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## Perceptions of Technology Uncertainty and the Consequences for Performance in Buyer-Supplier Relationships

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In this paper, we investigate how buyers' and suppliers' distinct perceptions of technology uncertainty affect the relationship between communication frequency, supplier performance. Information processing theory suggests that a fit is desirable between perceived environmental uncertainty and the communication processes between organizations. However, if partners in a buyer-supplier relationship do not concur on the high level of technology uncertainty, it is highly questionable whether increased communication will be effective in increasing supplier performance. Using dyadic data from 86 buyer-supplier relationships, involving 388 respondents, we found that communication frequency was positively related to supplier performance and buyers' goodwill trust only when both suppliers and buyers perceived high levels of technology uncertainty. When buyers perceived greater technology uncertainty than their suppliers, communication frequency was negatively related to supplier performance. The findings in this study show that it is important to take the distinct perceptions of buyers and suppliers of technology uncertainty into account when assessing the effects of communication frequency. It appears that increased communication is only effective when both parties acknowledge the need to communicate, and can be unfavourable when only one party sees the benefits of it.

Keywords: Buyer-supplier relationships, technology uncertainty, perceptions, survey, regression.

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## Perceptions of Technology Uncertainty and the Consequences for Performance in Buyer-Supplier Relationships

In this paper, we investigate how buyers' and suppliers' distinct perceptions of technology uncertainty affect the relationship between communication frequency and supplier performance. Information processing theory suggests that a fit is desirable between perceived environmental uncertainty and the communication processes between organisations. However, if partners in a buyer-supplier relationship do not concur on there being a high level of technology uncertainty, it is highly questionable whether increased communication will be effective in increasing supplier performance. Using dyadic data involving 388 respondents from 86 buyer-supplier relationships, we found that communication frequency was positively related to supplier performance, but only when both suppliers and buyers perceive there to be high levels of technology uncertainty. When buyers perceived greater technology uncertainty than their suppliers, communication frequency was negatively related to supplier performance. The findings from this study show that it is important to take the distinct perceptions of buyers and suppliers on technology uncertainty into account when assessing the effects of communication frequency. It appears that increased communication is only effective when both parties acknowledge the need to communicate, and can even be unfavourable when only one party sees the benefits of it.

Keywords: Buyer-supplier relationships, technology uncertainty, perceptions, survey, regression.

### 1. Introduction

It is generally believed that frequent communications between buyers and suppliers enable suppliers to realise improvements linked to specific relationship goals and so to enhance their performance (e.g. Chen & Paulraj, 2004a; Modi & Mabert, 2007; Paulraj Lado & Chen, 2007; Prahinski & Benton, 2004). This view has had partially empirical support, with results suggesting that contingent variables play a moderating role in the relationship between communication frequency and supplier performance (Fynes, De Búrca & Marshall, 2004; Fynes, De Búrca & Voss, 2005; Noordewier, John & Nevin, 1990; Prahinski & Benton, 2004). An important contingent variable is the technological environment in which the suppliers operate since this can greatly influence the need for communication between buyers and suppliers. When the products that a supplier delivers are characterised by constantly changing technologies, and especially when these changes are unpredictable, decision-making and coordination in a relationship become more difficult. In this situation, parties in a relationship will want to communicate because they experience technology uncertainty (e.g. Fynes, De Búrca & Marshall, 2004; Noordewier, John & Nevin, 1990; Walker & Weber, 1984). Conversely, when the technological environment of suppliers is stable and predictable, buyers and suppliers will have much less need or incentive to communicate because the perceived technology uncertainty is low. This argument

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3 is based on information processing theory, which suggests that a fit is desirable between  
4 perceived environmental uncertainty and the communication processes in organisations  
5 (Galbraith, 1973; Tushman & Nadler, 1978).  
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9 Supplier performance may thus be expected to increase when there is a fit between the  
10 frequency of communication between buyers and suppliers and the extent of the technology  
11 uncertainty confronting suppliers. Earlier research has investigated the idea that significant  
12 technology uncertainty requires frequent communication in order to perform successfully,  
13 although the results of these studies have been mixed (e.g. Fynes et al., 2004; Fynes et al., 2005;  
14 Noordewier et al., 1990). A basic explanation for these mixed results may be that buyers and  
15 suppliers have generally been assumed to react similarly to technology uncertainty whereas  
16 several studies have shown that, particularly when it comes to technology uncertainty, the  
17 perceptions of buyers and suppliers are likely to diverge (Heide & John, 1990; Atuahene-Gima &  
18 Li, 2004; Oosterhuis, Molleman & Van der Vaart, 2007). Not only do buyers and suppliers  
19 experience differing levels of technology uncertainty, they are also likely to react differently to  
20 technology uncertainty (Jap, 1999).  
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30 In this paper, we emphasise the importance of studying the distinct perceptions of  
31 technology uncertainty by suppliers and buyers. Although it is reasonable to expect suppliers to  
32 have the most comprehensive view of technological developments in their industry (Oosterhuis et  
33 al., 2007), the perceptions of their buyers may also play a crucial role. When suppliers perceive a  
34 large level of technology uncertainty related to the products they deliver, they will want to  
35 communicate with their buyers in order to enhance their own performance. However, if a buyer  
36 does not concur that there is a high level of technology uncertainty, it is highly questionable  
37 whether increased communication will be effective in increasing supplier performance. Earlier  
38 studies have indicated that parties need, in general, to share a similar understanding of the matters  
39 they communicate about in order for communication to be effective (Gelfand, Kuhn &  
40 Radhakrishnan, 1996; Padgett & Wolosin, 1980; Triandis, 1959). That is, only when both the  
41 supplier and the buyer perceive a high level of technology uncertainty in the supplier's industry  
42 will frequent communication be effective in enhancing supplier performance.  
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53 We start this paper by describing the moderating effect of a supplier's perception of  
54 technology uncertainty on the relationship between communication frequency and supplier  
55 performance. Then, we extend the argument with the idea that increased communication will only  
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3 be effective when not only the supplier, but also the buyer, perceives there to be significant  
4 technology uncertainty. Following this line of reasoning, we propose a three-way interaction  
5 among supplier's perception of technology uncertainty, buyer's perception of technology  
6 uncertainty and communication frequency regarding supplier performance. We test the resulting  
7 hypotheses with dyadic data from 388 respondents involved in 86 buyer-supplier relationships.  
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## 13 14 15 **2. Theory**

