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the Autonomous Management School of  
Ghent University and Katholieke Universiteit Leuven

**Vlerick Leuven Gent Working Paper Series 2008/15**

**CREATING SUCCESSFUL COLLABORATIVE RELATIONSHIPS**

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## **CREATING SUCCESSFUL COLLABORATIVE RELATIONSHIPS**

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## **ABSTRACT**

Stevens (1989) was among the first to stress the strategic importance of collaboration in the supply chain. On the other hand, some recent studies point out that supply chain collaboration is no guarantee for success (Van Wassenhove et al, 2003; Vereecke et al, 2004; Holweg et al, 2005) and that there is a need to investigate what makes a collaborative relationship successful. Building on the work of Mohr and Spekman (1994), Monczka (1998) and Solis (2004) and several other researchers (Bowersox (2000), Mentzer (2000), etc), we have identified three key antecedents of supply chain collaboration: collaboration attributes, systems & processes and conflict resolution techniques. To measure these antecedents and the link between the antecedents and the performance improvement of the relationship, we developed a survey to measure the least successful and the most successful strategic supplier- and customer-relationships. Based on a cluster analysis on the operational benefits of collaboration, we identified 4 types of collaborative relationships: stagnant, internally-focused, externally-focused and best-in-class collaborative relationships. We found that the characteristics of the relationships are different according to the type of collaborative relationship. Based on the differences in the antecedents of these clusters, we identified different paths to improve supply chain collaboration and we identified 4 types of capabilities to improve the performance of a relationship: cumulative, internal, external and progressive capabilities. This categorization helps management to highlight which aspects of the relationship require more attention, depending on the kind of benefits one wants to accomplish through the relationship.

## **INTRODUCTION**

Although the fundamental importance of supply chains is widely accepted (Saunders, 1997; Gattorna, 1997) and there exists a rich continuum of strategies for collaboration amongst supply chain partners (Holweg et al, 2005), little is known about the magnitude of the different factors driving the performance improvements of collaborative practices. Moreover, some recent studies point out that supply chain collaboration is no guarantee for success (Van Wassenhove et al, 2003; Holweg et al, 2005; Vereecke et al, 2006). Therefore, it is our objective to gain insights into the reason why some supply chains increase their performance more through collaboration than others. This calls for an investigation of the relationship between the success of collaboration in the supply chain and the antecedents of these collaborative relationships.

In the next paragraph, the literature is reviewed and hypotheses developed. The data and method are presented. At the end of the paper, the results are discussed and directions for further research are indicated.

## **LITERATURE REVIEW**

### **Supply Chain Collaboration**

Spekman et al (1998) define supply chain management as ‘a process of designing, developing, optimizing and managing the internal and external components of the supply system (including material supply), transforming materials and distributing the finished products or services to customers in a way that is consistent with the overall objectives and strategies’. Stevens (1989) was among the first to stress the strategic importance of collaboration in the supply chain. Other researchers (e.g. New, 1996) mention collaboration as one of the core elements of supply chain management, removing barriers (or boundaries) between organizations (Naylor et al, 1999; Romano, 2003).

Spekman et al (1998) summarize the development of supply chain integration into three stages: cooperation, coordination and collaboration. We use here the word ‘collaborative relationships’. The starting level for supply chain integration, i.e. cooperation, requires firms to exchange essential information and engage some suppliers into a long-term contract. The next stage is coordination, whereby specified material and information are exchanged among partners to create seamless linkages, such as EDI, among trading partners.

At the highest level of supply chain integration, referred to as “collaboration”, the trading partners integrate processes such as planning and R&D with those of their suppliers and/or customers. In this paper, we will only focus on the most advanced form of integration: collaboration. Simatupang et al define supply chain collaboration as two or more chain members working together to create a competitive advantage through information sharing, joint decision making, and benefit sharing which result in greater profitability from satisfying end customer needs than acting alone (Simatupang and Sridharan, 2002). Likewise, Burnes and Whittle (1995) point to the presence of a proactive, cooperative, win-win philosophy with a long-term commitment to continuous improvement, integration and performance determination for partner relationships to exist. Burnes and New (1997) use the term collaboration as a way of describing buyer-supplier relationships that embrace both conflict and partnership, implying some form of mutuality without an apparent need for lifetime commitment or total openness and trust.

### **Antecedents of collaboration**

Based on a comprehensive literature study, we collected the antecedents of supply chain collaboration. A collaborative relationship implicitly consists of multiple antecedents. Many studies focus on separate antecedents such as the relational attributes trust or commitment (e.g. Arnulf, 2005), while others focus on information sharing (e.g. Sohung, 2006) or the use of IT systems in supply chain management (e.g. Thermitocleas, 2004). Only a few empirical studies explored the formation of collaborative relationships and included multiple antecedents (Gulati, 1995; Handy, 1995; Mohr and Spekman, 1994; Monczka, 1998 and Solis, 2004).

Based on our literature review, we identified 3 types of antecedents: Collaboration attributes, Systems & Processes and Conflict Resolution Techniques. The Collaboration attributes consist of all the relational, people and information-related attributes. Systems & Processes are the backbone of structured and standardized collaboration. Conflict resolution techniques will only be used when communication problems or disputes between the partners arise. In the literature review, we first of all describe the three types of antecedents in more detail. Furthermore, we describe the literature on measuring supply chain performance improvement.

A lot of attention has been placed in the literature on relational attributes such as commitment, trust, coordination, interdependence and clarity of the expectations. *Commitment* refers to the willingness of buyers and suppliers to exert effort on behalf of the relationship, which may occur in the form of an organization's time, money, facilities, etc. These types of resources are often referred to as 'asset specific' resources, since they are directed specifically towards the other party (Monzka, 1998). Mcallister (1995) concluded that *trust* occurs in two forms. One of these has its roots in reliable role performance, cultural-ethnic similarity, and professional credentials, whereas the other has its roots in 'citizenship behavior' and interaction frequency. Important is that both forms of trust enhance coordination by lowering administrative costs (Monzka, 1998). *Interdependence* exists when one actor does not entirely control all of the conditions necessary for achievement of an action or a desired outcome (Monzka, 1998). *Coordination*, reflects the set of tasks each party expects the other to perform and is directed at mutual objectives that are consistent across organizations (Narus and Anderson, 1987) Finally, *clarity of expectations* measures whether all parties understand what is expected of them in the relationship (Mentzer, 2000)

Furthermore, McCarter (2005) identified four important people related attributes of success for supply chain collaboration: leadership capabilities, level of process thinking, resource and time allocation, and a culture of change. Firstly, the ability of the managers of the company to *lead supply chain projects* is crucial (Russell, 2004). Without a champion who moves collaboration forward, nothing significant will ever be accomplished (Mentzer, 2000). Secondly, a supply chain view requires a company to think in terms of processes and not in terms of functions. This can be done by creating liaison devices like matrix structures or cross-functional teams. A lack of *process thinking* can have a negative effect on the performance of collaboration practices (Croxtton, 2001). Thirdly, collaboration requires *time and a lot of hard work* (Mentzer, 2000). Most companies underestimate this investment in resources (cross-functional teams, supply chain specialist) and time (training, specific projects). Finally, supply chain projects require the willingness to *change*. People have a natural resistance to change and as a consequence like to do things the old way (Mentzer, 2000).

Finally, effective communication not only requires relation and people attributes, but also information exchange with high information quality (Stohl and Redding, 1987; Petri, 2005), participation (Anderson, Lodish and Weitz, 1987; Mentzer, 2000) and openness of both partners (Mentzer, 2000). The *quality of the information* is reached if the exchanged information is accurate, timeless, adequate and credible (Draft and Lengel, 1986; Huber and Daft, 1987; Stohl and Redding, 1987). This exchange of correct and real-time information is believed to generate benefits in the supply chain (Petri, 2005). *Participation* or the extent to which partners engage jointly in planning and goal setting (Anderson, Lodish and Weitz, 1987) is believed to improve the supply chain performance (Mentzer, 2000). Companies sharing information with their partners should also be willing to openly discuss their practices and processes with partners (Mentzer, 2000). *Openness* creates an atmosphere where information sharing is easy and as a consequence could lead to higher performance in the supply chain. When companies for example engage in joint R&D projects, partners need to understand each other's competencies and technology roadmaps, and need to share information on their latest developed technologies. Another example is a JIT system, where two partners need to have in-depth information on each other's production process and capacities.

