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HAL Id: hal-00661560
https://hal.archives-ouvertes.fr/hal-00661560
Submitted on 20 Jan 2012

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<th>Journal:</th>
<th><em>International Journal of Production Research</em></th>
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<tr>
<td>Manuscript ID:</td>
<td>TPRS-2010-IJPR-0473</td>
</tr>
<tr>
<td>Manuscript Type:</td>
<td>Original Manuscript</td>
</tr>
<tr>
<td>Date Submitted by the Author:</td>
<td>14-May-2010</td>
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<tr>
<td>Complete List of Authors:</td>
<td>Oosterhuis, Marian; University of Groningen, Faculty of Economics and Business Van der Vaart, Taco; University of Groningen, Faculty of Economics and Business Molleman, Eric; University of Groningen, Faculty of Economics and Business</td>
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<tr>
<td>Keywords:</td>
<td>SUPPLY CHAIN MANAGEMENT, REGRESSION ANALYSIS, HUMAN FACTORS, OPERATIONS MANAGEMENT</td>
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<tr>
<td>Keywords (user):</td>
<td>Technology uncertainty, perceptions</td>
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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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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.

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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
is based on information processing theory, which suggests that a fit is desirable between perceived environmental uncertainty and the communication processes in organisations (Galbraith, 1973; Tushman & Nadler, 1978).

Supplier performance may thus be expected to increase when there is a fit between the frequency of communication between buyers and suppliers and the extent of the technology uncertainty confronting suppliers. Earlier research has investigated the idea that significant technology uncertainty requires frequent communication in order to perform successfully, although the results of these studies have been mixed (e.g. Fynes et al., 2004; Fynes et al., 2005; Noordewier et al., 1990). A basic explanation for these mixed results may be that buyers and suppliers have generally been assumed to react similarly to technology uncertainty whereas several studies have shown that, particularly when it comes to technology uncertainty, the perceptions of buyers and suppliers are likely to diverge (Heide & John, 1990; Atuahene-Gima & Li, 2004; Oosterhuis, Molleman & Van der Vaart, 2007). Not only do buyers and suppliers experience differing levels of technology uncertainty, they are also likely to react differently to technology uncertainty (Jap, 1999).

In this paper, we emphasise the importance of studying the distinct perceptions of technology uncertainty by suppliers and buyers. Although it is reasonable to expect suppliers to have the most comprehensive view of technological developments in their industry (Oosterhuis et al., 2007), the perceptions of their buyers may also play a crucial role. When suppliers perceive a large level of technology uncertainty related to the products they deliver, they will want to communicate with their buyers in order to enhance their own performance. However, if a buyer does not concur that there is a high level of technology uncertainty, it is highly questionable whether increased communication will be effective in increasing supplier performance. Earlier studies have indicated that parties need, in general, to share a similar understanding of the matters they communicate about in order for communication to be effective (Gelfand, Kuhn & Radhakrishnan, 1996; Padgett & Wolosin, 1980; Triandis, 1959). That is, only when both the supplier and the buyer perceive a high level of technology uncertainty in the supplier’s industry will frequent communication be effective in enhancing supplier performance.

We start this paper by describing the moderating effect of a supplier’s perception of technology uncertainty on the relationship between communication frequency and supplier performance. Then, we extend the argument with the idea that increased communication will only
be effective when not only the supplier, but also the buyer, perceives there to be significant technology uncertainty. Following this line of reasoning, we propose a three-way interaction among supplier’s perception of technology uncertainty, buyer’s perception of technology uncertainty and communication frequency regarding supplier performance. We test the resulting hypotheses with dyadic data from 388 respondents involved in 86 buyer-supplier relationships.