### 16 17 18 *2.1 Technology uncertainty and communication frequency*

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20 Technology uncertainty reflects the perceived speed of technological change in a firm's industry.  
21 It concerns changes in the standards or specifications of products and can be characterised by  
22 rapid process obsolescence (Geyskens, Steenkamp & Kumar, 2006; Heide & John, 1990; Walker  
23 & Weber, 1984). In this paper, we focus on technology uncertainty as it relates to the products a  
24 supplier delivers to a specific buyer. Further, we focus on perceived, rather than objective,  
25 technological change since managers inherently act upon what they perceive to be the reality  
26 (Daft, 1992; Weick, 1979). Suppliers will adjust their activities to the technology uncertainty they  
27 experience and, consequently, supplier performance will be significantly influenced by their  
28 perceptions of their technological environment and how they cope with these.  
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36 If technology uncertainty is perceived as high, suppliers will feel a need to adapt their  
37 products and processes to the developments in their industry. Information processing theory  
38 suggests that suppliers will want to communicate with their buyers as part of coping with the  
39 technology uncertainty they perceive (Fynes et al., 2004; Galbraith, 1973; Stock & Tatikonda,  
40 2007; Tushman & Nadler, 1978). Discussions with buyers will aid suppliers in exploring how to  
41 adapt their products and processes in such a way that they continue to address the specific  
42 demands for their products (Jap, 1999). Therefore, when suppliers perceive great technology  
43 uncertainty, they will want to communicate more frequently with their buyers in order to ensure  
44 they continue to deliver products that satisfy their buyers' needs and so improve their  
45 performance.  
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53 Conversely, when suppliers perceive little technology uncertainty, they will feel little  
54 need to communicate with their buyers. The technology of the products they deliver to their  
55 buyers is stable, and their production processes hardly need to change. In this situation, little  
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3 information on how best to revise their products and processes is required. Frequent  
4 communication may even be seen as distractive. Therefore, in such circumstances, supplier  
5 performance will not be enhanced by frequent communication about technical changes,  
6 innovation and the like.  
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10 Summarising, the general expectation is that, under conditions of high levels of perceived  
11 technology uncertainty, communication frequency will be positively related to supplier  
12 performance, whereas under conditions of low perceived technology uncertainty, communication  
13 frequency will be unrelated to supplier performance (e.g. Fynes et al., 2004; Stock & Tatikonda,  
14 2007; Tushman & Nadler, 1978). This leads to:  
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20 Hypothesis 1: Technology uncertainty, as perceived by the supplier, will moderate the  
21 relationship between communication frequency and supplier performance. If perceived  
22 technology uncertainty is high, there will be a positive relationship between communication  
23 frequency and supplier performance, whereas this relationship will be absent if perceived  
24 technology uncertainty is low.  
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## 30 31 32 **2.2 Perceptual congruence**

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34 In the discussion above, we have argued that suppliers feel the need to communicate with their  
35 buyers when they experience significant technology uncertainty in order to help them improve  
36 their performance. However, we question whether increased communication will always be  
37 effective when suppliers perceive such technology uncertainty because buyers may perceive  
38 different levels of technology uncertainty. Past research suggests that each individual  
39 organisation uniquely perceives, interprets and evaluates the technological environment (Daft &  
40 Weick, 1984; Daft, 1992; Weick, 1979). Further, buyers and suppliers naturally hold distinct  
41 positions in a dyad, and this can also cause them to perceive technology uncertainty differently  
42 (e.g. Dougherty, 1992). Moreover, since technological change is difficult to assess, technology  
43 uncertainty is more likely to engender divergent perceptions than other forms of environmental  
44 uncertainty (Atuahene-Gima & Li, 2004). Studies by Heide and John (1990) and Oosterhuis et al.  
45 (2007) showed, empirically, that buyers and suppliers in a dyad do indeed perceive different  
46 levels of technology uncertainty.  
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3 When partners in a relationship perceive different degrees of technology uncertainty in  
4 the supplier's industry, it is highly questionable whether frequent communication will be  
5 effective. There is ample evidence that a difference in the way people perceive things is related to  
6 lower communication quality and lower communication effectiveness in their interactions  
7 (Gelfand et al., 1996; Padgett & Wolosin, 1980; Triandis, 1959). For communication to be  
8 effective, parties need to feel that they share a common understanding of the matters they  
9 communicate about (Padgett & Wolosin, 1980; Ring & Van de Ven, 1994). This is consistent  
10 with work by Dougherty (1992) which indicated that perceptual differences caused by different  
11 positions in an organisation hindered parties in sharing and discussing information on  
12 technological developments in their common environment. What people perceived seemed  
13 critical to them, while what they did not see did not seem to be particularly noteworthy. When  
14 one party wanted to discuss matters that looked trivial to another partner, frequent  
15 communication was unlikely to generate positive outcomes since the partners did not share  
16 common concerns.  
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28 We thus expect increased communication to only be effective when both parties in a  
29 relationship perceive similarly high levels of technology uncertainty. In the next section, we  
30 develop hypotheses that predict the relationship between communication frequency and supplier  
31 performance for various combinations of buyer and supplier perceptions of technology  
32 uncertainty.  
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### 40 ***2.3 Combined effects of supplier perceived technology uncertainty, buyer perceived technology*** 41 ***uncertainty and communication frequency on supplier performance***

