factors and the performance of our three clusters. Business and relational characteristics are identified as environmental factors impacting the effectiveness and performance of the strategic alliances.

3.1 Contextual factors affecting the information flow strategy

In this paragraph, we describe the contextual factors that are posited to affect the information flow characteristics. Two contextual factors are presented to describe the context of the relationship: business and relationship characteristics. Business characteristics describe the size of the responding company and the business context of the alliance. The relationship specific characteristics are measured by the degree of trust and interdependence in the strategic alliance. We describe these contingencies more in depth in the following paragraphs.

3.1.1 Business characteristics

The size of the firms in the strategic alliance has been highlighted as a driver of differences in information sharing characteristics (Harland et al, 2007). It is often argued that larger firms have more resources to invest in information sharing, and therefore it is easier for larger firms to invest in technologies for information sharing than for relatively small firms. Furthermore, larger companies can exert more power in strategic alliances, which may lead to higher levels of performance improvement of inter-company integration (Benton and Maloni, 2005; Subramani and Venkatraman, 2003; Lee, 2004). Mehrthens, Gragg and Mills (2001) suggest three main factors that influence a companies' decisions about IT supply chain applications investments: the perceived benefits, the organizational readiness and the external pressures. Small companies score generally lower on all three characteristics, indicating that they invest less in IT supply chain applications. Salmeron and Bueno (2006) and Harland et al (2007) highlighted that smaller firms are often less aware of the full potential benefits of IT supply chain applications.

Beyond the lack of awareness, small fims have been shown to exhibit a greater uncertainty of the benefits of IT adoption than larger firms (Salmeron et al, 2006), thus impacting their motivation to invest in IT supply chain applications. Based on these studies, we could state that small companies invest less in IT supply chain applications compared to large companies. Consequently, smaller firms use relatively less advanced information flow strategies compared to larger firms.

A second business characteristic is the business context of the alliance. Information processing theory supports the influence of supply chain dynamism on the information flow (Galbraith, 1974; Zhou et al, 2007). As supply chain dynamism increases, information processing capacity needs to be increased in order to achieve superior firm performance. Fisher (1997) for instance suggests that supply chains facing a different supply chain dynamism should use different supply chain practices. Based on these theories, we can state that product (e.g. volatile versus stable demand) and market (e.g. level of competitiveness, foreign competition) characteristics, influence the information flows between partners in the supply chain. Ketzenberg et al (2007) also state that information sharing is more valuable in supply chains with high uncertainty. In summary, we state that more supply chain dynamism leads to higher levels of information flows.

3.1.2 Relational characteristics

Two relation-specific characteristics receive a great deal of attention in the literature on strategic alliances. The first relational characteristic, interdependence, exists when one actor does not entirely control all the conditions necessary for achievement of an action or a desired outcome (Pfeffer, 1988). Resource dependency theory provides the major organizational view regarding power and management in strategic alliances. According to this view, firms are seen as interdependent entities seeking to manage uncertainty affecting them (Pfeffer, 1988). These interdependencies create patterns of dependencies among the firms, a situation in which firms that own or control valuable, scarce resources hold power over firms seeking those resources to the extent that the dependency is not mutual. Firms lacking control of scarce resources can manage the resulting uncertainty through strategic alliances (Pfeffer and Salancik, 1978). Previous empirical studies investigated the relationship between dependence, control and performance of inter-company relationships and found that a firm is less opportunistic when it depends on its partner

(Provan and Skinner, 1989) and that it can also influence other outcomes such as delivery performance (Handfield, 1993).

The second relational characteristic is trust. A large variety of dimensions of trust exist in the literature. Drawing on the literature in social psychology and marketing, trust can be defined as the perceived credibility and benevolence of the partner in the relationship (Geyskens, Steenkamp, Kumar, 1998). Based on this definition, trust can be described by two dimensions. The first dimension focuses on the objective credibility of the partner in the buyer-supplier relationship and the expectancy that the partner's word or written statement can be relied on. The second dimension, benevolence or goodwill, is the extent to which one partner is genuinely interested in the other partner's welfare and is motivated to seek joint gains (Johnston et al, 2008). As mentioned by Sako (1992) this second dimension, which is also called goodwill trust (Sako, 1992), is particularly interesting in long-term buyer-supplier relationships and is responsible for creating a relational culture (Ireland and Webb, 2007). Since our study focuses on strategic alliances, which are long-term in nature, we focus on the second dimension of trust: benevolence or goodwill trust. The important point here is that trust creates the feeling that the inter-firm relationship is beneficial for both parties. In addition, trust is considered to create a form of business harmony between two parties due to interaction frequency. The main purpose of increasing trust is that it is found to enhance integration while lowering administrative costs. Some researchers suggest that greater levels of asset specificity, which create interdependence among the partners, increase trust in the alliance (Handfield et al, 2002).

Proposition 2: *The information flow strategy selected by the strategic alliance is influenced by contextual factors such as business characteristics and relational characteristics.*

3.2 Performance of the alliance

The potential benefits of inter-firm information flows include improved supply chain integration and decreased supply chain costs by reducing uncertainties caused by both the bullwhip effect (Anand and Mendelson, 1997; Lee et al, 1997) and by differences in the timing of demand and arrival of supply (Kouvelis and Li, 2008). We use two indicators of successful integration: the use of advanced integrative forms and performance benefits.