Our first hypothesis **H1** is that **'Successful collaborative practices are associated with a higher use of Collaboration Attributes.'**

Systems are often referred to as the backbone of the supply chain business structure (Grover and Malhotra; 1999, Kent and Mentzer, 2003). Setting up standardized systems and processes provides visibility in the supply chain. This visibility helps to improve the production, inventory and distribution planning and as such relates to the performance of the supply chain. Information can be shared through systems and processes such as *information systems (IT)*, *accounting processes or systems* and *supplier/customer selection and evaluation systems and processes*. Chae et al (2005) posit that the effect of the systems is not pre-determined by its technological capabilities. Rather, its effect depends on the interplay between the systems and the existing relationships (such as trust and information sharing, as discussed earlier) between partners. Efficient supplier and customer management systems and processes are also of central importance for successful supply chain management. It begins with the identification of potential suppliers and customers and leads to controlling the supplier-buyer-connections (Solis, 2004).

Our second hypothesis therefore is **H2: 'Successful collaborative relationships are associated with a higher degree of use of Systems and Processes.'**



The above mentioned aspects of the collaboration describe the collaboration under usual circumstances. However, conflict may arise with the partner and may require techniques to solve these problems. The way companies handle these conflicts has also an impact on the degree of success on the relationship. Research has shown that the use of *constructive conflict resolution techniques*, where both companies jointly eliminate the conflict or persuade the other company, has a positive impact on the performance of the partnership.

The use of *conflict avoidance techniques*, where the companies are ignoring or avoiding the issues, or *destructive conflict resolution techniques*, such as domination, harsh words or arbitration, is reported to have a negative impact on the performance of the relationship (Deutsch, 1986; Thomas, 1977; Patterson and Handfield, 1996, Solis, 2004).

Our 3<sup>rd</sup> hypothesis **H3** is **‘The degree of success of a Collaborative Relationship is influenced by the way in which conflicts are dealt with.’**

### **Supply Chain Performance improvement**

Supply chain collaboration is in general expected to increase performance in three broad areas: cost reductions, service gains and pure financial gains (Bowersox, 2000; Mentzer, 2000). This is in line with other research measuring operational performance (Frochlich and Westbrook, 2001; Rozenzweig, 2003; Vereecke, 2006). The cost reductions studied in our research are the reduction in inventories, the gains in efficiency in the use of human resources and the product cost reductions. The service gains identified in our research are the improved customer service, the better delivery, the speed to market of new products, the use of market intelligence and the quality gains. The financial gains considered in our research are the return on assets and the improved shareholder value (Bowersox, 2000).

## RESEARCH DESIGN

### Research Methodology

Since the objective of our research has been to test our hypotheses on a broad sample, survey research has been the preferred methodology.

To identify the antecedents of supply chain collaboration and to test the link between the antecedents and the performance of the relationship, a questionnaire has been designed to measure the antecedents of both the least successful and the most successful strategic supplier- and customer-relationships as perceived by managers managing different collaborative relationships. Most of the questionnaire items in our survey have been used in previous research (Solis, 2004; Monczka, 1998; Spekman, 1994). Some questionnaire items have been added, based on the review of recent literature discussed above. The draft of the questionnaire has been pre-tested on a sample of 10 experts (academics and people in the field), upon which some minor changes have been made.

The questionnaire has been sent to the supply chain manager, logistics manager or purchasing manager in manufacturing and distribution companies in Belgium, in several industries (mainly chemical, pharmaceutical, consumer goods and electronics).

We took great care to reach scale validity in three ways: content validity, construct validity and criterion-referenced validity (Thorndike, 1996). For purpose of this study, content validity refers to the degree to which the scales properly reflect the antecedents of collaboration and measure the performance improvements of a specific relationship. Since our questionnaire is based on a comprehensive in-depth literature study on the antecedents of supply chain collaboration, content validity is accomplished. To guarantee construct validity several variables have been measured through multiple item measures. The reliability of these variables has been assessed by calculating the Cronbach's alpha and factor analysis has been used to reject or confirm the assumption that some theoretical constructs underlie the items (Carmines and Zeller, 1979, DeVellis, 1991). To assess the criterion-related validity for our scale on supply chain performance improvement, we measured the Pearson correlation matrix among the factor scores of benefits of collaboration and the overall satisfaction of collaborative relationship, as measured in previous studies by Monczka (1998) and Solis (2004). The results of these tests can be found in the empirical section of this paper and indicates that criterion-related validity is reached.

## **Data collection**

The sample consists of manufacturing companies with more than fifty employees, collaborating with at least two suppliers and/or customers. Data were collected mid 2006. The unit of analysis is the collaborative relationship. Based on these criteria, we developed a contact list of 200 companies. This list is randomly drawn from the supply chain managers (see functions as described above) of the CRM database of the Vlerick Leuven Gent Management School. Before sending out the questionnaire, we have contacted the 200 target companies by phone, to check whether they are collaborating, i.e. the most advanced form of integration (see table 1 for the definition of Spekman, 1998) with their suppliers and/or customers. Exhibit 1 presents the questions we asked to our target companies based on the definition of Spekman (1998). In case of a positive response on the first 3 questions (see exhibit 1) and on one of the 4 other questions (i.e. in 115 cases), the questionnaire has been sent via e-mail, and follow-up phone calls have been made in order to maximize the response rate.

We received responses of 56 companies or 112 collaborations (56 most successful and 56 least successful collaborations). 34 of the 112 collaborations were customer-relationships (downstream) and 78 were supplier-relationships (upstream). More information on the companies responding to the survey can be found in table 1.

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Insert Table 1 About Here

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## **Operationalization of the antecedents of collaboration**

In our questionnaire, we use 1 to 7 likert-scales to measure our items. To develop our scales, we used factor analysis and cronbach's alpha. To secure the convergent and discriminant validity, we only considered items that had a factor loading higher than 0.60 and did not have important cross-loads (items with a loading on a second factor with a difference lower than 0.20 were omitted for further analysis).

As described in the literature, we defined three types of antecedents: Collaboration attributes, Systems & Processes and Conflict Resolution Techniques. A list of all the theoretical constructs as found in the literature can be found in Appendix 1 and is used to develop our questionnaire. Based on our empirical data analysis (factor analysis), we then used the items of our theoretical constructs to define the underlying construct in our study. A description of this analysis can be found in the following paragraphs.

## **Collaboration attributes**

The collaboration attributes represent the way, the quality and the amount in which collaboration techniques are used.

An obvious starting point for analysis of multiple correlated items is to use factor analysis to transform the numerous antecedents into a smaller set of orthogonal factors. The principal component analysis with varimax rotation is used. As described above, some of the items were excluded since they did not load on one of the factors. This factor analysis shows 8 factors. All factors are measured by at least 2 items and have a Cronbach's alpha of more than 0,70. The final factor analysis can be found in appendix 3.

- A first factor consists of the expertise in the supply chain, the support of executive management, the drive and leadership of the supply chain managers and the presence of a balanced and beneficial agreement for both parties. Contrary to what was expected based on the literature, measures for leadership, change, trust and commitment seem to group into a single factor. We labeled the factor as "*Leadership & Business harmony*".

- The second factor consists of 4 items which express the extent to which the company is dependent on the collaborative relationship: 'the length of time to establish a new collaboration', 'the ease with which collaboration can be stopped without losses', 'the easy to end collaboration and start a new one' and 'the cost of establishing a new collaboration'. The easier it is to stop the alliance (qua cost and competences), the less the company is dependent on this collaborative relationship. We have labeled this factor "*Interdependence*" since it measures the level of dependence on the company which whom one collaborates.

- The next factor describes how the relationship is coordinated. It groups 'knowing the role of each party in the relationship', 'planning the tasks and activities in the relationship carefully' and 'setting up clear expectations'. This factor is labeled "*Coordination*".

- A fourth factor consists of the creation of cross-functional supply chain teams and teams with members from both companies. We labeled this factor "*Process thinking*".

- Another factor is the time and training provided to the personnel involved in the collaborative relationship. Since we are only measuring the time and training invested in the relationship, and not the money, we put the label "*Effort*" on this one, rather than "Resources".