42 Consistent with information-processing theory, we have argued that suppliers will perform well  
43 when the degree of technology uncertainty they perceive matches the frequency with which they  
44 communicate with their buyers. However, we expect an increased level of communication to only  
45 be effective when not only suppliers but also buyers perceive significant technology uncertainty.  
46 When buyers agree with their suppliers that technology uncertainty is high, frequent  
47 communications about technological developments are likely to facilitate suppliers in managing  
48 the complexities that evolve from these developments. Thus, in a situation where buyers perceive  
49 the same high levels of technology uncertainty as their suppliers, increased communication will  
50 help the suppliers to explore how they should adapt their products and processes to reflect the  
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3 developments in their environment. Therefore, it is likely that frequent communication in such a  
4 situation will be effective in dealing with the perceived uncertainty, and this will result in  
5 enhanced supplier performance.  
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9 However, in a situation where the supplier perceives extensive technology uncertainty  
10 whereas the buyer perceives little technology uncertainty, we would expect frequent  
11 communication to add little to supplier performance. Here, increased communication about  
12 technical adaptations and innovation has little purpose since the buyer does not perceive there to  
13 be significant technology uncertainty that warrants discussion. Buyers, in such a situation, will  
14 offer little as sparring partners since they do not recognise the supplier's concerns and can offer  
15 little in the way of additional insights (e.g. Dougherty, 1992). Since frequent communication will  
16 not help a supplier in dealing with the uncertainty, it will not increase their performance. Thus,  
17 we argue that communication frequency and supplier performance are not related when only the  
18 supplier perceives there to be significant technology uncertainty.  
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26 Finally, we have already argued that communication frequency will not be positively  
27 related to supplier performance when suppliers experience little technology uncertainty. In  
28 essence, since suppliers are not confronted with a level of uncertainty that needs to be reduced,  
29 their performance will gain little from increased communication. Frequent communication is  
30 simply not needed in this situation because the supplier is not facing uncertainty. Even if the  
31 buyer perceives there to be significant technology uncertainty while the supplier does not,  
32 increased communication will not increase supplier performance since the supplier does not share  
33 the same concerns as the buyer. Increased communication in such a situation will not be effective  
34 since buyers and suppliers do not share similar perceptions. We therefore expect that, when  
35 suppliers perceive little technology uncertainty, communication frequency and supplier  
36 performance will not be related, regardless of buyers' perceptions.  
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46 Based on these arguments, we propose a refinement to Hypothesis 1:  
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49 Hypothesis 2: Communication frequency will only be positively related to supplier  
50 performance when both the supplier and the buyer perceive high levels of technology uncertainty.  
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54 The hypothesised relationships between the various aspects are illustrated in Figure 1.  
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### 3. Method

#### *3.1 Sampling and procedures*

The data used to test the hypotheses were collected in three phases. In Phase 1, we identified an initial group of Dutch firms manufacturing discrete products (i.e. SIC codes 33 to 38). From this group, we selected 1000 firms, each with a minimum of 50 employees. In Phase 2, purchasing managers from the selected organisations were phoned to ask if they would be interested in receiving information about the research project. If interested, the purchasing managers were asked to recommend the research project to a selected supplier, and to provide us with contact information of their contact person at the supplying organisation. Furthermore, they were asked to identify the three people within their own organization who interacted most with this supplier. In Phase 3, we mailed questionnaires to each of the three identified respondents at the buying organisations and similarly to three identified respondents at the manufacturing firm's supplier. In total, 101 buying firms (10.1%) and 89 suppliers (88.1%) agreed to participate. We received completed questionnaires from 388 people at these 190 companies (a 68.1% response rate): 226 from buyer companies (75.0%) and 162 from supplier companies (60.7%). We received questionnaires from at least one buyer and one supplier in 86 relationships (8.6% of the original 1000 companies). The number of relationships for each possible combination of individual buyer/supplier respondents is presented in Table 1. Table 2 presents an overview of the respondents' job titles.

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Insert Table 1 about here

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### 3.2 Measures

The relationship between a buying company and a supplying company formed the unit of analysis in our study. There were three steps in developing our questionnaires. First, we prepared two draft questionnaires, one for buyers and one for suppliers, using established scales that measured the constructs of interest. We then asked nine purchasing managers and five sales managers to evaluate the scale items in the relevant questionnaire: for content, meaningfulness and readability. The feedback we received led us to add one new item and modify the wording of some others. Next, we asked eight academic experts from the fields of Operations Management and Organisational Behaviour to comment on the content and clarity of the items. Based on their remarks, we further refined the scale items to create the final survey instruments.

The measurement scales are now described in some detail. Table 3 presents the scale items, and the results of a confirmatory factor analysis.

*Technology uncertainty* was measured using a five-point scale adapted from Chen and Paulraj (2004b). Respondents were asked to indicate the extent to which technology uncertainty existed in the industry of the delivered products (1: “to a limited extent”, through to 5: “to a large extent”). The technology uncertainty as perceived by a purchasing company was measured as the mean of all the buyer responses from that firm. Similarly, supplier perceived technology uncertainty was calculated as the mean of all the supplier responses from an individual firm on that issue.

To measure *communication frequency*, we asked respondents from both sides to indicate the frequency with which their company had communicated with their partner about technical adaptations and innovations to the delivered parts and about adaptations to the supplier’s production process, during the past year, using a scale ranging from 1 (never) to 6 (daily). The overall mean of both supplier and buyer responses was used to assess the communication frequency within a relationship.

*Supplier performance* was assessed with measurement scales adapted from Johnston et al. (2004) and Chen and Paulraj (2004b). *Buyers* were asked to indicate, for five performance indicators, to what extent their supplier had improved over the past year. Responses were to be given using a five-point scale ranging from 1: “not at all”, to 5: “very much”. Overall supplier performance was again measured as the mean of all the individual responses from a buying firm.

### 3.3 Non-response bias

A common concern in dyadic data gathering is the rather low response rates, and our study was not immune from this. We assessed the possibility of non-response bias in two ways. First, we conducted tests that compared early and late responses, on the assumption that the opinions of the late respondents were more likely to be representative of the views of non-respondents (Armstrong and Overton, 1977). We split the individual informants into two groups: those that responded directly and those that only responded after follow-up emails and telephone calls, and compared the responses of these two groups on all the key variables using a t-test. The t-tests did not show any significant differences between the two groups, from which we argue that the non-respondents are unlikely to have different views to the respondents. Second, we compared our final sample of 101 buying firms, in terms of industry type and number of employees, to the 899 firms that had not responded to our approaches. T-tests indicated that our final sample was representative of the original list of potential companies. Combined, these findings suggest that non-response bias is unlikely to be a serious problem in our study.