2. Theory

2.1 Technology uncertainty and communication frequency

Technology uncertainty reflects the perceived speed of technological change in a firm’s industry. It concerns changes in the standards or specifications of products and can be characterised by rapid process obsolescence (Geyskens, Steenkamp & Kumar, 2006; Heide & John, 1990; Walker & Weber, 1984). In this paper, we focus on technology uncertainty as it relates to the products a supplier delivers to a specific buyer. Further, we focus on perceived, rather than objective, technological change since managers inherently act upon what they perceive to be the reality (Daft, 1992; Weick, 1979). Suppliers will adjust their activities to the technology uncertainty they experience and, consequently, supplier performance will be significantly influenced by their perceptions of their technological environment and how they cope with these.

If technology uncertainty is perceived as high, suppliers will feel a need to adapt their products and processes to the developments in their industry. Information processing theory suggests that suppliers will want to communicate with their buyers as part of coping with the technology uncertainty they perceive (Fynes et al., 2004; Galbraith, 1973; Stock & Tatikonda, 2007; Tushman & Nadler, 1978). Discussions with buyers will aid suppliers in exploring how to adapt their products and processes in such a way that they continue to address the specific demands for their products (Jap, 1999). Therefore, when suppliers perceive great technology uncertainty, they will want to communicate more frequently with their buyers in order to ensure they continue to deliver products that satisfy their buyers’ needs and so improve their performance.

Conversely, when suppliers perceive little technology uncertainty, they will feel little need to communicate with their buyers. The technology of the products they deliver to their buyers is stable, and their production processes hardly need to change. In this situation, little
information on how best to revise their products and processes is required. Frequent communication may even be seen as distractive. Therefore, in such circumstances, supplier performance will not be enhanced by frequent communication about technical changes, innovation and the like.

Summarising, the general expectation is that, under conditions of high levels of perceived technology uncertainty, communication frequency will be positively related to supplier performance, whereas under conditions of low perceived technology uncertainty, communication frequency will be unrelated to supplier performance (e.g. Fynes et al., 2004; Stock & Tatikonda, 2007; Tushman & Nadler, 1978). This leads to:

Hypothesis 1: Technology uncertainty, as perceived by the supplier, will moderate the relationship between communication frequency and supplier performance. If perceived technology uncertainty is high, there will be a positive relationship between communication frequency and supplier performance, whereas this relationship will be absent if perceived technology uncertainty is low.

2.2 Perceptual congruence

In the discussion above, we have argued that suppliers feel the need to communicate with their buyers when they experience significant technology uncertainty in order to help them improve their performance. However, we question whether increased communication will always be effective when suppliers perceive such technology uncertainty because buyers may perceive different levels of technology uncertainty. Past research suggests that each individual organisation uniquely perceives, interprets and evaluates the technological environment (Daft & Weick, 1984; Daft, 1992; Weick, 1979). Further, buyers and suppliers naturally hold distinct positions in a dyad, and this can also cause them to perceive technology uncertainty differently (e.g. Dougherty, 1992). Moreover, since technological change is difficult to assess, technology uncertainty is more likely to engender divergent perceptions than other forms of environmental uncertainty (Atuahene-Gima & Li, 2004). Studies by Heide and John (1990) and Oosterhuis et al. (2007) showed, empirically, that buyers and suppliers in a dyad do indeed perceive different levels of technology uncertainty.
When partners in a relationship perceive different degrees of technology uncertainty in the supplier’s industry, it is highly questionable whether frequent communication will be effective. There is ample evidence that a difference in the way people perceive things is related to lower communication quality and lower communication effectiveness in their interactions (Gelfand et al., 1996; Padgett & Wolosin, 1980; Triandis, 1959). For communication to be effective, parties need to feel that they share a common understanding of the matters they communicate about (Padgett & Wolosin, 1980; Ring & Van de Ven, 1994). This is consistent with work by Dougherty (1992) which indicated that perceptual differences caused by different positions in an organisation hindered parties in sharing and discussing information on technological developments in their common environment. What people perceived seemed critical to them, while what they did not see did not seem to be particularly noteworthy. When one party wanted to discuss matters that looked trivial to another partner, frequent communication was unlikely to generate positive outcomes since the partners did not share common concerns.