3.2.1 Advanced forms of supply chain integration

Ketzenberg et al (2007) describe that the responsiveness and the use of the information flow moderates the value of the information flows. Increased responsiveness and use of this information can be obtained by more advanced forms of supply chain integration. Examples of these advanced forms of integration are Information participation, Coordination and Conflict resolution (Monczka, Petersen, Handfield and Ragatz, 1998). Information participation refers to the extent to which partners engage jointly in planning and goal setting (Mohr and Spekman, 1994). Supply chain partners must first commit to providing better and more accurate information and forecasts in order to allow them to plan their available capacity more effectively. Coordination, another advanced form of integration, reflects the set of tasks each party expects the other to perform (Monczka et al, 1998). Coordination reduces the transaction costs since it makes clear which tasks need to be done in the relationship and who will perform the specific tasks. Both Information participation and Coordination describe integration under typical circumstances. However, conflicts often arise with partners and require techniques to resolve problems. The way companies handle these conflicts has a substantial impact on the success of the integration. Research has shown that the use of constructive conflict resolution techniques, where both companies jointly eliminate the conflict has a positive impact on the strategic alliance (Deutsch, 1986). The way in which these conflicts are resolved among the alliance partners has direct implications for the success and continuity of the relationship. Since information flows form the foundation for more advanced forms of supply chain integration, we could state that more advanced information flow strategies will be associated with more advanced forms of supply chain integration.

3.2.2 Performance benefits

While past studies primarily focus on financial performance measures, our study measures a more comprehensive set of benefits for the company, called first-order or operational capabilities. First-order benefits are posited to generate second-order benefits for the firm, which occur over the long run, and include measures such as improved financial performance and market share (Mukhopadyay and Kerke, 2002; Subramani, 2004). Since this study looks at a broad set of first-order benefits and Relationship satisfaction, it provides a more comprehensive evaluation of performance.

We measure the first-order benefits by the four operational capabilities: quality, cost, flexibility and delivery. Hayes and Wheelwright (1984) originally presented these capabilities as the dimensions on which a company chooses to compete within a market. There is general agreement in the operations strategy literature that these four capabilities are indeed the core areas from which a company chooses to compete (Roth and Miller, 1992; White, 1996). In addition, innovation has recently been recognized as another dimension upon which companies can compete (Ward et al, 1998). These capabilities have been used in the literature to measure both process abilities and operational performance. We measure here the operational performance and expect that higher levels of information flows will lead to better performance.

Relationship satisfaction is based on the notion that success is determined by how well the relationship achieves the performance expectations set by the alliance partners (Anderson and Narus, 1990; Mohr and Spekman, 1994).

Proposition 3: The information flow strategy selected by the strategic alliance influences the performance of the alliance in terms of the use of advanced integration practices, the operational performance and relationship satisfaction.

4. METHODS

4.1 Data collection

The sample consists of manufacturing companies in Belgium. Data were collected during the second half of 2006 and beginning of 2007. The unit of analysis is a strategic alliance of a principal company with a supplier or customer. We asked the respondents to describe a most successful and a least successful strategic alliance. This is different from most other research focusing only on successful alliances (e.g. Johnston and Kristal, 2008).

Where possible, the scales are based upon existing scales in the literature. Pre-testing of the questionnaire was conducted using a sample of 10 experts (academics and people in the field). The pre-testing provided support for the face validity of the constructs and resulted in a few minor changes in wording and presentation of items. The questionnaire was administered in English to prevent possible interpretation errors.

The targeted informants for the study were supply chain managers, logistics managers and purchasing managers from companies with more than fifty employees. This choice was made to focus on managers with appropriate supply chain knowledge and companies of sufficient size to be likely to employ supply chain information flow strategies. An initial contact list of 300 manufacturing companies was randomly developed from the Customer Relationship Management database of the sponsoring university. This database consists of an extensive list of supply chain managers who participated in executive education programs. We were thus able to select participants based on their function and company. An initial effort was made to contact participants to request their participation in the study, with the result that 200 managers agreed. The extra effort devoted to making such an initial contact has been shown in prior studies to be an effective method of improving both response rate and reliability of the data (Zhao, Flynn and Yeung, 2007). Furthermore, the initial contact helped us for instance to identify those companies, and their managers that worked closely together with suppliers and/or customers and as such were in our target group. The next step was to send the questionnaire to all participants via e-mail. Following Dillman's (1978) total design method for survey data collection, follow-up phone calls have been made in order to maximize the response rate. The final results included 56 responses

or 112 strategic alliances, for a response rate of 18.7% of the initial contact sample of 300 managers.

We allowed respondents to decide whether to focus on supplier or customer collaborations, since we believe that most managers have no in-depth experience with both supplier and customer relationships. We believe this leads our respondents to give more accurate responses than when asked to simultaneously fill out a survey for both an upstream supplier and a downstream supplier as in Frohlich and Westbrook (2001). Of the 112 strategic alliances, 34 alliances focused on customer-relationships (downstream) and 78 focused on supplier-relationships (upstream).

Table 1 provides a demographic overview of the sample, which consists of companies in the primary goods, chemical, pharmaceutical, consumer goods, media and informatics industries.

The largest groups in the sample are the chemical and consumer goods industries. This is representative of Belgian industry which possesses a large proportion of firms in these industries. The sample is biased towards larger companies, which is acceptable since the goal of the study is to focus on larger firms. In addition, the sample is biased toward supplier relationships with 68% of the respondents describing an upstream relationship. This may be a function of the job positions of the respondents, which are supply chain focused, and thus more likely to look upstream than downstream.

We checked our responses for missing data. Since less than 5% of the data were missing and since these were randomly missing, we used the most conservative approach of listwise deletion to handle missing data.

Insert Table 1 About Here

In order to assess the potential for non-response bias we tested for significant differences between early and late respondents as prescribed by Armstrong and Overton (1977). Employing a significance level of $p < 0.05$, no differences were found at a 95% level between the early and late respondents. These results indicate that there is no reason to believe non-response bias is present in the data (Vaidyanathan and Devaraj, 2008).