## 4. Results

### 4.1 Preliminary analyses

*Confirmatory factor analyses.* The questionnaire used multi-item scales to assess the various constructs. Confirmatory factor analyses (CFA) were used to estimate a measurement model composed of two first-order latent factors for suppliers, and a measurement model composed of four first-order latent factors for buyers. The models were estimated from the scores of individual informants using the maximum likelihood (ML) method in LISREL 8.51. One item was removed from the technology uncertainty as perceived by suppliers scale and one from the technology uncertainty as perceived by buyers scale as these items did not seem to reflect their respective latent factors with poor loadings and high standardised residuals.

The chi-square value for the suppliers' measurement model is 27.75 ( $df = 13, p < .01$ ), and for the buyers' model 120.76 ( $df = 84, p < .01$ ). Since the chi-square test is known to be sensitive to sample size (e.g. Hair, Anderson, Tatham & Black, 1998), we used four additional fit indexes: the goodness of fit index (GFI), the adjusted goodness of fit index (AGFI), the Tucker-Lewis index (TLI), and the root mean squared error of approximation (RMSEA). Guidelines on

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3 values for these indices that indicate a satisfactory fit are: .90 or above for the GFI, AGFI and  
4 TLI; and .08 or less for RMSEA. Values calculated for our measurement models satisfied all  
5 these criteria: GFI = .95, AGFI = .90, TLI = .92 and RMSEA = .084 for suppliers, and GFI = .93,  
6 AGFI = .90, TLI = .95 and RMSEA = .044 for buyers.  
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10 We next examined the CFA results for convergent validity, discriminant validity and  
11 reliability. The factor loading for each indicator onto its corresponding construct was significant  
12 at the .001 level and exceeded the critical value of .40, indicating that the constructs were  
13 appropriately reflected by their indicators (convergent validity). We assessed discriminant  
14 validity by comparing the average variance extracted (AVE) to the squared correlations between  
15 the constructs. In all cases, the squared correlations between constructs did not exceed the AVE,  
16 which is an indication that the constructs have discriminant validity. Additionally, we checked to  
17 ensure that the confidence interval ( $\pm$  twice the standard error) for each pairwise correlation did  
18 not include the value 1.0. Since none of them did, all the constructs also satisfied this criterion for  
19 discriminant validity. Finally, we examined composite reliability by calculating the Cronbach's  
20 alphas for our measures. They were all very close to, or above, the recommended level of .70 (see  
21 Table 3). Thus, to sum up, the analyses provided reasonable evidence that the measurement  
22 models were satisfactory in terms of convergent validity, discriminant validity and reliability.  
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42 *Interrater agreement and data aggregation.* As noted earlier, our sample included a maximum of  
43 three informants from each organisation, and we assumed that an informant's ratings would  
44 reflect views shared within their organisation. If this assumption is valid, we would expect the  
45 ratings from different informants within the same organisation to be similar. We tested this  
46 expectation using the average interrater agreement coefficient, rwg (James, Demaree & Wolf,  
47 1984). The scores of the informants from a single organisation were deemed to be sufficiently  
48 consistent, and subsequently averaged, when the mean rwg was .70 or above (James, Demaree,  
49 and Wolf, 1984; Klein and Kozlowski, 2000). On this basis, only one relationship was excluded  
50 from further analysis because the informants from one organisation showed too little consensus.  
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5 *Control variables.* We tested whether industry type, power, relationship length, distance between  
6 companies, number of employees at the buying company and number of employees at the  
7 supplying company had any effect on the results of our study. We used the SIC codes of  
8 participating firms as a basis on which to test whether industry type had any influence on the  
9 outcome of our study. A MANOVA test of SIC codes and supplier performance showed no  
10 significant association ( $F = 1.92, p = .09$ ). Further, we used the difference score between buyer  
11 dependence and supplier dependence to measure power (e.g. Kumar et al., 1995) and to test  
12 whether power affected the results of our study. We looked at the correlation between power and  
13 supplier performance and found that power was not related to supplier performance ( $r = .012, p =$   
14  $.91$ ). Further, correlations between supplier performance and relationship length ( $r = -.084, p =$   
15  $.42$ ), distance between companies ( $r = -.075, p = .47$ ), number of employees at the buying  
16 company ( $r = .19, p = .07$ ) and number of employees at the supplying company ( $r = -.08, p = .48$ )  
17 were not significant. We thus conclude that these control variables did not affect the results of our  
18 study and, accordingly, that there is no reason to suppose that our results cannot be generalised to  
19 manufacturing dyads in general. We further decided not to include these factors as control  
20 variables in our analyses since this could lead to Type II errors (Becker, 2005) and because we  
21 wanted to avoid a loss of power.  
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37 *Descriptive statistics.* The means, the standard deviations and the Pearson correlations between  
38 the variables are presented in Table 4. The means indicate that, on the whole, suppliers perceive  
39 greater technology uncertainty than buyers. A paired sample t-test showed that this difference in  
40 means was statistically significant ( $t = 2.49, p < .05$ ). Further, the correlation between supplier  
41 perceived technology uncertainty and buyer perceived technology uncertainty is low ( $r = .02,$   
42 n.s.), which is similar to findings by Heide and John (1990). Further, the correlations between  
43 supplier perceived technology uncertainty and communication frequency ( $r = .36, p < .001$ ), and  
44 between buyer perceived technology uncertainty and communication frequency ( $r = .21, p < .05$ )  
45 are both positive and significant.  
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#### 4.2 Testing the Hypotheses

We used moderated regression analyses to test the hypotheses. To facilitate interpretation and minimise multicollinearity problems when testing moderated relationships, standardised predictors are used (Aiken & West, 1991). Further, the variance inflation factors associated with each of the regression coefficients ranged from 1.06 to 1.82, suggesting that multicollinearity was unlikely to be a serious problem. For each of the regression equations reported below, we checked the underlying model assumptions. Through comparing the standardised residuals with the predicted values, we were able to detect two outliers (beyond three standard deviations) and these outliers were excluded from the regression analyses reported below. Table 5 summarises the results of the hierarchical regression analyses.