- A sixth factor consists of the reliability, completeness, exactness, timeliness and appropriateness of the information. As expected in the literature, communication reliability,

completeness, exactness, timeliness and appropriateness group into a single factor, which we have labeled as “*Communication quality*”.

- The next factor measures whether the partner provides enough information on changes which affect the business, planning, aims and goals. It also indicates whether the partner is helping by giving suggestions for improvement or by proposing new ideas for the company. We labeled this factor as “*information sharing*”. It is important to note that this factor expresses a one-way communication in the collaborative relationship.

- The last factor measures whether both parties share all useful information and whether both parties keep each other informed of changes. We labeled this factor “*Information participation*”, expressing two-way communication in the collaborative relationship.

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As we see from these descriptions of the factors, not all variables are having the same specifications as in our literature study. For example, trust is measured here as an aspect of the variable “*leadership & business harmony*”.

## **Systems & Processes**

To exchange data, information and knowledge in the relationship, companies need to have systems in place. Three factors of systems & processes have been identified through factor analysis. A list of these factors, can be found in Appendix 3. The cronbach’s alpha is for the three different factors higher than 0.70.

- A first factor consists of the following items: use of ABC-systems in the supply chain, target costing in the supply chain, balanced scorecards to measure collaboration, incentive systems based on supply chain measures, metrics to measure critical performance indicators in the supply chain and tax systems to optimize the supply chain. We labeled this factor “*Accounting practices*”.

- Systems or processes to evaluate suppliers and customers and processes to identify opportunities, are a second factor in our analysis. We labeled the factor “*Partner selection and evaluation*”.

- The final factor contains information exchange systems (EDI, Internet, e-mail, Audio, POS on the web, EFT), planning systems (ERP and DRP) and database systems (knowledge management systems, CRM and SRM systems) to capture the information for collaboration. We decided to label them “*IT applications*”.

### **Conflict Resolution Techniques**

Conform to the literature, we measured 4 conflict resolution techniques variables. An explorative factor analysis shows three factors of conflict resolution techniques (see Appendix 3), in other words 2 of the factors contain only 1 variable. The first type of conflict resolution techniques are those techniques used by both parties such as joint resolution of the conflict or ignoring the problem. The item ignoring the problem has a negative sign and is inverted before the factor score is calculated. Our second factor describes those conflict resolution techniques that include a third party intervening when problems arise. Thirdly, one partner can take the initiative and can try to persuade the other partner with its solution. We labeled our factors “*joint conflict resolution*”, “*3rd party conflict resolution*” and “*persuasive conflict resolution*”. The cronbach’s alpha of joint resolution of the problem is rather low, 0.67 but still acceptable (see appendix 4).

Tests for discriminant validity are performed to determine whether two or more sets of scales are not measuring the same construct. Correlations among the pairs of the antecedents were examined for significant interfactor correlations. All correlations are significantly different from zero, but there are no high or very high correlations (that is higher than 0.69 (Westgard,1999) (see table 2)). Also the collinearity tolerance indicator shows values of more than .10, indicating that there is no problem of multicollinearity.

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Insert Table 2 About Here

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## Clustering of the performance improvement data

We measured the performance improvement of the collaborative relationships by 16 items (see appendix 3). The respondents had to indicate to which extent the described relationship enabled them to improve on the 16 performance measures on a scale of 1 to 7, with 1 = very little and 7 = very much.

We addressed multicollinearity through subjecting the variables to factor analysis and using the resultant uncorrelated factor scores for each observation as the basis for our clustering (Punj and Stewart, 1983). Principal component analysis with varimax rotation was used to identify the key dimensions of the benefits of supply chain collaboration. A first factor analysis can be found in Appendix 3 and resulted in two factors. Also the scree plot and the Kaiser's criterion indicate two factors. Items that did not load on only one of the factors (B5, B7, B8, B9, B10) or did not improve the reliability of the factor measured by cronbach's alpha (B3,B6) or did practically not fit with the other items of the factor (B12, B13) were dropped from further analysis. A second factor analysis with the remaining item can be found in table 3. As depicted in table 3, after 3 iterations and using a minimum factor loading of 0.60 (Nunnally and Bernstein, 1994), we could conclude that managers see 2 different types of coherent benefits of supply chain collaboration. The first factor consists of reduction in product costs, reduction in process costs, more efficient use of the human resources and more focus on core competencies. The second factor consists of delivery speed, delivery reliability and improved customer service. In combination, the two factors account for 78% of the scale variance: factor 1 for 62% and factor 2 for 16% of the scale variance. Both factors are reliable. The chrohnbach's alpha of the first factor is 0.90 and 0.66 for the second factor.

In our literature study, we discussed three types of benefits: cost benefits, service gains and financial gains. Our analysis only shows two coherent key benefits of supply chain collaboration. We labeled the first factor as internally-oriented supply chain benefits and the second factor as externally-oriented supply chain benefits. The items of the first factor are all cost benefits, while the second factor measures the service improvement towards the partner in the collaborative relationship. In our research, the financial benefits (B5 and B10) are not seen as a separate key benefit for supply chain collaboration.

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Insert Table 3 About Here

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We will now use the uncorrelated factor scores as input for our cluster analysis. A two-stage procedure, as suggested by Ketchen and Shook (1996), has been followed to cluster the collaborative relationships, using Ward's hierarchical clustering method. The number of clusters has then been 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 is compensating for a poor initial partitioning of the hierarchical clustering. Research has shown that this procedure increases the validity of the solutions (Milligan, 1980; Punj and Stewart, 1983).

To determine the number of clusters, we used multiple techniques (Ketchen and Shook, 1996). Based on the visual inspection of the dendrogram, we could recognize four clusters. An inspection of the change in the agglomeration coefficient also indicated 4 clusters to be appropriate. We therefore opted for a classification into four clusters.

### **Criterion-related Validity**

To measure criterion-related validity of our scales, we measured the correlation of our overall factor score of the benefits of collaboration (a score consisting of both the internally- and externally-oriented benefits) and the degree of satisfaction of collaboration used in previous studies by Monzcka (1998), Mohr (1994) and Solis (2004). Monzcka (1998), Mohr (1994) and Solis (2004) measured overall (past) success of collaboration through a 1 to 5 likert scale with the following descriptions:

- 1 = In this collaborative relationship, the parties work together to solve problems.
- 2 = This collaborative relationship is flexible in response to requests we make.
- 3 = This collaborative relationship makes an effort to help us during emergencies.
- 4 = When an agreement is made, we can always rely on the partner to fulfil the requirements.
- 5 = Please indicate the overall degree of results satisfaction with your most/least successful collaboration partner.

The pearson correlation between the overall satisfaction score and the overall benefits is 0.71 and highly significant ( $p < 0.01$ ), indicating the criterion-related validity of our performance improvement measures.



Furthermore, we can conclude from table 8 that only 2 of the successful collaborative relationships are in the Stagnant collaborative relationship cluster (cluster A) and 7 of the 51 unsuccessful collaborative relationships in the Best-in-class collaborative relationship cluster (cluster D), indicating that the cases clustered in the ‘wrong’ cluster are limited.

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Insert Table 4 About Here

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## EMPIRICAL RESULTS

### Supply chain performance improvement clusters

Figure 1 plots all observed collaborative relationships according to their internal and external performance improvements. The horizontal and vertical lines in the graph represent the 25, 50 and 75 quartiles. Remarkable is that the plot shows few collaborative relationships in the upper left corner and the right down corner, which indicates that ‘effective supply chain collaboration’ typically leads to internally- and externally-oriented benefits simultaneously. 5 cases from our data could not be plotted, since there was no information on the performance improvements of those cases.

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Insert Figure 1 About Here

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As discussed earlier, our cluster analysis suggests four different groups of collaborative relationships based on their impact on the performance improvement. Details on each cluster can be found in Table 4. A first cluster consists of those relationships which score low on internally- and externally-oriented benefits. Since their performance is hardly improving, we have labeled them the “*Stagnant Collaborative Relationships*”. The second cluster of collaborative relationships has medium levels of both internal and external performance (average internally-oriented performance of 3.48, and externally-oriented performance of 3.17). The third cluster of collaborative relationships shows a medium level of internal performance and high level of external performance (average score of 2.91 on internally-oriented performance and 5.69 on externally-oriented performance).