4.2 Scales

We performed exploratory factor analyses with principal components and varimax rotation on three sets of scales: Information flow characteristics, Integration characteristics and Performance. Table 2 shows the results of the factor analysis of the Information flow characteristics. The other factor analyses can be found in Appendix. The measures are described in the following paragraphs.

4.2.1 Information flow characteristics

Based on the literature review, in combination with a factor analysis, we employ three constructs to capture the information flow characteristics. Communication quality and Information sharing are scales adapted from previous research by Mohr et al (1994) and Monczka et al (1998), who measured the antecedents of strategic alliances. The respondents were asked to rate a set of statements on a 1-7 likert scale, ranging from completely disagree (1) to completely agree (7). The constructs have been shown to be reliable and valid. The third scale employed to assess the information flow characteristics are the IT supply chain applications. The items in this scale are selected based on a review of recent literature. We feel that developing our own construct is appropriate given the rapidly changing area of IT applications. The goal was to capture current technologies and achieve good construct validity. The use of IT supply chain applications was measured by asking respondents to rate the extent to which they used the following technologies in their alliance: Information exchange systems including EDI, POS on the web and internet (Cagliano et al, 2003); planning systems such as ERP/MRP/MRPII and DRP systems and collaboration databases such as CRM and SRM databases. A 1 to 7 scale was used, with (1) no use and (7) highly used. Descriptive data for Information Flow Characteristics is shown in Table 2. The data indicate that the firms in our study place the least emphasis on IT supply chain Information applications, as the mean for this scale is substantially lower (3.15) than for Communication quality (5.01) and Information sharing (4.94). Table 2 also shows that the Cronbach's alpha for all three constructs is above the cut-off level of 0.70, indicating acceptable reliability (Nunnally, 1978, Churchill, 1979).

4.2.2 Relational characteristics

As stated in the literature review, we measure relational characteristics using two constructs: trust and interdependence. These constructs are based on scales developed by Mohr et al (1994) and Monzcka et al (1998). Each construct consists of 4 items and can be found in Appendix 1. Cronbach's alpha is 0.93 and 0.80 for Trust and Interdependence respectively.

4.2.3 Performance of the alliance

Advanced forms of supply chain integration such as Coordination, Information participation and Constructive conflict resolution all require an extensive degree of quantitative information flow and facilitate the use of the information flows in the relationship. Coordination and Information participation both consists of 3 items. The Cronbach's alpha is 0.83 for Coordination and respectively 0.71 for Information participation. Constructive conflict resolution consists of two items and has a bivariate correlation of 0.52.

The items and the reliability for Relationship satisfaction and the Operational capabilities can be found in Appendix 2. Relationship satisfaction consists of 4 items and has a Cronbach's alpha of 0.94. The bi-variate correlations for the Operational capabilities are between 0.61 and 0.92.

Both Relationship satisfaction and the Operational capabilities are subjective measures rather than objective financial data. These types of measures are commonly used in operations and supply chain research, since managers are often reluctant to provide confidential information regarding performance. Previous researchers (Boyer et al, 1996; Randall et al, 2001) tested the correlation between the subjective and objective measures, and found evidence to support the reliability of subjective performance measures to predict more objective measures.

4.2.4 Validity and reliability of measurement scales

We assess scale validity and reliability of our survey instrument in three ways: content validity, construct validity and reliability. Content validity refers to the degree to which the scales properly reflect the different integration constructs and measure the performance improvements of a specific relationship. As stated earlier, the survey was developed based on a comprehensive literature review. In addition, our scales are based on earlier published work of Mohr et al (1994) and Monczka et al (1998).

Convergent and discriminant validity of our scales is assessed by exploratory factor analyses. Table 2 shows the results of the factor analysis of the Information flow characteristics. The three factors derived in the factor analysis showed eigenvalues higher than 1 and account for 71.39 % of the variance. As described in the literature review, we labeled the factors as Information sharing, Information quality and IT supply chain applications. The factor analyses for Integration characteristics and Performance can be found in Appendix 1 and 2. The Items omitted from the analysis are indicated by a star (*). We omitted these items since their factor loading proved to be too small (< 0.50) (Hair et al, 1998) or since they had high loadings on more than one factor. The final factor loadings of the constructs are provided in the Appendix. All factor loadings are between 0.55 and 0.87 and are significant. Also unidimensionality is supported since all factors have eigenvalues greater than 1. Appendix 1 shows that the 5 factors of integration accounted for 75.92% of the variance. As described in the literature review, we labeled the factors as Trust, Interdependence, Information participation, Coordination and Conflict resolution. Furthermore, the 6 factors presented in Appendix 2 measure performance, accounting for 87.37% of the variance. These factors are labeled as Relationship satisfaction and the 5 operational capabilities: Cost, Flexibility, Delivery, Quality and Innovation.

Insert Table 2 About Here

We computed the inter-factor correlations as shown in Table 3. No extreme correlations were found, indicating acceptable discriminant validity.

To guarantee reliability, several variables have been measured through multiple item measures. Scale reliability is the percent of variance in an observed variable that is accounted for by the true score of the latent factor or underlying construct (DeVellis, 1991). Cronbach's alpha is most commonly used to reject or confirm the assumption that some theoretical constructs underlie the items (Carmines and Zeller, 1979). As mentioned before, all Cronbach's alpha scores are between 0.71 and 0.94 (see appendix), exceeding the lower threshold of 0.70 for existing constructs (Nunally, 1969; Murphy and Davidshofer, 2001).