Hypothesis 1 predicts a two-way interaction between communication frequency and supplier perceived technology uncertainty on supplier performance such that when the supplier perceives a high technology uncertainty, communication frequency will be positively related with supplier performance. After adding, in Step 1, the main effects of communication frequency and supplier perceived technology uncertainty, Step 2 indicated that supplier perceived technology uncertainty did *not* moderate the relationship between communication frequency and supplier performance ( $b = .09$ , n.s.). As such, Hypothesis 1 is not confirmed.

However, the three-way interaction considered in Step 3 casts a different light on the lack of a two-way interaction effect between supplier perceived technology uncertainty and communication frequency. Here, we found that supplier perceived technology uncertainty and buyer perceived technology uncertainty *jointly* moderate the relationship between communication frequency and supplier performance ( $b = .24$ ,  $p < .01$ ). To further analyse these interaction effects, the regression equations were restructured into simple regressions of supplier performance onto communication frequency, with given conditional values for buyer perceived technology uncertainty (M+1SD; M-1SD) and for supplier perceived technology uncertainty (M+1SD; M-1SD) (cf. Aiken & West, 1991). Supporting Hypothesis 2, we then found that communication frequency is only positively related to supplier performance when both supplier perceived technology uncertainty and buyer perceived technology uncertainty are high (simple slope test:  $b = .23$ ,  $p < .10$ ), see also Figure 3b.

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3 In a situation where the technology uncertainty perceived by the supplier is high and by  
4 the buyer low, communication frequency and supplier performance are not significantly related  
5 (Figure 3a; simple slope test:  $b = -.21$ , n.s.). Similarly, Figure 3a further shows that when both the  
6 supplier and the buyer perceive the technology uncertainty to be low, communication frequency  
7 and supplier performance are again not significantly related (simple slope test:  $b = -.04$ , n.s.).  
8 These findings are in line with our expectations. However, we also found that when the supplier  
9 perceives a low technology uncertainty but the buyer's perceived technology uncertainty is high  
10 that communication frequency is negatively related to supplier performance (simple slope test:  $b$   
11  $= -.57$ ,  $p < .01$ ). This finding is inconsistent with Hypothesis 2.  
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Insert Table 5 about here  
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Insert Figure 2 about here  
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### 4.3 Additional findings

36 Although we found that communication frequency was positively related to supplier performance  
37 when both the supplier and the buyer perceive significant technology uncertainty, we also found  
38 that communication frequency was strongly and negatively related to supplier performance when  
39 buyers perceive much greater technology uncertainty than their suppliers. This finding was  
40 contrary to our expectations. To obtain a better understanding of this finding, we explored further  
41 what exactly occurs when communications increase in a situation where the buyer perceives  
42 greater technology uncertainty than the supplier.  
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49 First, we determined the number of relationships in our sample that fitted each  
50 combination involving supplier perceived technology uncertainty, buyer perceived technology  
51 uncertainty and communication frequency. We looked at the number of cases where technology  
52 uncertainty and communication frequency were rated above or below the mean (high and low  
53 respectively). As can be seen from the summary presented in Table 6, the most common  
54 combinations found were those where the three aspects (supplier perceived technology  
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3 uncertainty, buyer perceived technology uncertainty and communication frequency) were either  
4 all high or all low (18 instances of each); and the least common a situation in which supplier  
5 perceived technology uncertainty is low, buyer perceived technology uncertainty is high and  
6 communication frequency is high (4 instances). Although this latter situation is relatively  
7 uncommon (5% of evaluated cases), we explored it further because of its strongly negative  
8 relationship with supplier performance. As part of this process, we conducted telephone  
9 interviews with the respondents in these four relationships to obtain more background  
10 information. Below, we will describe one case in detail as an illustration.  
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28 One of the buyers that participated in our study is a yacht builder, and the relationship studied  
29 was with a supplier of electrical equipment. The yacht builder perceived significantly greater  
30 technology uncertainty than the supplier, and consequently contacted the supplier on an almost  
31 monthly basis to discuss technical modifications and related issues such as quality and costs. In  
32 this relationship the supplier's performance was rated below average by the buyer. The situation  
33 as it was described to us is outlined below.  
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39 During the contract phase, the yacht builder and the supplier generally agreed on the  
40 specifications of the electrical installations to be delivered. However, while the yacht building  
41 was progressing, the buyer would often become aware of technological developments in the  
42 supplier's field, and often want to integrate these latest technologies in the yacht under  
43 construction. As the yacht builder put it: "there are many technical modifications and innovations  
44 in the electrical installations market which we want to incorporate during the course of a project.  
45 This is also expected by our customers who want state-of-the-art technologies." The supplier,  
46 however, sees less change in the market and only wants to consider modifications when a new  
47 project is started, rather than revise ongoing projects. The yacht builder, nevertheless, frequently  
48 initiates communications in order to push the supplier into modifying ongoing installations. The  
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3 supplier finds it difficult to realise this in practice, which explains the rather low perception of  
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5 supplier performance.  
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7 In this example, the increased communication is initiated by the buyer and is aimed at  
8 making the supplier adapt its products to the buyer's wishes. The supplier in this illustration was  
9 pushed into being flexible, something the supplier did not particularly aspire to. As a result, both the  
10 buyer and the supplier were of the opinion that the supplier's performance was below optimum.  
11 This case shows what can happen when buyers perceive greater technology uncertainty than  
12 suppliers and increase communication. The overall picture that emerges is one where buyers  
13 perceive technology uncertainty in the industry of their suppliers because of the technology  
14 uncertainty in their own industry. Buyers then initiate frequent communications in order to urge  
15 their suppliers to follow the developments they perceive. Given the differences in perceptions of  
16 both technology uncertainty and, as a consequence, the importance of certain performance  
17 indicators, increased communication is likely to be counterproductive and lead to a decline in  
18 perceived supplier performance.  
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28 In the next section, we will return to these results and then discuss how future research  
29 could build on these findings.  
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### 34 **5. Discussion**