We labeled the 2<sup>nd</sup> and 3<sup>rd</sup> cluster the “*Internally-focused*” respectively the “*Externally-focused Collaborative Relationships*”, since these kinds of relationships are mostly focused on the internally-oriented benefits respectively the externally-oriented benefits. Finally, the fourth cluster of collaborative relationships scores high on both types of benefits (average score of 5.35 on internally-oriented performance and 5.62 on externally-oriented performance). Consequently, we labeled these relationships the “*Best-in-Class Collaborative Relationships*”.

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Insert Table 5 About Here

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### **Cluster Validation**

Analysis of variance on the variables used to generate the cluster solution is frequently used to test the validity of the cluster analysis solution.

The clusters are on both scales, internally-oriented and externally-oriented benefits, significantly different at  $p = 5\%$ . Since clustering attempts to minimize the variance within the clusters, it is logical that the F-test is significant (Aldenderfer and Blashfield, 1984). Table 5 summarizes the results.

We tested our clusters on the variance of variables that have not been used to generate the cluster solution, but yet are relevant (Aldenderfer and Blashfield, 1984; Milligan and Cooper, 1985). The following control variables were tested here: position in the supply chain, company’s activity or sector, annual sales, number of employees, type of relationship (customer relationship or supplier relationship) and the length of the relationship. Since the assumption of normality is violated for the control variables, we used the nonparametric alternative test to the ANOVA, the Kruskal-Wallis and the Median Test. The test indicated no significant differences concerning these variables between the 4 clusters. We only see small differences (based on a 90% confidence interval) in the clusters concerning the type of relationship: supplier or customer relationships. More details can be found in table 7, indicating that the cluster B and D contain more than average supplier relationships and cluster A and C more than average customer relationships. This leads to the conclusion that supplier relationships seem to score slightly better on internally-oriented benefits.

Both tests indicate that our clusters are valid.

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Insert Table 6 & 7 About Here

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### **Antecedents of Supply Chain Collaboration**

To test our hypotheses, we compared the antecedents of supply chain collaboration for our four clusters. The results of the comparisons of the four clusters on these variables are listed in Table 8.

We started our analysis by checking the normality of the variables. To test normality, we used the Kolmogorov-Smirnov test. All of the variables are normally distributed, except for communication quality, information participation, the selection process and the three conflict resolution techniques. For the normally distributed variables, we used the parametric ANOVA test. For the other variables, we have used the Kruskal-Wallis and Median test.

For those variables that showed a significant difference across the four clusters (with significance level  $p < 5\%$ ), pairwise comparison of the mean or median is reported in Table 7.

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Insert Table 8 About Here

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If we look at the antecedents, we could conclude from the comparison of the clusters that some antecedents have no influence, while others have a strong influence on the performance improvement of the collaboration. Based on our analysis in table 7, we could draw the following conclusions for the 3 types of antecedents:

#### **Collaboration attributes**

1. *Leadership and Business harmony* has a significant influence on the performance of the relationship. The level of Leadership & Business harmony is significant different between all clusters. To climb up from cluster A to C, one should have strong leaders, a drive for change, executive support and making the benefits visible for both parties. A strong drive and executive support can help you to grow on the externally-oriented benefits, while to reach cluster D, one should create a strong drive in the organization and should be supported by the executive management.

2. Interdependence between the collaborative partners does not influence the supply chain performance of the collaborative relationship. This could be explained by the fact that companies in our sample are large companies (see table 1).
3. Coordination has a positive impact on the supply chain performance. We see significant differences between the four clusters.
4. Process thinking has a positive impact on the supply chain performance. The level of process thinking is significant different between cluster B and D and C and D, in other words between medium and high levels of performance improvements.
5. Competence training and time investment in the collaborative relationship (mentioned here as effort) is no guarantee for success according to our data.
6. The way partners exchange information is crucial in the relationship. The quality, the way and the amount of information that is shared between the partners is influencing the supply chain performance.

In figure 7, we see differences in the Quality of the communication across the four clusters. If we look at the differences between cluster B and C, we could conclude that the timing, exactness, appropriateness, completeness and reliability of the shared information is significantly higher than for cluster A. If we look on the other hand at the differences between cluster D, B and C, we see no differences in completeness and appropriateness, but only in the timeliness, exactness and reliability of the information. Depending on the current stage of performance improvement of the collaborative relationship, partners need to focus on other aspects of communication quality: in a first stage they need to work on the appropriateness and completeness of the information while in a later stage the timeliness, the exactness and reliability of the information is a major concern.

7. Information participation is significant different between the low performance improvement clusters (cluster A) and the medium performance improvement clusters (cluster B and C).
8. Information sharing is significantly different between the medium levels of performance improvement clusters (cluster B and cluster C) and between high levels of performance improvement (cluster D).

We could conclude that our first hypothesis H1 ‘Successful collaborative practices are associated with a higher use of Collaborative Attributes’ is partially confirmed.

## **Systems & Processes**

9. If we look at the use of Accounting practices, we see some differences in our clusters. To improve the performance of a collaborative relationship from cluster B to D, partners should work on the use of metrics and proper incentive systems for that relationship. Partners who want to improve their collaboration from cluster C to D on the other hand should work on the use of target systems and ABC-systems in the collaborative processes. We could in other words conclude that in a collaborative relationship with medium performance, partners should work on incentive systems and metrics if their primary focus is to improve the externally-oriented benefits and on target and ABC systems if their primary focus is on internally-oriented benefits.
10. The use of IT systems also influences the performance improvements of a collaborative relationship. To improve the performance from cluster B to D, partners should work on all kind of IT systems: planning, information exchange systems and databases for collaboration. To improve performance from cluster C to D, partners should mainly focus on the planning systems.
11. The use of IT systems also influences the performance improvements of a collaborative relationship. To improve the performance from cluster B to D, partners should work on all kind of IT systems: planning, information exchange systems and databases for collaboration. To improve performance from cluster C to D, partners should mainly focus on the planning systems.
12. Process Selection and Evaluation tools do not significantly influence the performance of the collaborative relationship.

The second hypothesis H2 'Successful collaborative practices are associated with a higher use of Systems & Processes' is partially confirmed.

## **Conflict resolution techniques**

13. The only effective way to solve conflicts between collaborative partners is to solve them jointly.
14. The use of a 3rd party and persuasive conflict resolution techniques of one of the partners to solve a conflict between two partners has no influence on the performance of the relationship.

The 3rd hypothesis H3 ‘The degree of success of a collaborative relationship is influenced by the way in which conflicts are dealt with’ is partially confirmed.

Based on these analyses, we roughly conclude that hypotheses H1, H2, H3 are confirmed. Although not for all the variables underlying the constructs. We could also conclude that the difference between low and high performance improvement of collaborative relationships is rather complex. There is no linear correlation between the individual antecedents and the performance. As a result, we could NOT support the following statement: ‘The more you improve on each of the antecedents, the better the performance improvement.’ Important is that some antecedents help companies to improve internally-oriented and others externally-oriented benefits.

## DISCUSSION

Figure 2 summarizes the significant differences across the 4 clusters. The figure can be seen as a roadmap towards collaborative performance improvement.

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Insert Figure 2 About Here

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Important is to state that not for all collaborative relationships, companies want to install best-in-class relationships.

The results discussed above suggest that there are four types of capabilities for building a successful supply chain collaboration:

Leadership & business harmony as well as communication quality, are what we will call "*cumulative capabilities*". These antecedents help companies to improve both on the internally- and externally-oriented benefits of collaboration. By improving on these antecedents, total performance of the collaborative relationship gradually improves. These capabilities, such as leadership & business harmony and communication quality, will help you to steadily improve your supply chain performance.

We use the term "*external capabilities*" to the antecedents that make the difference along the vertical axis in figure 2, that is the externally-oriented benefits. Here we identify a single factor: joint conflict resolution techniques.

This indicates that in case of conflicts, having joint conflict resolution techniques helps to improve the performance towards the partner.

We use the term “*internal capabilities*” to refer to the differences along the horizontal axis of figure 2, that is the internally-oriented benefits. Here again, we identify a single factor which make the difference between cluster C and D and between cluster B and D: information participation or the two-way communication.

Finally, we identify some *progressive capabilities*: information sharing, process thinking, accounting practices and IT systems, which help companies to work together in a more structured and formal way. Collaborative relationships scoring already on one of the dimensions, i.e. externally-oriented or internally-oriented benefits, or on both dimensions, but do not succeed to climb up towards outstanding performance improvement, need to work on these progressive capabilities to score not only on the internally- or externally-oriented benefits, but outperform on both dimensions.