Insert Table 3 About Here

5. DATA ANALYSIS

Our analysis consists of three steps. First, we analyze the characteristics of the information flows of the strategic alliances, by using cluster analysis. This enables us to test proposition 1. The cluster analysis develops a taxonomy of strategies towards information flows in strategic alliances. In step two, we examine the relationship between the context and the information flow strategy to determine the extent to which they explain the differences in choosing different Information flow strategies. By doing so, we test proposition 2. In the final step, we analyze the performance of the different Information flow strategies. We examine how the information flow strategies relate to facilitating strategies for integration such as Coordination, Information participation and Constructive conflict resolution techniques. We also test the link between information flow strategies and both the Operational capabilities and the level of overall satisfaction with the relationship. These are stated in proposition 3.

5.1 Information flow strategies

To evaluate our first proposition, a cluster analysis is performed on the three information flow characteristics: Communication quality, Information sharing and IT supply chain applications. The goal is to classify the complete sample into several groups or subsets of strategic alliances having similar patterns of use of information flows. A two-stage procedure, as suggested by Ketchen and Shook (1996), has been followed to create our subsets of firms with similar information flows. This two-stage procedure first applies Ward's hierarchical clustering method, followed by a K-means clustering. The number of clusters as suggested by the hierarchical clustering is then used as a parameter in the nonhierarchical K-means clustering method with Euclidian distance measure. This K-means clustering is preferred over the hierarchical clustering because it is an iterative partitioning method and compensates for a poor initial partitioning of the hierarchical clustering. Research has shown that this procedure increases the validity of the solutions (Milligan, 1996).

To determine the number of clusters, we used multiple techniques (Ketchen and Shook, 1996): some rule of thumb, inspection of the dendogram and the agglomeration coefficient. The objective of cluster analysis is generally to make a balanced choice between parsimony and accuracy. First, Lehmann (1979) suggests that the number of clusters should be between n/30 and n/60, with n being the sample size. Since our sample size is 112, this rule suggests approximately 2 to 3 clusters. Based on the visual inspection of the dendogram and more specifically the 'rescaled distance cluster combine' measure, we chose three clusters to be an attractive choice. A final criterion for choosing the appropriate number of clusters involves the managerial interpretability of the solution. To assess the differences across the groups, a one-way ANOVA was performed to test for differences between individual pairs of groups. Table 5 provides the data for the cluster means, standard errors, the F test and significance level of the ANOVA, as well as the post-hoc Scheffe's pairwise comparisons. The results indicate that the groups represent three significantly different clusters at the $p < 0.01$ level. Each of these clusters represents an approach or strategy towards the information flow between two firms in the supply chain. We have labeled the three groups: Silent, Communicative and IT intensive alliances, each describing a distinct strategy towards the foundations of integration. The rational for the names is discussed in the section below.

A first analysis shows that successful alliances are proportionally more classified as IT intensive alliances, while least successful alliances are mainly categorized as Silent alliances.

Insert Table 4 About Here

5.1.1. Silent alliances

The 38 cases in this cluster have the lowest means on all three scales. The Scheffe tests in Table 5 indicate that these companies have the lowest means for both Communication quality and Information sharing, which are statistically different from the other two groups. With respect to IT supply chain applications, the mean for Silent alliances is significantly lower than the group labeled IT intensive alliances, but equivalent to the group labeled Communicative alliances. In essence, the Silent alliances are the least advanced group in terms of supply chain information flow. Interestingly, this is also the largest group, indicating that still a lot of strategic alliances do not make substantial efforts to share information across the supply chain. We consider these alliances to represent the 'base case' with respect to supply chain. Our expectation is that this group will exhibit worse performance than the other two groups.

5.1.2 Communicative alliances

The Scheffe pairwise comparison procedure indicates that this cluster has levels of Information sharing and Communication quality that are similar to the IT intensive alliances, but that these levels are significantly higher than those for the Silent alliances. What sets this group apart is that its level of technology usage is significantly lower than the IT intensive alliances. In essence, this group works hard to integrate with its alliance partner, with a minimal usage of technology. We have labeled this the Communicative alliances.

5.1.3 IT intensive alliances

IT intensive alliances have the highest scores on all information flow characteristics. As noted earlier, both Communication quality and Information sharing are statistically higher than for the Silent alliances, but equivalent to the Communicative alliances. The distinguishing feature of this group is that it has, by far, the highest usage of technology with a mean for IT supply chain applications of 4.72, which is significantly higher for the other two groups. Our priori expectation is that this group will have higher levels of performance than the Silent alliances, but we are less confident that they would show higher performance than the Communicative alliances.

5.2 Contextual factors

Having developed a taxonomy of strategies regarding information flows, we now turn to potential contextual and performance factors. We note that while the groups seem to make intuitive sense, a cluster analysis will always develop some groups with substantial differences. Thus, one of the methods for validating these groups is to examine other variables not included in the initial cluster analysis (Boyer et al, 1996).

5.2.1 Firm size

We measure firm size by the numbers of employees of the responding firm. Table 5 shows the results of a chi-square test with the number of employees as dependent variable and the three clusters as independent variable. The chi-square test for number of employees is significant at the $p < 0.10$ level. We consider this to be reasonable given our small sample size. This is an interesting finding since it suggests that there is a positive correlation between size and investment in information flows.

Insert Table 5 About Here

5.2.2 Business context

More competitive environments require a more responsive supply chain. Consequently, more competitive environments imply the use of more advanced forms of information flow integration. More specifically, these alliances are more likely to be clustered as IT intensive or Communicative alliances. The analysis in Table 6 suggests that alliances experiencing more competition on quality and on design and development, are more likely to be clustered as IT intensive alliances. Therefore, we can conclude that relationships in highly competitive environments with a high focus on quality and design and development are more likely to invest in IT supply chain applications for communication with partners.

Insert Table 6 About Here

5.2.3 Relationship characteristics

As explained in the literature, we examine the strategic alliances by their level of Trust and Interdependency. Table 7 shows an ANOVA for Interdependence and Trust. The data shows that the degree of Interdependence is much higher for IT intensive alliances than for the other two groups. Furthermore, both IT intensive and Communicative alliances show higher levels of Trust than Silent alliances.