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36 We found that increased communication between buyers and suppliers is only positively related  
37 to supplier performance when not only the suppliers but also their buyers perceive there to be  
38 significant technology uncertainty. Contrary to our expectations, increased communication is  
39 negatively related to supplier performance when suppliers perceive there to be little technology  
40 uncertainty but their buyers perceive much greater technology uncertainty. Although this  
41 combination is not very common, when it does occur it has a fairly strong negative effect.  
42 Moreover, the findings in this study demonstrate that it is important to take the distinct  
43 perceptions of technology uncertainty by buyers and suppliers into account when assessing the  
44 effects of communication frequency. It appears that increased communication is only effective  
45 when both parties acknowledge the need to communicate, and can be harmful when only one  
46 party sees the benefits of it. In such situations, the harmful effects of increased communication on  
47 supplier performance are quite strong.  
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### 5.1 Theoretical implications

Our study makes several contributions to the understanding of technology uncertainty and communication processes in buyer-supplier relationships. First, our results make clear that it is important to explicitly take into account the reality that parties in a relationship can have different perceptions of technology uncertainty, and that these perceptions jointly influence the effects of communication. While previous studies have acknowledged that perceptions of technology uncertainty can differ significantly (Heide & John, 1990; Atuahene-Gima & Li, 2004; Oosterhuis et al., 2007), to our knowledge no study has previously taken these perceptual differences into account when studying technology uncertainty in relation to communication processes. This is perhaps surprising since effective communication is commonly seen as requiring parties to share congruent perceptions of the matters they communicate about. Our study further shows that incongruent perceptions can have an especially strong effect when communication frequency is increased.

We unexpectedly found that the performance of suppliers is viewed as less satisfactory when their buyers perceive greater technology uncertainty than they themselves do, and especially when communication about this debatable uncertainty is high. Our interview data showed that, in the former situation, suppliers were pressured by their customers to communicate about technical modifications and innovations, and to react flexibly to the buyers' wishes. These findings are in line with an interorganisational study by Schmidt and Kochan (1977) which showed that if only one party was motivated to communicate, communication would only increase if the motivated party was powerful enough to force the other to communicate more frequently. The resulting communication processes were characterised by bargaining and tensions since the forcing party was trying to achieve its own goals at the expense of the other. When both parties agreed on the need to communicate, increased communication was not characterised by such tensions. Perhaps not surprisingly, if one of the parties perceives a high level of technological uncertainty and the other not, the one that perceives the uncertainty is the one most likely to initiate communication because it sees a need to change the status quo (De Dreu, Kluwer & Nauta, 2008). The other party does not feel this need and will possibly try to avoid communicating or withdraw from interactions. Such a response will frustrate the initiator and this will likely result in conflict or the escalation of existing conflict. Conflicts are likely to result in the desired change not happening and therefore the party who wanted change will be dissatisfied

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3 with the outcome (De Dreu et al., 2008). This could explain why we found that buyers are  
4 especially negative about the performance of suppliers in situations where only the buyer  
5 perceives a high level of technological uncertainty.  
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9 In light of this general pattern, perhaps the conclusion to draw from our findings is that  
10 attention should shift from the positive effects of collaborative communication to the negative  
11 effects of non-collaborative communication, since the latter seem to have a potentially greater  
12 impact on the buyer-supplier relationship.  
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### 15 16 17 18 19 **5.2 Practical implications**

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21 Our study shows that it is important for both parties to know what level of technological  
22 uncertainty the other party perceives. If both suppliers and buyers perceive low levels of  
23 technological uncertainty, neither will see reasons to communicate about technological  
24 innovations or adaptations, and communication frequency is unlikely to affect supplier  
25 performance. Our findings show that higher levels of communication are only positively related  
26 to supplier performance when both buyers and suppliers perceive similarly high levels of  
27 technology uncertainty. That is, the reasoning that more communication is better if technological  
28 uncertainty is high only seems to apply when suppliers and buyers perceive similar high levels of  
29 technology uncertainty. Only then will both parties see the need for adaptations or innovations,  
30 and only then will increased communication about these issues be effective. Further, in such a  
31 situation, communication will probably increase in a fairly natural way and there is no need for  
32 any kind of intervention.  
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43 If one of the parties perceives a high level of technological uncertainty and the other not,  
44 the party with the concerns will probably want to communicate but should be aware that frequent  
45 communications could be detrimental to the relationship if this is used to force the other party to  
46 do things they find unnecessary. The present study should also help buyers to understand that  
47 non-collaborative communication can be very harmful to a relationship. The question arises of  
48 what is the best course of action should such perceptual differences become apparent. A good  
49 option might be to seek mediation by a third party, such as a consultant (Jehn, Rupert & Nauta,  
50 2006). Such a mediator could facilitate the exchange of views and opinions about general  
51 developments in the markets, and about technological uncertainty in particular, as a step towards  
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3 aligning perceptions. If conflicts are already apparent, the mediator could encourage discussion  
4 about the way in which the communications have developed (i.e., metacommunication;  
5 Watzlawick, Bavelas & Jackson, 1967). Further, in such situations, it is much more important to  
6 emphasise the importance of high quality communication rather than simply the frequency of  
7 communication. The latter may serve only to strengthen the perceptions of both parties and, as  
8 such, be counterproductive. Earlier research has also found that, in order to overcome perceptual  
9 differences, it is preferable to use rich communication channels such as face-to-face meetings  
10 rather than less rich channels (Daft & Lengel, 1986), such as email. Another option in the event  
11 of a conflict is to look for common or super-ordinate goals (such as the possibility that high  
12 quality cooperation could enhance the performance of both the supplier and the buyer) that move  
13 both parties towards constructive cooperation (Hunger & Stern, 1976).  
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### 25 ***5.3 Limitations and future research***