In general, we could conclude that leadership & business harmony and communication quality are seen as important in all collaborative relationships. In all situations (successful or not) and for all type of collaborative relationships, companies should work on these to continually improve the relationship. Companies who want to improve the performance of the relationship even further and want to create best-in-class collaborative relationships, need to work on structured and formalized systems and processes of communication and coordination. Systems & Processes have an impact on the performance improvement only when installed to support a relationship that scores already reasonably well.

Furthermore, the roadmap shows two different paths to create best-in-class collaborative relationships: a path from cluster A to B to D (path 1) and a path from cluster A to C to D (path 2). Based on the number of cases in each cluster, we conclude that the second path is more popular (29 cases) than the first one (16 cases). Table 4 shows that 75% of the relationships in the C cluster and only 34% of the relationships in cluster B are perceived as being successful. This indicates that companies working on the externally-oriented benefits in a first stage (path 2) are perceived as more successful than the ones working first on the externally-oriented benefits (path 1). As such, we could conclude that although most relationships work first on the internally-oriented benefits, it seems that working first on the externally-oriented benefits like coordination and joint conflict resolution techniques are being perceived as more satisfactory. According to our data, the ideal sequence is to work first on the external capabilities and only in a later stage on the internal and progressive capabilities to improve the internally-oriented benefits.

## **CONTRIBUTION TO RESEARCH AND PRACTITIONERS**

Previous research on collaboration did indicate that collaboration is not a guarantee for success. However, it provides little insight into how successful relationships are different from non-successful relationships. With our research, we intend to contribute to this discussion.

Supply chain managers, purchasing managers, logistics managers and customer service managers can benefit from this research since it offers a roadmap towards more successful collaborative relationships. It also highlights which aspects of the relationship require attention, depending on the kind of benefits one wants to accomplish through the relationship. An evaluation of this roadmap could help them to identify opportunities for establishing best-in-class collaborative relationships.

## **LIMITATIONS AND FUTURE RESEARCH**

In our research, we describe collaborative relationships as perceived by one of the partners in the relationship. We did not ask the other collaborative partner about his experience of the relationship. Describing the relationship from two sides should be a subject for future research.

Secondly, our research describes different clusters of collaborative relationships based on the internally and externally oriented benefits they create. The research is not explaining how the collaborative relationships evolved over time. The research is static and raises questions on the evolution of collaborative relationships.

Third, we asked managers to describe a most successful and a least successful strategic collaborative relationship, without describing the word 'successful'. We asked in other words for their judgment. In a later stage of the questionnaire, we asked them to describe the differences in benefits of the most and least successful collaborative relationship. To measure this judgement, we compared the classification of the managers with some classifications of other research and test variables in our questionnaire, indicating that the cases clustered in the 'wrong' cluster are limited.

A confirmative factor analysis, by using Structural Equation Modeling, would be particularly helpful in this kind of research. We measured the relationship between each antecedent and its impact on performance, while confirmative factor analysis could also help us to identify the links between the different antecedents. However, given the large number of variables, more data is required to allow for this kind of technique.



We measured the performance improvement of the collaborative relationship, not the level of performance. Since hard data on performance is difficult to collect and even more difficult to compare, we decided to ask managers for the perceived performance improvement of the collaborative relationship.

Finally, the cases have been limited to companies in Belgium to avoid cultural differences. Whether the conclusions still hold for collaborative relationships in other regions is unexplored.

## **CONCLUSION**

Four types of collaborative relationships, with a different stage of performance improvement, are identified: stagnant, internally-focused, externally-focused and best-in-class collaborative relationships. The research indicates that collaborative relationships may lead to both internally- and externally-oriented benefits and that collaboration is no guarantee for success.

To improve the performance of the collaborative relationship, four types of capabilities are identified: cumulative capabilities, which help companies to steadily improve supply chain performance, external capabilities, to improve your service towards the partners, internal capabilities, to improve the own costs and efficiencies in the supply chain, and finally, the progressive capabilities to score both high on external and internal benefits. The cumulative capabilities are leadership & business harmony and communication quality. Information sharing, process thinking, accounting practices and IT systems are characterized as progressive capabilities. Finally, information participation is an internal capability while joint conflict resolution techniques is seen as an external capability.

Overall, this leads us to the belief that to improve the performance of a collaborative relationship, partners need to work in a first stage on information quality and the exchange of data, with strong leadership. Furthermore, the partners should believe in the benefits that the relationship will bring for their company. Only in a later stage, supply chain performance will be increased by standardizing the information exchange and the processes to coordinate and measure in the supply chain. Although our data also shows that companies first working on the externally-oriented benefits are perceived as more successful than the ones first working on internally-oriented benefits, in practice we see that most companies are following the least successful path.

## APPENDIX 1

### Definition of supply chain collaboration (Spekman, 1998)

Co-operation	<ul style="list-style-type: none"><li>- Do you have long-term (formal or informal) contracts with your partner?</li><li>- Do you exchange information with your partner?</li></ul>
Co-ordination	<ul style="list-style-type: none"><li>- Do you set up seamless information exchange mechanisms (i.e. in a consistent way)?</li></ul>
Collaboration	<ul style="list-style-type: none"><li>- Is there a certain level of trust and commitment towards the partner?</li><li>- Are some of the processes integrated with your partner?</li><li>- Do you use forms of joint planning with your partner?</li><li>- Do you share some of the technologies with your partner?</li></ul>

## APPENDIX 2

### List of all the theoretical variables of the antecedents in our questionnaire

Item	Statement
trust_a (Monczka, 1998)	Alliance is beneficial voor BU
trust_b	Alliance achieved a balanced agreement
trust_c	Alliance has high level of business harmony
trust_d	Alliance offers significant benefits to both partners
trust_e	Duration expectancy of alliance
interdependence_a (Monczka, 1998)	Alliance can easily be stopped without losses
interdependence_b	Easy to end alliance and start new one
interdependence_c	Time to establish new alliance will be extremely long
interdependence_d	Cost of establishing new alliance would be high
coordination_a (Monczka, 1998)	Each party knows his role
coordination_b	Collaborative practices are planned carefully
coordination_c	Degree of coordination in alliance
clear_expectation_a (based on Mentzer, 2000)	Expected targets are ambitious, but realistic
clear_expectation_b	Expectations are clear for both parties
commitment_a (Monczka, 1998)	Time spent by key personnel in the collaboration
commitment_b	Training provided by partner to understand each other
commitment_c	Financial investments made by partner for the collaboration
commitment_d	Non financial investments made by partner for the collaboration
info_participation_a (Monczka, 1998)	Actively seeking for advice, guidelines and info from partner
info_participation_b	Partner takes part in planning activities and setting aims and goals
info_participation_c	We take part in planning activities, aims and goals of partner
info_participation_d	Actively seeking for proposals or suggestions for improvement from partner
info_participation_e	React appropriately to partner's suggestions
info_sharinging_a (based on Monczka, 1998)	Share confidential info about BU with partner
info_sharing_b	Partner shares info about his BU
info_sharing_c	Inform partner in advance of changes in needs
info_sharing_d	Both parties share all useful info
openness_a (based on Mentzer, 2000)	Both parties keep each other informed of any changes or events that affect them
openness_b	Both parties share info agreed in signed agreements
openness_c	Partner keeps us informed about issues which affect our business
communication_quality_a (Huber et al, 1987)	Communication is on time
communication_quality_b	Communication is exact
communication_quality_c	Communication is appropriate
communication_quality_d	Communication is complete
communication_quality_e	Communication is reliable
supplier_assessment_a (Monczka, 1998)	Process to identify opportunities
supplier_assament_b	Process to evaluate and select suppliers and customers
IT_1	use of planning systems
IT_2	use of info exchange
IT_3	use of databases for collaborative information
conflict_a (Monczka, 1998)	Ignoring the problem or conflict
conflict_b	Persuasion from any of the parties
conflict_c	Joint resolution to the problem
conflict_d	Unilateral imposition
conflict_e	Intervention of an external arbitrator
accounting_a	ABC-system that provides info on activities across SC
accounting_b	Target costing process, extended into partners
accounting_c	Balanced scorecard to measure performance of alliance
accounting_d	Both parties work with open books
accounting_a	Tax issues are considered in setting up alliance
leadership_a (based on McCarter, 2005)	Both partners have strong leaders who believe in SCM
leadership_b	Both partners have real experts in SC transformation and seeking collaboration
leadership_c	Persons working on SC projects are empowered to make changes
leadership_d	Persons working on SC projects have enough knowledge for new initiatives
process_a (based on McCarter, 2005)	SC teams are lead by cross-functional teams
process_b	SC teams consists of members of both parties
process_c	Use of metrics to measure total SC performance
time_investment_a (based on McCarter, 2005)	Clear commitment of resources for SC projects
time_investment_b	Time for training and developing new competencies
time_investment_c	Projects obtain necessary executive support from both companies
change_a (based on McCarter, 2005)	Incentive system based on SC performance
change_b	There is a strong leader in both companies to lead SC changes
change_c	There is common understanding of the degree of change that is needed
change_d	There is a strong drive throughout the organisation to make the alliance work