Insert Table 7 About Here

5.3 Performance of the alliance

Table 8 shows clear differences among the information flow strategies in terms of use of advanced forms of supply chain integration, all at the $p < 0.01$ level. The Silent alliances have the lowest mean for all three scales: Coordination, Information participation and Constructive conflict resolution. Our analysis indicates that two strategies, i.e. IT intensive and Communicative alliances, use similar degrees of Coordination and Conflict resolution techniques. Therefore, it can be concluded that alliances can be integrated either with or without specific IT supply chain applications. On the other hand, the analysis shows that there is a significant difference between

these two groups in terms of Information participation, indicating that the level of Information participation depends upon the IT supply chain applications used in alliances. This provides support for our taxonomy of Information flow strategies as being real foundations for supply chain integration.

Insert Table 8 About Here

Table 9 provides the means for each of the performance benefits, separated by the information flow strategy groups. Overall, the IT intensive alliances have the best performance benefits, with significantly higher performance on Cost, Flexibility, Delivery, Quality and Innovation. In turn, the Communicative alliances have significantly higher scores for Cost, Flexibility and Quality than the Silent alliances. However, our analysis shows no differences in Relationship satisfaction between the IT intensive and Communicative alliances, albeit significantly higher values than the Silent alliances.

Insert Table 9 About here

In summary, we could state that our analyses identify three strategies for integrating information flows in a strategic alliance. We labeled these strategies as Silent, Communicative and IT intensive alliance strategies. Silent alliances, on the one hand, are characterized by low levels of information flows. Communicative and IT intensive alliances, on the other hand, share high levels and high quality of information in the supply chain, although the IT intensive alliances use significantly higher levels of IT to share this data. The results suggest that the choice of the information flow strategy depends on the business and relational environment of the strategic alliance and may affect the performance of the alliance. Table 6 shows that IT intensive alliances are more prominent in innovative alliances. Furthermore, our analyses suggest that the use of IT in the alliance depends on the interdependence between the partners, while the level of trust determines the level of information sharing and the quality of the shared information.

Our results confirm that Communicative and IT intensive alliances perform better than Silent alliances. While Communicative and IT intensive alliances report similar levels of Relationship satisfaction, they do differ in Performance benefits. Investing in IT applications in an alliance is shown to improve costs, deliveries, quality and innovation, but not flexibility. Furthermore, not all advanced forms of integration are positively affected by investments in IT supply chain applications. We did not find an effect of IT supply chain applications on the coordination and the use of constructive conflict resolution techniques in the supply chain.

7. DISCUSSION AND FUTURE RESEARCH

The study presented in this paper highlights the existence of different information flow strategies for integrating strategic alliances. A few studies have already proposed some contingencies of information flows, but they are generally based on conceptual thinking or case studies of best practices. The present work, instead, is based on survey data, enabling us to test some of the propositions. These strategies have been explored in terms of contextual factors and in their relationship with broader aspects of performance.

The value of the study is twofold. It contributes to the current research on inter-firm information sharing and supply chain practices and it provides insightful information for managers.

Our study shows different information flow strategies for integrating strategic alliances. The results show that inter-organizational information integration is not well advanced despite the development of some advanced forms of supply chain integration. Our study shows that many firms do not invest in technology to integrate the information flow and as such are not integrated in a structural way. A study of Carr and Kaynak (2007) showed that these advanced communication methods, such as IT supply chain applications, are not critical with respect to influencing inter-firm information flows and that partners still share a lot of information by non-integrative systems like fax, phone and e-mail. However, we find that a third of the strategic alliances do not even share information in a regular way. Although practitioners as well as academics advocate the use of strategic alliances and how these should be integrated, still few alliances really succeed in doing so. Furthermore, we see that these strategic alliances are perceived as being less successful.

A success factor for information flow strategies is the coherence with the context of the firm and the alliance. In the literature, IT supply chain applications are considered 'lean' rather than 'rich', as they are still predominantly written and numerical representations of data (Stephens, 2007). In less ambiguous environments, communication can be managed using less rich media (Donabedian, 2006). However, Harland et al (2007) found, based on interviews, that IT supply chain applications can enhance relationships by freeing up time from administrative tasks which can then be used to spend more time for building the relationship. Our data confirms this latter view and shows that IT supply chain applications are used in environments that are highly dynamic. Furthermore, it indicates that IT supply chain applications do not replace the more traditional communication, but rather are an additional medium for partners to communicate and also create additional efforts in more advanced forms of integration.

Additionally, our results suggest that information flow strategies co-evolve with the creation of trust and interdependence in the strategic alliance. While high levels of trust seem to create an environment to share information, interdependence creates the willingness to invest in IT supply chain applications. The results also show that partners first need to invest in information sharing processes based on traditional media and to create trust, before evolving towards investing in IT supply chain applications.

However, it is important to stress that not all strategic alliances need to develop towards IT intensive alliances. This statement is supported by previous research of Das et al (2006) who argue that optimum supply chain performance will only be achieved through the appropriate, and not necessarily highest, level of supply chain integration. As mentioned above, this appropriate level depends on the business and relational environment of the strategic alliance.

Based on these results, some managerial implications can be drawn. Although the supply chain literature (e.g. Currie, 2000) claims that supply chain integration is always beneficial, the findings of the study suggest that a prescriptive approach to inter-firm information flows could hinder effective communication. One example could be for instance promoting IT supply chain applications in all circumstances. While more advanced information flow strategies seem to pay off, this might not be the optimal strategy for every strategic alliance.