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27 The cross-sectional design of our study makes it difficult to draw conclusions about causality,  
28 and a longitudinal research design would certainly help researchers to be more certain about our  
29 potential bidirectional effects. Moreover, a longitudinal design would not only add to the  
30 understanding of causality, it could also be used to examine how relationships develop.  
31 Specifically, a longitudinal study could address how the perceptions of buyers and suppliers  
32 develop over time, as a relationship develops, and how these influence the relationship between  
33 communication and supplier performance. In particular, the suggestion from our study that, if  
34 perceptions become more congruent that the technology uncertainty is significant, then increased  
35 communication can improve supplier performance (see also Ring & Van de Ven, 1994) could be  
36 tested through such a study.  
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45 From our additional findings from the follow-up interviews, it appears that in situations  
46 where buyers perceive greater technology uncertainty than their suppliers, communication will  
47 increase if buyers take the initiative and pressure their suppliers to communicate about technical  
48 modifications and innovations. However, this finding is tentative since, in our survey, we did not  
49 ask about which parties took the initiative to communicate in what situations. Therefore, we are  
50 unable to statistically test the proposition that, in this situation, it is the buyer that takes the lead  
51 in increasing communication. With hindsight, it is regrettable that we did not investigate this  
52 aspect since our results suggest that who takes the initiative to communicate, and how  
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3 communication patterns are established, has a bearing on the success of the relationship.  
4 Especially when one partner is forced to communicate about matters they find unimportant, the  
5 increased communication can prove harmful. Future research should therefore investigate how  
6 communication processes between buyers and suppliers are initiated in order to understand when  
7 frequent communication is beneficial, and when it becomes non-collaborative and harms  
8 performance.  
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14 Further, we only studied the frequency at which buyers and suppliers communicate about  
15 technical changes and innovation. Other aspects of communication patterns may also play an  
16 important role in establishing supplier performance and, possibly, reducing perceptual  
17 differences. For example, the additional interview findings suggest a need to examine in greater  
18 detail the *quality* of communication processes in buyer-supplier relationships. Not only because  
19 the quality seems to be particularly affected when perceptual differences exist, but also because  
20 an emphasis on communication quality may decrease or remove perceptual differences. Future  
21 research could determine whether and how perceptions could be aligned by enhancing the quality  
22 of communication between partners. It seems particularly useful to identify the *interpersonal*  
23 *behaviour* of the people who communicate and the media they use while communicating.  
24 Frequent communications between buyers and suppliers might be very effective when people act  
25 in a friendly and helpful way, but ineffective when people behave indifferently or are even hostile  
26 (Leary, 1957; Kiesler, 1983). As another option, future research could examine the way that the  
27 formality of communications influences supplier performance (Mohr and Nevin, 1990) and  
28 whether formal, i.e. structured and routine, communications suffer from perceptual differences in  
29 the same way as informal, i.e. unstructured and spontaneous, communications. Studying all these  
30 aspects of communication together may further enhance our understanding of the effectiveness of  
31 communication patterns between buyers and suppliers, and the development or removal of  
32 perceptual differences.  
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48 Our study could usefully be extended by including power differences in relationships  
49 since our results suggest that increased communication is particularly harmful when it is used to  
50 bully partners into do things. Since parties require power to force partners to carry out actions  
51 they do not see as necessary, this would suggest that a combination of incongruent perceptions  
52 and power differences is a potential source of non-collaborative communication, with all the  
53 accompanying detrimental consequences.  
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3 In conclusion, our study has important implications for future research on technology  
4 uncertainty and communication processes in buyer-supplier relationships. We have shown that it  
5 is crucial to take the sometimes distinct perceptions of buyers and suppliers into account when  
6 studying communication processes. In more concrete terms, we found that if both suppliers and  
7 buyers perceive significant technology uncertainty then an increase in communication is  
8 beneficial. Under these circumstances, increased communication is associated with higher levels  
9 of supplier performance. However, when buyers perceive greater technology uncertainty than  
10 their suppliers, our study showed that frequent communication can be very detrimental and is  
11 associated with lower levels of supplier performance.  
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Figure 1. Theoretical model.

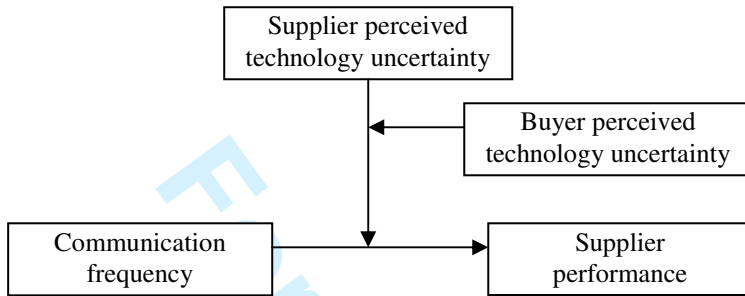
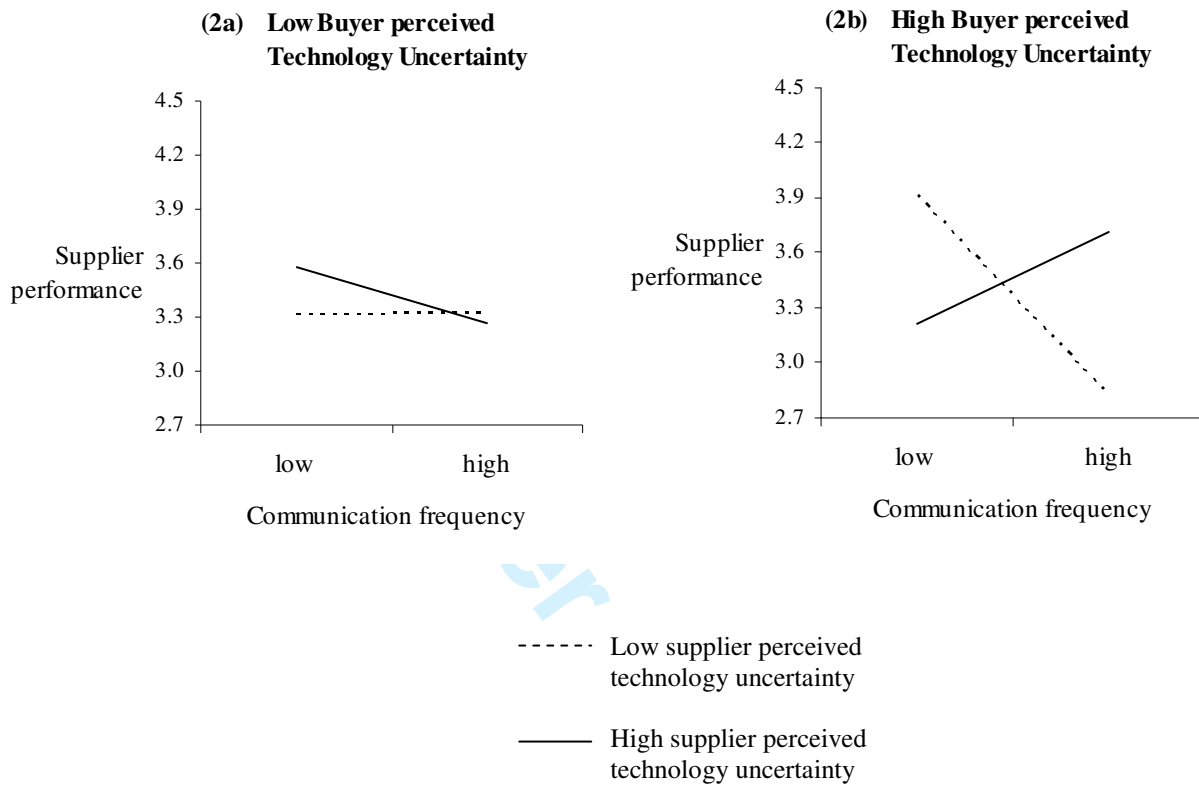