## APPENDIX 3

### Final factor analysis on the antecedents

#### Collaboration attributes

##### Rotated Component Matrix(a)

	Component							
	1	2	3	4	5	6	7	8
MSA: both partners have real experts in SC transformation and seeking collaboration	,821	,189	,147	-,003	,056	,275	,130	,069
MSA: alliance achieved a balanced agreement	,786	,228	,137	-,043	,411	-,032	,056	-,073
MSA: alliance is beneficial voor BU	,761	,334	,167	-,053	,306	-,024	-,015	,064
MSA: there is a strong leader in both companies to lead SC changes	,738	,258	,202	,102	,178	,138	,277	-,028
MSA: projects obtain necessary executive support from both companies	,726	,088	,134	,022	,055	,353	,376	-,082
MSA: alliance offers significant benefits to both partners	,716	,282	,134	-,066	,370	-,079	,060	-,066
MSA: both partners have strong leaders who believe in SCM	,703	,238	,335	,113	,024	,139	,168	,093
MSA: there is a strong drive throughout the organisation to make the alliance work	,577	,273	,406	,095	,340	,176	,006	,030
MSA: communication is reliable	,265	,834	,263	,108	,133	,065	,031	-,012
MSA: communication is complete	,240	,818	,192	,145	,162	,065	,186	-,009
MSA: communication is exact	,329	,797	,221	,148	,108	,206	,095	-,016
MSA: communication is on time	,203	,781	,376	,034	,156	,186	-,050	-,022
MSA: communication is appropriate	,427	,692	,095	,084	,078	,061	,309	-,065
MSA: partner keeps us informed about issues which affect our business	,241	,279	,717	-,062	,208	,060	,162	,051
MSA: partner takes part in planning activities and setting aims and goals	,251	,185	,709	,277	,084	,156	,032	-,101

MSA: actively seeking for proposals or suggestions for improvement from partner	,042	,298	,684	-,138	,152	,238	,119	,206
MSA: partner shares info about his BU	,381	,225	,667	,137	,258	,128	,165	,005
MSA: share confidential info about BU with partner	,269	,221	,667	,241	-,070	,171	,240	,134
MSA: time to establish new alliance will be extremely long	-,015	,089	,074	,858	,028	-,019	,079	-,053
MSA: alliance can easily be stopped without losses	,051	,015	-,022	-,796	,019	,034	-,012	-,127
MSA: easy to end alliance and start new one	-,136	-,177	,071	-,767	-,110	-,061	-,121	,080
MSA: cost of establishing new alliance would be high	-,028	,067	,218	,746	,067	,058	,002	-,182
MSA: collaborative practices are planned carefully	,391	,252	,119	,044	,753	,065	,218	-,007
MSA: each party knows his role	,351	,003	,091	-,059	,719	,178	,312	,000
MSA: expectations are clear for both parties	,195	,183	,276	,196	,647	,245	,260	-,129
MSA: degree of coordination in alliance	,259	,332	,163	,361	,609	,191	-,135	,109
MSA: use of metrics to measure total SC performance	,092	,250	,045	,033	,117	,794	,023	-,010
MSA: SC teams consists of members of both parties	,105	,035	,258	-,027	,193	,715	,093	,073
MSA: SC teams are lead by cross-functional teams	,349	,080	,383	,096	,021	,619	-,101	-,234
MSA: both parties share all useful info	,248	,125	,285	,160	,168	,025	,757	,005
MSA: both parties keep each other informed of any changed or events that affect	,234	,177	,134	,076	,274	,021	,749	-,124
MSA: time spent by key personnel	,088	-,092	,045	,067	-,176	-,134	-,053	,831
MSA: training provided by partner	-,074	,045	,091	-,215	,154	,104	-,047	,818

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.  
a. Rotation converged in 7 iterations.

*Systems & Processes*

**Rotated Component Matrix(a)**

	Component		
	1	2	3
MSA: ABC-system that provides info on activities across SC	,810	,230	-,112
MSA: incentive system based on SC performance	,736	,010	,322
MSA: target costing process, extended into partners	,672	,358	-,053
MSA: use of metrics to measure total SC performance	,596	-,102	,445
MSA: tax issues are considered in setting up alliance	,520	,099	,149
MSA: balanced scorecard to measure performance of alliance	,519	-,199	,288
process to identify opportunities for SA	,075	,850	,116
process to evaluate and select suppliers for SA	,216	,832	,196
process to evaluate and select customers for SA	-,018	,761	,234
db_collaboration	,073	,140	,778
planning_systems	,119	,246	,765
info_exchange	,273	,280	,623

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.  
a Rotation converged in 7 iterations.

*Conflict Resolution Techniques*

**Rotated Component Matrix(a)**

	Component		
	1	2	3
MSA: joint resolution to the problem	-,871	,067	,108
MSA: ignoring the problem or conflict	,808	,306	,085
MSA: intervention of an external arbitrator	,183	,879	,134
MSA: unilateral imposition	,477	-,525	,505
MSA: persuasion from any of the parties	-,086	,125	,927

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.  
a Rotation converged in 7 iterations.

## Appendix 4 Antecedents of supply chain collaboration, based on factor analysis on our data

Construct	Factor	Item	Crohnbach's alpha	
Communication & Coordination mechanisms	Leadership & Business harmony	Both partners have real experts in SC transformation and seeking collaboration	.938	
		The collaboration achieved a balanced agreement		
		The collaboration is beneficial for BU		
		There is a strong leader in both companies to lead supply chain changes		
		Projects obtain necessary executive support from both companies		
		The collaboration offers significant benefits to both partners		
		Both partners have strong leaders who believe in SCM		
		There is a strong drive throughout the organisation to make the alliance work		
		Communication quality		.941
		Information sharing		communication is reliable
	communication is complete			
	communication is on time			
	communication is appropriate			
	Interdependence	communication is exact	.798	
		Partner keeps us informed about issues which affect our business		
		Partners takes part in planning activities and setting aims and goals		
		Actively seeking for proposals or suggestions for improvement from partner		
		Partner shares info about his BU		
		Share confidential info about BU with partner		
	Coordination	Time to establish new collaboration will be extremely long	.872	
Collaboration can easily stopped without losses				
Easy to end collaboration and start a new one				
Cost of establishing a new collaboration would be high				
Process thinking	Collaborative practices are planned carefully	.805		
	Each party knows his role			
	Expectations are clear for both parties			
	Degree of coordination in the collaborative relationship			
Information participation	SC teams consists of members of both parties	.862		
	SC teams are lead by cross-functional teams			
Systems & Processes	Effort	Both parties share all useful information	.862	
		Both parties keep each other informed of any changes or events that effect them		
	IT applications	Time spent by key personnel	.739	
		Training provided by partner		
	Accounting practices	Planning systems	.754	
		Information exchange systems		
		Databases for collaboration		
		ABC-systems that provide information on processes across the supply chain		
		Target costing processes are extended into partners		
		Tax issues are considered in setting up collaboration		
Partner selection & evaluation	Balanced scorecards to measure the performance of Collaboration	.941		
	Incentive systems are based on supply chain performance			
	Use of metrics to measure supply chain performance			
	Processes to select and evaluate suppliers and customers			
Conflict resolution techniques	Joint conflict resolution	Processes to identify opportunities	.668	
		Joint resolution to the problem		
	3th party conflict resolution	Ignoring the problem or conflict		
		Persuasive conflict resolution		Intervention of an external arbitrator
		Persuasion from any of the parties		

## Appendix 5 First factor analysis on the benefits of collaboration

Rotated Component Matrix(a)

	Component	
	1	2
B1: improve customer service	.835	.276
B2: delivery speed	.831	.265
B3: reduce cycle time	.818	.241
B4: delivery reliability	.792	.353
B5: increase return on assets	.681	.478
B6: reduce inventory	.655	.157
B7: increase flexibility	.642	.525
B8: use of market data in more efficient way	.632	.379
B9: increase speed to market for new products	.595	.439
B10: increase shareholder value	.509	.463
B11: reduce product costs	.243	.828
B12: improve quality	.262	.826
B13: improve quality reliability	.290	.820
B14: reduce process costs	.375	.784
B15: focus more on core competencies	.311	.758
B16: use HR more efficient	.284	.625

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.  
a. Rotation converged in 3 iterations.