Consequently, managers need to invest carefully in advancing information flows, as it can support coordination or can be used to participate in each others information processing cycle. Furthermore, these investments in IT should be in line with the overall integration strategy, the company's product portfolio and the supply chain configuration (Silveira et al, 2004) which also takes softer (e.g. relational characteristics), less technological forms (e.g. business characteristics) of integration into consideration. Finally, before investing in these types of technologies, managers need to think about which outcomes they hope to accomplish and how these practices can help the company to reach these outcomes.

Like most empirical work, this study has limitations that might be addressed by further research. First of all, this study is limited towards strategic alliances, excluding traditional buy-sell relationships. Since we believe that relationships differ according to the specific context, we believe this approach to be insightful. Future studies, however, could focus on other types of relationships. Alliances are here measured by talking into account the view of only one of the parties. Generalizing these results towards the alliance may misrepresent the actual state of the alliance. Future research should address this issue by collecting dyadic data. Since we use cross-sectional data for our analysis, we can not prove causality. We infer that contextual factors may lead to certain strategic choices, while the information flow strategies may lead to differences in performance. However, we note the limitation that to definitively address this issue longitudinal data is required. Future research could address this issue. Furthermore, our results are limited to strategic alliances of manufacturing firms. Service contexts are characterized by more ambiguity, uncertainty and variability and the use of different communication media (Ambrose et al, 2008), which may impact the information flow strategies. As such, we can not generalize our findings towards service companies. The same holds for the geographical context. The cases have been limited to Belgian firms to avoid cultural differences. Whether the conclusions still hold in other areas is unexplored and can be subject to future research.

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APPENDICES

Appendix 1

Descriptives and Factor Analysis of the Integration Scales

Constructs	Mean	Std. dev.	Factor loading
Trust (Cronbach's alpha = 0.93)			
TR1: Relationship is beneficial for us.	4.79	1.79	0.87
TR2: Relationship achieved a balanced agreement.	4.47	1.82	0.86
TR3: Relationship has high level of business harmony.	4.17	1.75	0.79
TR4: Relationship offers significant benefits to both partners.	4.60	1.83	0.86
TR5: Duration expectancy of relationship. (very short term versus very long term)*	5.02	1.54	-
Eigenvalue			3.59
Variance explained			22.42%
Interdependence (Chronbach's alpha = 0.80)			
I1: It is easy to end the relationship and start a new one. (inverted)	4.50	1.90	0.79
I2: Time to establish a new relationship will be extremely long.	4.29	1.99	0.87
I3: The cost of establishing a new relationship would be high.	4.23	1.79	0.8
I4: The relationship can easily be stopped without losses. (inverted)	3.76	2.11	0.75
Eigenvalue			2.85
Variance explained			17.82%
Coordination (Chronbach's alpha = 0.83)			
CO1: In this relationship, each party knows his exact role.	5.35	1.51	0.85
CO2: The collaborative practices are planned very carefully.	4.77	1.44	0.78
CO3: The degree of coordination in this relationship is extremely high.	4.80	1.58	0.58
Eigenvalue			2.03
Variance explained			12.71%
Information Participation (Cronbach's alpha = 0.71)			
IP1 : We are actively seeking for advice, guidelines and information from partner.	5.23	1.50	0.55
IP2: The partner takes part in planning activities and setting aims and goals.	3.96	1.83	0.75
IP3: We take part in planning activities, aims and goals of partner.*	4.38	1.76	-
IP4: We are actively seeking for proposals or suggestions for improvement from partner.	5.08	1.58	0.84
IP5: We react appropriately to a partner's suggestions.*	5.27	1.26	-
Eigenvalue			1.97
Variance explained			12.30%
Constructive Conflict Resolution Techniques (Bi-variate correlation = 0.52)			
CR1: joint resolution of problems	5.39	1.39	0.68
CR2: ignoring the problem (inverted)	6.28	1.06	0.87
CR3: Pursuation from any of the parties*	4.09	1.37	-
CR4: Unilaterial imposition*	3.12	1.59	-
CR5: External arbitration*	5.56	0.89	-
Eigenvalue			1.71
Variance explained			10.67%

* These items were dropped based on the explanatory factor analysis, based on high cross-loadings or low loadings (<0.50) on the factor.

Appendix 2
Descriptives and Factor analysis of the Performance Scales

Constructs	Mean	Std. dev.	Factor loading
Relationship Satisfaction (Crohnbach's alpha = 0.94)			
SA 1: In this collaboration, the parties work together to solve problems.	4,90	1,83	0,86
SA2: This collaboration is flexible in response to requests we make.	4,50	1,77	0,86
SA3: This collaboration makes an effort to help us during emergencies.	4,84	1,75	0,84
SA4: When an agreement is made, we can always rely on the partner to fulfill the requirements.	4,79	1,84	0,82
SA5: Please indicate the overall degree of satisfaction with your collaboration.*	4,30	1,84	-
Eigenvalue			3,61
Variance explained			24,09%
Flexibility (Bi-variate correlation = 0.66)			
F1: increase flexibility	4,31	1,84	0,61
F2: reduce cycle time	3,71	1,86	0,77
Eigenvalue			2,86
Variance explained			19,11%
Quality (Bi-variate correlation = 0.92)			
Q1: improve product quality	3,84	1,72	0,87
Q2: improve quality reliability	3,89	1,79	0,84
Eigenvalue			2,11
Variance explained			14,08%
Cost (Bi-variate correlation = 0.84)			
C1: reduce product costs	3,71	1,87	0,85
C2: reduce process costs	3,8	1,91	0,75
C3: Reduced Inventories*	3,58	2,03	-
C4: More efficient use of HR*	3,75	1,87	-
Eigenvalue			1,83
Variance explained			12,23%
Innovation (Bi-variate correlation = 0.61)			
I1: increase speed to market for new products	2,98	1,82	0,73
I2: use of market data in a more efficient way	3,09	1,70	0,79
Eigenvalue			1,68
Variance explained			11,25%
Delivery (Bi-variate correlation = 0.77)			
D1: delivery speed	4,01	1,88	0,83
D2: delivery reliability	4,36	1,85	0,70
Eigenvalue			1,02
Variance explained			6,61%

* These items were dropped based on the explanatory factor analysis, based on high cross-loadings or low loadings (<0.50) on the factor.