Figure 2. The three-way interaction for supplier performance



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Table 1. Number of relationships for each combination of individual responses.

Supplying firm respondents	Buying firm respondents			
	0	1	2	3
0	0	6	3	6
1	1	21	5	15
2	2	2	6	11
3	0	0	5	21

For Peer Review Only

Table 2. Job descriptions of respondents.

Buying firm respondents			Supplying firm respondents		
Titles	Number	Percentage	Titles	Number	Percentage
Director	7	3.1	Director	22	13.6
Purchasing manager	59	26.1	Sales manager	38	23.5
Senior Buyer	23	10.2	Sales representative	42	25.9
Buyer	59	26.1	Sales support	29	17.9
Materials planner	44	19.5	Planner	10	6.2
Engineer	19	8.4	Engineer	14	8.6
Other	14	6.2	Other	6	3.7
Not specified	1	0.4	Not Specified	1	0.6
TOTAL	226	100	TOTAL	162	100

Table 3. Scale descriptions, factor loadings and reliability statistics.

6	7	8	Standardized
Scales and associated indicators			factor loadings
9	<i>Communication frequency (suppliers; Cronbach's <math>\alpha = .83</math>; CR = .85; AVE = .59)</i>		
10	How frequently did your company communicate with customer A during the past year about:		
11	Technical adaptations of parts		.85
12	Innovation of parts		.81
13	Adaptations of the supplier's production process		.61
14	Market developments		.79
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18	<i>Communication frequency (buyers; Cronbach's <math>\alpha = .73</math>; CR = .83; AVE = .56)</i>		
19	How frequently did your company communicate with supplier A during the past year about:		
20	Technical adaptations of parts		.92
21	Innovation of parts		.86
22	Adaptations of the supplier's production process		.55
23	Market developments		.60
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26			
27	<i>Supplier perceived technology uncertainty (suppliers; Cronbach's <math>\alpha = .69</math>; CR = .69; AVE = .44)</i>		
28	The following statements refer to the parts your company delivers to customer A. Please indicate		
29	to what extent each statement is applicable.		
30	In order to remain competitive, our company frequently needs to carry out technical product		
31	modifications.		.73
32	These parts are characterized by a lot of technical modifications.		.53
33	The rate of process obsolescence is high in the industry of these parts.		.70
34	The production technology necessary to produce these parts changes frequently. ( <i>dropped</i> )		-
35			
36			
37			
38	<i>Buyer perceived technology uncertainty (buyers; Cronbach's <math>\alpha = .82</math>; CR = .81; AVE = .59)</i>		
39	The following statements refer to the parts your company buys from supplier A. Please indicate		
40	to what extent each statement is applicable.		
41	In order to remain competitive, this supplier frequently needs to carry out technical product		
42	modifications.		.76
43	These parts are characterized by a lot of technical modifications.		.96
44	The rate of process obsolescence is high in the industry of these parts.		.53
45	The production technology necessary to produce these parts changes frequently. ( <i>dropped</i> )		-
46			
47			
48			
49	<i>Supplier performance (buyers; Cronbach's <math>\alpha = .77</math>; CR = .80; AVE = .44)</i>		
50	Please indicate to what extent supplier A realized improvements in the past year with regard to:		
51	Quality of parts		.62
52	Price of parts		.65
53	Innovation of parts		.65
54	Volume flexibility		.62
55	High delivery reliability		.76
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Table 4. Means, standard deviations and correlations.

Variable	M	SD	1	2	3
1 Communication frequency	2.00	0.77			
2 Supplier perceived Technology Uncertainty	2.20	0.83	.34**		
3 Buyer perceived Technology Uncertainty	1.91	0.68	.23*	.02	
4 Supplier performance	3.25	0.57	.09	.10	.13

$n = 83$  (buyer-supplier relationships).

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$



Table 5. Results of the regression analyses for the mediated moderation model.

Step	Variables	Supplier performance		
		1	2	3
1	<i>Main effects</i>			
	Communication frequency	-.05	-.07	-.15 *
	Supplier perceived technology uncertainty (STU)	.05	.06	.05
	Buyer perceived technology uncertainty (BTU)	.08	.08	.02
2	<i>Two-way interactions</i>			
	Communication frequency × STU		.09	.16 **
	Communication frequency × BTU		-.12	-.03
	STU × BTU		.00	.00
3	<i>Three-way interaction</i>			
	Communication frequency × STU × BTU			.24 **
	$R^2$	.03	.09	.18 *
	<i>Adjusted <math>R^2</math></i>	-.01	.01	.11 *
	$\Delta R^2$	.03	.06	.10 **

Unstandardized coefficients are reported.  $n = 83$  (buyer-supplier relationships).

\*  $p < .05$ ; \*\*  $p < .01$

Table 6. Number of relationships for each combination of buyer perceived technology uncertainty, supplier perceived technology uncertainty and communication frequency

		<b>Buyer TU low</b>	<b>Buyer TU high</b>
<b>Supplier TU low</b>	Communication freq. low	18	9
	Communication freq. high	9	4
<b>Supplier TU high</b>	Communication freq. low	11	6
	Communication freq. high	8	18