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**TABLE 1**

**Characteristics of the surveyed companies**

<p><b>Type of relationship:</b> Customer (30%) / Supplier (70%)</p> <p><b>Age of company:</b> &gt; 10 years (100%)</p> <p><b>Annual sales:</b> &lt; 25 million € (4%) / 26-50 million € (10%) / 51-100 million € (12%) / 101-500 million € (35%) / &gt; 500 million € (39%)</p> <p><b>Number of employees:</b> 51-250 (12%) / 251 -500 (32%) / 501-1000 (19%) / &gt; 1000 (37%)</p> <p><b>Position in the chain:</b> raw material supplier (9%) / assembler (8%) / manufacturer (62%) / others (21%)</p> <p><b>Company's activity:</b> chemical (27%) / consumer goods (9%) / informatics/electronics (9%) / mining and metallurgy (7%) / pharmaceutical (7%) / agriculture (4%) /others (37%)</p> <p><b>Length of the relationship:</b> Median= 9 years, Standard error= 7,64</p>
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**TABLE 2**

**Correlation matrix**

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Leadership & Business harmony	4.79	1.47	1													
2. Communication quality	5.01	1.41	.64*	1												
3. Information sharing	4.63	1.37	.66*	.61*	1											
4. Interdependence	4.21	1.54	.11	.22	.26*	1										
5. Coordination	5.03	1.33	.69*	.52*	.56*	.19	1									
6. Process thinking	4.35	1.76	.49*	.37*	.56*	.07	.45*	1								
7. Information participation	5.81	1.12	.58*	.39*	.56*	.20	.60*	.25*	1							
8. Effort	4.34	1.19	.03	.01	.08	-.11	-.00	-.02	-.07	1						
9. Partner selection and evaluation	4.63	1.35	-.06	-.13	.10	-.20	-.05	.09	.17	.082	1					
10. IT applications	2.72	1.62	.27*	.21	.26*	.31*	.12	.33*	.15	.06	.18	1				
11. Accounting practices	3.40	1.38	.41*	.27*	.45*	.15	.36*	.54*	.39*	.13	.09	.37*	1			
12. Persuasive conflict resolution	4.09	1.38	.06	-.05	-.15	.05	-.05	-.12	-.12	.09	-.31*	.067	.06	1		
13. 3rd party conflict resolution	1.46	0.89	-.01	-.24*	.13	-.04	.03	.26*	-.01	.02	.09	.02	.14	.09	1	
14. Joint conflict resolution	5.84	1.08	.45*	.49*	.42*	.01	.46	.23*	.45*	-.11	.15	.21	.27*	-.20	-.17	1

\* significantly different from 0 at  $p < .01$  (one-tailed)



**TABLE 3**

**Final Rotated Component Matrix of the benefits of collaboration**

	Component	
	1= internally-oriented supply chain benefits	2= externally-oriented supply chain benefits
B11: reduce product costs	.901	.157
B14: reduce process costs	.858	.331
B16: Use HR more efficient	.730	.258
B15: focus more on core competencies	.715	.387
B2: delivery speed	.248	.891
B1: improve customer service	.259	.887
B4: delivery reliability	.352	.839

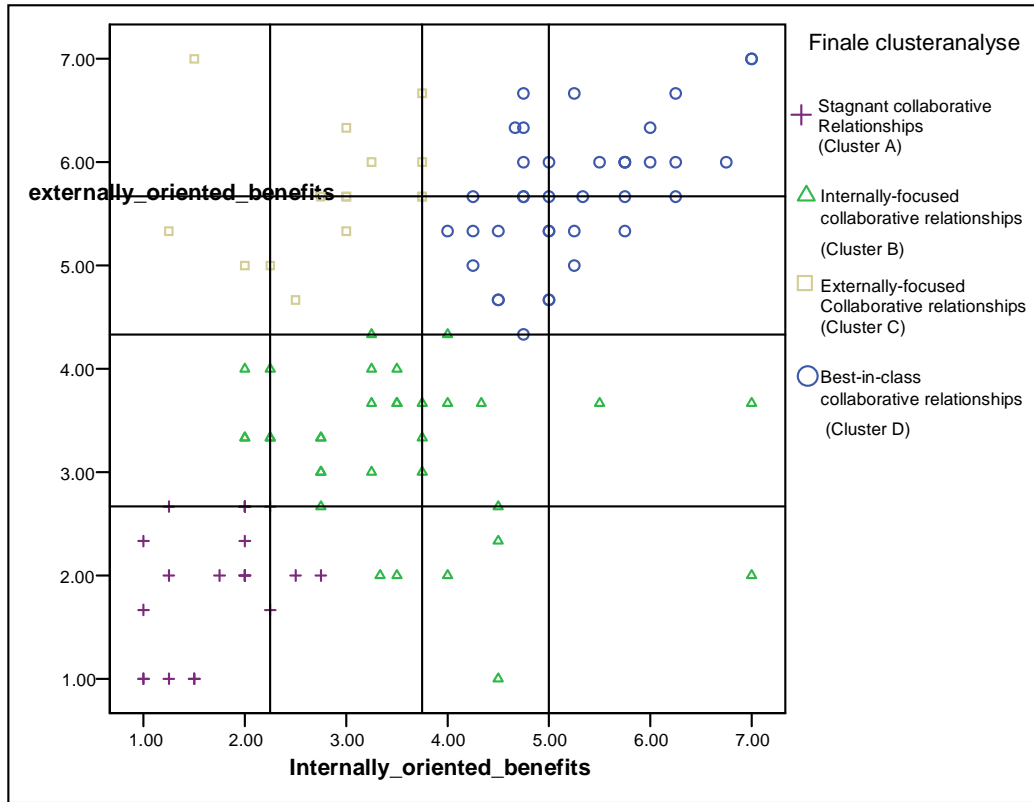
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.  
a. Rotation converged in 3 iterations.

**TABLE 4****Perception of success of each of the clusters**

		Cluster Number of Case				Total
Success of relationship		A	B	C	D	
Success	Count	2 (9%)	10 (34%)	12 (75%)	32 (82%)	56
	Expected Count	12.037	15.18	8.37	20.41	56
No Success	Count	21 (91%)	19 (66%)	4 (25%)	7 (18%)	51
	Expected Count	10.93	13.82	7.63	18.59	51
Total	Count	23 (100%)	29 (100%)	16(100%)	39 (100%)	107
	Expected Count	23	29	16	39	107

FIGURE 1

Supply Chain performance improvement



**TABLE 5****Supply Chain Performance improvement clusters**

	Cluster A Stagnant collaborative relationship	Cluster B Internally- focused collaborative relationship	Cluster C Externally- focused collaborative relationship	Cluster D Best-in-class collaborative relationship	F-test	p-level
Number of cases	23	29	16	39		
Internally- oriented benefit						
<i>Mean</i>	1.75	3.48	2.91	5.35	76.121	0.000
<i>Standard Error</i>	0.11	0.18	0.21	0.13		
Externally- oriented benefit						
<i>Mean</i>	2.04	3.17	5.69	5.62	186.076	0.000
<i>Standard Error</i>	0.15	0.15	0.15	0.13		

**TABLE 6****Analysis of external variance on clusters**

	p-level
Position in the supply chain	0.174
Company's activity	0.739
Annual sales	0.393
Number of employees	0.420
Type of relationship	0.057
Length of the relationship	0.815
Age of the company	1.000