TABLES AND FIGURES

Figure 1

Model of contextual and performance factors of the foundations of supply chain integration

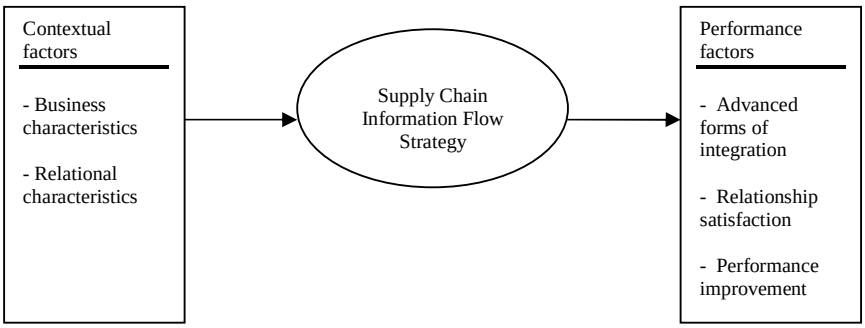

TABLE 1

Demographic Characteristics of the respondents and respondent function

Type of relationship:	**Companies activity:**
- Customer: 18 (32%)	- Chemical: 26 (46%)
- Supplier: 38 (68%)	- Consumer goods: 11 (19%)
Annual sales:	- Primary industry: 8 (14%)
- < 25 million €: 2 (4%)	- Informatics and media: 7 (12%)
- 26-50 million €: 6 (11%)	- Pharmaceuticals: 4 (8%)
- 51-100 million €: 7 (12%)	**Position in the supply chain:**
- 101-500 million €: 18 (32%)	- Upstream: 13 (25%)
- > 500 million €: 23 (41%)	- Manufacturing: 34 (61%)
Number of employees:	- Downstream: 8 (14%)
- 51-250: 8 (15%)	**Length of the collaboration:**
- 251 -500: 18 (32%)	- Average: 8.61 years
- 501-1000: 9 (16%)	- Standard error: 7.64
- > 1000: 21 (37%)	
Function of respondents:	
- Supply chain Manager or Director: 30	
- Purchasing Manager or Director: 7	
- Logistics Manager or Director: 19	

Table 2
Information flow characteristics - Factor analysis

Variables	Factor 1 Information quality	Factor 2 Information sharing	Factor 3 IT SC applications	Mean	Std. dev.
Communication is reliable	**0.90**	0.12	0.20	5.06	1.59
Communication is complete	**0.89**	0.18	-0.01	5.00	1.58
Communication is exact	**0.91**	0.22	0.07	4.95	1.57
Communication is on time	**0.88**	0.12	0.12	5.05	1.53
Communication is appropriate	**0.80**	0.25	-0.05	5.01	1.43
We inform partner in advance of changes	0.14	**0.81**	0.05	5.55	1.39
Both parties share all usefull information	0.16	**0.74**	0.12	5.70	1.26
We share confidential information with partner	0.41	**0.63**	0.05	4.26	1.92
Partner shares information with us	0.06	**0.55**	0.15	4.25	1.74
Planning systems	0.16	0.30	**0.76**	3.71	1.32
Information exchange systems	0.03	-0.01	**0.89**	3.32	1.76
Databases for collaboration	0.07	0.39	**0.58**	2.41	1.34
Eigenvalues	4.42	2.47	1.68		
Percent of Variance Explained	36.87	20.55	13.97		
Cumulative Percent	36.87	57.42	71.39		
Cronbach's alpha	0.94	0.79	0.74		
Mean	5.01	4.94	3.15		
Std. dev.	1.39	1.26	3.15		

Note: Each factor shows the mean of all respondent's answers on a seven-point scale asking wether they agree with the following statements, with 1 = completely disagree and 7 = completely agree for the first 2 constructs. For the IT SC Applications, the use of different IT applications in the specified relationship is measured with 1 = not used and 7 = highly used.

Table 3
Scale inter-correlation Matrix

	Mean	SD	1	2	3	4	5	6	7	8
1. Information sharing	4.94	1.26	1							
2. Information quality	5.01	1.39	.57**	1						
3. IT SC applications	3.15	1.15	.42**	.25*	1					
4. Interdependence	4.19	1.55	.32**	.27**	.37**	1				
5. Trust	4.51	1.63	.56**	.61**	.31**	.15	1			
6. Coordination	4.19	1.30	.56**	.55**	.22*	.23*	.68**	1		
7. Information participation	4.76	1.18	.76**	.59**	.44**	.25*	.54**	.50**	1	
8. Constructive conflict resolution	5.84	1.08	.44**	.49**	.23*	.04	.49**	.44**	.43**	1

** significantly different at p < .01 (2-tailed)
* significantly different at p < .05 (2-tailed)

Table 4
Information flow clusters

Measure	Supply chain information flow strategies			
	Silent alliances *n = 38*	Communicative alliances *n = 36*	IT intensive alliances *n = 25*	
Information Quality	(2,3)	(1)	(1)	
Cluster Mean	3.57	**5.84**	**5.96**	F = 78.31
Standard Error	0.16	0.11	0.20	p < 0.001
Information Sharing	(2,3)	(1)	(1)	
Cluster Mean	3.84	**5.47**	**5.97**	F = 54.59
Standard Error	0.15	0.15	0.14	p < 0.001
IT SC Applications	(3)	(3)	(1,2)	
Cluster Mean	2.64	2.61	**4.72**	F = 80.88
Standard Error	0.12	0.09	0.17	p < 0.001

Note: Numbers in parentheses indicate the group numbers from which this group was significantly different at the p < 0.05 level according to the Scheffe pairwise comparison procedure. F statistics and associated p-values are derived from one-way ANOVAs.

Table 5
Company size

	Supply chain information flow strategies			
Number of employees	Silent alliance	Communicative alliance	IT intensive alliance	Total
Less than 500	**22**	15	9	46
501-1000	3	**9**	3	15
Over 1000	12	11	**13**	36
Total	37	35	25	97

Note: A chi-square test of the sample distribution against the expected distribution based on a random distribution does indicate a significant difference (p < 0.10).
The numbers in **bold** represent the cells with greater than expected proportions.

Table 6
Business context

Measure	Supply chain information flow strategies			
	Silent alliance *n = 38*	Communicative alliance *n = 33*	IT intensive alliance *n = 25*	
Competion on costs				
Cluster Mean	4.29	4.36	4.44	F = 0.27
Standard Error	0.13	0.11	0.19	p = 0.75
Competition on quality	(1)	(1)	(2,3)	
Cluster Mean	3.53	3.61	**4.40**	F = 7.85
Standard Error	0.17	0.15	0.14	p < 0.01
Competition in response speed				
Cluster Mean	3.87	3.74	4.12	F = 1.96
Standard Error	0.11	0.12	0.17	p = 0.15
Competition in design and development		(1)	(2)	
Cluster Mean	3.55	3.33	**4.04**	F = 3.58
Standard Error	0.18	0.17	0.18	p =0.03
Speed of change				
Cluster Mean	3.34	3.56	3.56	F = 0.90
Standard Error	0.13	0.11	0.17	p = 0.41
Foreign competition				
Cluster Mean	4.39	4.11	4.36	F = 1.34
Standard Error	0.12	0.15	0.15	p = 0.27

Note: Numbers in parentheses indicate the group numbers from which this group was significantly different at the p < 0.05 level according to the Scheffe paiwise comparison procedure. F statistics and associated p-values are derived from one-ways ANOVA's.

Table 7
Relationship characteristics

Measure	Supply chain information flow strategies			
	Silent alliance *n = 38*	Communicative alliance *n = 33*	IT intensive alliance *n = 25*	
Interdependence	(3)	(3)	(1,2)	
Cluster Mean	3.77	4.20	**5.48**	F = 11.06
Standard Error	0.25	0.24	0.25	p < 0.01
Trust	(2,3)	(1)	(1)	
Cluster Mean	3.45	**4.96**	**5.75**	F = 25.02
Standard Error	0.20	0.26	0.19	p < 0.01

Note: Numbers in parentheses indicate the group numbers from which this group was significantly different at the p < 0.05 level according to the Scheffe pairwise comparison procedure. F statistics and associated p-values are derived from one-ways ANOVA's.

Table 8
Supply Chain Integration

Measure	Supply chain information flow strategies			
	Silent alliance *n = 38*	Communicative alliance *n = 33*	IT intensive alliance *n = 25*	
Coordination	(2,3)	(1)	(1)	
Cluster Mean	4.14	**5.40**	**5.91**	F = 20.69
Standard Error	0.20	0.21	0.16	p < 0.01
Information participation	(2,3)	(1,3)	(1,2)	
Cluster Mean	3.88	5.03	**5.73**	F = 19.87
Standard Error	0.16	0.15	0.15	p < 0.01
Constuctive conflict resolution	(2,3)	(1)	(1)	
Cluster Mean	5.29	**6.21**	**6.36**	F = 15.09
Standard Error	0.17	0.14	0.10	p < 0.01

Note: Numbers in parentheses indicate the group numbers from which this group was significantly different at the p < 0.05 level according to the Scheffe paiwise comparison procedure. F statistics and associated p-values are derived from one-ways ANOVA's.

Table 9
Supply Chain Performance

Measure	Silent alliance *n = 38*	Communicative alliance *n = 33*	IT intensive alliance *n = 25*	
Relationship Satisfaction	(2,3)	(1)	(1)	
Cluster Mean	3.43	**5.17**	**5.90**	F = 28.37
Standard Error	0.21	0.26	0.19	p < 0.01
Competitive Capabilities				
Cost	(2,3)	(1,3)	(1,2)	
Cluster Mean	2.82	3.91	**4.89**	F = 12.13
Standard Error	0.22	0.31	0.35	p < 0.01
Flexibility	(2,3)	(1,3)	(1,2)	
Cluster Mean	2.96	4.25	**5.19**	F = 16.97
Standard Error	0.22	0.29	0.27	p < 0.01
Delivery	(3)	(3)	(1,2)	
Cluster Mean	3.43	4.19	**5.36**	F = 10.92
Standard Error	0.24	0.33	0.21	p < 0.01
Quality	(2,3)	(1,3)	(1,2)	
Cluster Mean	3.01	4.13	**5.19**	F = 20.57
Standard Error	0.20	0.24	0.27	p < 0.01
Innovation	(3)	(3)	(1,2)	
Cluster Mean	2.28	2.72	**4.60**	F = 25.32
Standard Error	0.16	0.24	0.30	p < 0.01

Note: Numbers in parentheses indicate the group numbers from which this group was significantly different at the p < 0.05 level according to the Scheffe pairwise comparison procedure. F statistics and associated p-values are derived from one-ways ANOVA's. The numbers in **bold** respresent mean values significant different from the other mean values.