**TABLE 7****Median test on the type of relationship**

Type of relationship		Cluster Number of Case				Total
		A	B	C	D	
customer	Count	11	7	9	6	33
	Expected Count	7.16	9.03	4.98	11.83	33
supplier	Count	12	22	7	32	73
	Expected Count	15.84	19.97	11.02	26.17	73
Total	Count	23	29	16	38	106
	Expected Count	23	29	16	38	106

**TABLE 8**

**Differences in the antecedents of collaboration for the different clusters**

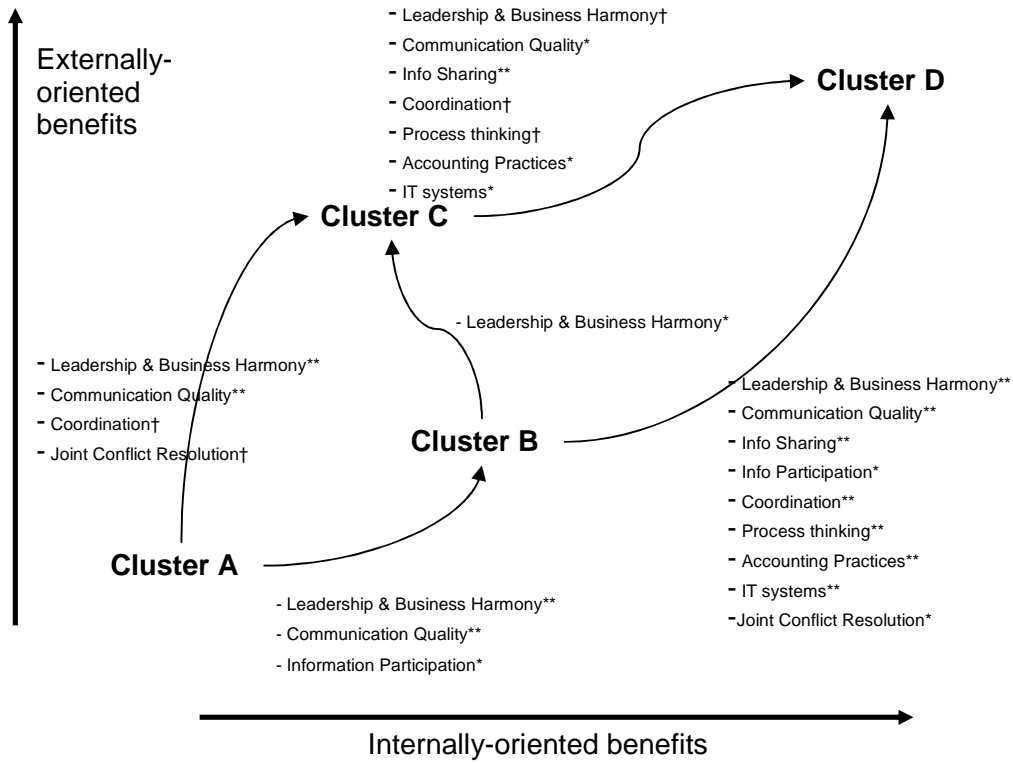
Variable	Mean / Median				Difference between clusters
	A	B	C	D	
<i>Leadership &amp; Business harmony</i>					
Cluster mean	3.34	4.41	5.15	5.73	<i>A&lt;B**/ A&lt;C** /A&lt;D** /B&lt;C* /B&lt;D** /C&lt;D<sup>†</sup></i>
Standard error	0.3	0.24	0.26	0.15	<i>F = 21.63 ; p &lt; 0.05</i>
<i>Interdependence</i>					
Cluster mean	3.94	4.34	3.85	4.44	Not Significant
Standard error	0.35	0.29	0.32	0.25	<i>F = 0.856 ; p &gt; 0.05</i>
<i>Coordination</i>					
Cluster mean	4.1	4.59	5.23	5.77	<i>A&lt;B<sup>n.s.</sup> / A&lt;C<sup>n.s.</sup> /A&lt;D** /B&lt;C<sup>n.s.</sup> /B&lt;D** /C&lt;D<sup>n.s.</sup></i>
Standard error	0.34	0.21	0.24	0.14	<i>F = 11.742 ; p &lt; 0.05</i>
<i>Process thinking</i>					
Cluster mean	3.96	3.69	4.31	5.03	<i>A&lt;B<sup>n.s.</sup> / A&lt;C<sup>n.s.</sup> /A&lt;D* /B&lt;C<sup>n.s.</sup> /B&lt;D** /C&lt;D<sup>n.s.</sup></i>
Standard error	0.41	0.31	0.36	0.25	<i>F = 4.042 ; p &lt; 0.05</i>
<i>Effort</i>					
Cluster mean	4.02	4.46	4.22	4.42	Not significant
Standard error	0.26	0.24	0.25	0.19	<i>F = 0.736 ; p &gt; 0.05</i>
<i>Communication quality</i>					
Cluster median	3.6	4.4	5.4	6	<i>A&lt;B**/ A&lt;C<sup>†</sup> /A&lt;D** /B&lt;C<sup>n.s.</sup> /B&lt;D** /C&lt;D*</i>
					<i>Chi-square = 31.132 ; p &lt; 0.05</i>
<i>Information sharing</i>					
Cluster mean	3.71	4.21	4.3	5.6	<i>A&lt;B<sup>n.s.</sup> / A&lt;C<sup>n.s.</sup> /A&lt;D** /B&lt;C<sup>n.s.</sup> /B&lt;D** /C&lt;D**</i>
Standard error	0.29	0.22	0.3	0.15	<i>F = 15.707 ; p &lt; 0.05</i>
<i>Information participation</i>					
Cluster median	5	6	5.5	6	<i>A&lt;B** / A&lt;C* /A&lt;D** /B&lt;C<sup>n.s.</sup> /B&lt;D<sup>n.s.</sup> /C&lt;D<sup>n.s.</sup></i>
					<i>Chi-square = 14.951 ; p &lt; 0.05</i>
<i>Accounting practices</i>					
Cluster mean	2.55	3.13	3.05	4.19	<i>A&lt;B<sup>†</sup> / A&lt;C<sup>n.s.</sup> /A&lt;D** /B&lt;C<sup>n.s.</sup> /B&lt;D** /C&lt;D**</i>
Standard error	0.24	0.23	0.33	0.19	<i>F = 9.929 ; p &lt; 0.05</i>
<i>IT applications</i>					
Cluster mean	2.49	2.16	2.37	3.44	<i>A&lt;B<sup>n.s.</sup> / A&lt;C<sup>n.s.</sup> /A&lt;D* /B&lt;C<sup>n.s.</sup> /B&lt;D** /C&lt;D*</i>
Standard error	0.41	0.23	0.27	0.27	<i>F = 4.432 ; p &lt; 0.05</i>
<i>Process selection and evaluation</i>					
Cluster median	4.5	5	4	5	<i>Not Significant</i>
					<i>Chi-square = 4.214 ; p &gt; 0.05</i>
<i>Joint conflict resolution techniques</i>					
Cluster median	5.5	5.5	6	6.5	<i>A&lt;B<sup>n.s.</sup> / A&lt;C* /A&lt;D** /B&lt;C<sup>n.s.</sup> /B&lt;D* /C&lt;D<sup>n.s.</sup></i>
					<i>Chi-square = 12.07 ; p &lt; 0.05</i>
<i>3rd party conflict resolution techniques</i>					
Cluster median	1	1	1	1	<i>Not Significant</i>
					<i>Chi-square = 1.363 ; p &gt; 0.05</i>
<i>Persuasive conflict resolution techniques</i>					
Cluster median	2	1	2	1	<i>Not Significant</i>
					<i>Chi-square = 6.073 ; p &gt; 0.05</i>

Notes. Variables for which the assumption of normality is rejected are in italic. For those variables, the median value is mentioned (in italic). For the other variables, the mean value is mentioned.

\*\*Significant at p < 1%, \* significant at p < 5%, <sup>†</sup> significant at < 10%

**FIGURE 2**

**A roadmap of 4 clusters of supply chain performance improvement**



Cluster A = Stagnant collaborative relationship, Cluster B = Internally-focused collaborative relationship, C = Externally-focused collaborative relationship, D = Best-in-class collaborative relationship

\*\* Significant at  $p < 1\%$ , \* significant  $t p < 5\%$ , † significant at  $< 10\%$