We thus expect increased communication to only be effective when both parties in a relationship perceive similarly high levels of technology uncertainty. In the next section, we develop hypotheses that predict the relationship between communication frequency and supplier performance for various combinations of buyer and supplier perceptions of technology uncertainty.

2.3 Combined effects of supplier perceived technology uncertainty, buyer perceived technology uncertainty and communication frequency on supplier performance

Consistent with information-processing theory, we have argued that suppliers will perform well when the degree of technology uncertainty they perceive matches the frequency with which they communicate with their buyers. However, we expect an increased level of communication to only be effective when not only suppliers but also buyers perceive significant technology uncertainty. When buyers agree with their suppliers that technology uncertainty is high, frequent communications about technological developments are likely to facilitate suppliers in managing the complexities that evolve from these developments. Thus, in a situation where buyers perceive the same high levels of technology uncertainty as their suppliers, increased communication will help the suppliers to explore how they should adapt their products and processes to reflect the
developments in their environment. Therefore, it is likely that frequent communication in such a situation will be effective in dealing with the perceived uncertainty, and this will result in enhanced supplier performance.

However, in a situation where the supplier perceives extensive technology uncertainty whereas the buyer perceives little technology uncertainty, we would expect frequent communication to add little to supplier performance. Here, increased communication about technical adaptations and innovation has little purpose since the buyer does not perceive there to be significant technology uncertainty that warrants discussion. Buyers, in such a situation, will offer little as sparring partners since they do not recognise the supplier’s concerns and can offer little in the way of additional insights (e.g. Dougherty, 1992). Since frequent communication will not help a supplier in dealing with the uncertainty, it will not increase their performance. Thus, we argue that communication frequency and supplier performance are not related when only the supplier perceives there to be significant technology uncertainty.

Finally, we have already argued that communication frequency will not be positively related to supplier performance when suppliers experience little technology uncertainty. In essence, since suppliers are not confronted with a level of uncertainty that needs to be reduced, their performance will gain little from increased communication. Frequent communication is simply not needed in this situation because the supplier is not facing uncertainty. Even if the buyer perceives there to be significant technology uncertainty while the supplier does not, increased communication will not increase supplier performance since the supplier does not share the same concerns as the buyer. Increased communication in such a situation will not be effective since buyers and suppliers do not share similar perceptions. We therefore expect that, when suppliers perceive little technology uncertainty, communication frequency and supplier performance will not be related, regardless of buyers’ perceptions.

Based on these arguments, we propose a refinement to Hypothesis 1:

**Hypothesis 2**: Communication frequency will only be positively related to supplier performance when both the supplier and the buyer perceive high levels of technology uncertainty.

The hypothesised relationships between the various aspects are illustrated in Figure 1.
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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Insert Table 2 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
values for these indices that indicate a satisfactory fit are: .90 or above for the GFI, AGFI and TLI; and .08 or less for RMSEA. Values calculated for our measurement models satisfied all these criteria: GFI = .95, AGFI = .90, TLI = .92 and RMSEA = .084 for suppliers, and GFI = .93, AGFI = .90, TLI = .95 and RMSEA = .044 for buyers.

We next examined the CFA results for convergent validity, discriminant validity and reliability. The factor loading for each indicator onto its corresponding construct was significant at the .001 level and exceeded the critical value of .40, indicating that the constructs were appropriately reflected by their indicators (convergent validity). We assessed discriminant validity by comparing the average variance extracted (AVE) to the squared correlations between the constructs. In all cases, the squared correlations between constructs did not exceed the AVE, which is an indication that the constructs have discriminant validity. Additionally, we checked to ensure that the confidence interval (± twice the standard error) for each pairwise correlation did not include the value 1.0. Since none of them did, all the constructs also satisfied this criterion for discriminant validity. Finally, we examined composite reliability by calculating the Cronbach’s alphas for our measures. They were all very close to, or above, the recommended level of .70 (see Table 3). Thus, to sum up, the analyses provided reasonable evidence that the measurement models were satisfactory in terms of convergent validity, discriminant validity and reliability.

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Inter-rater agreement and data aggregation. As noted earlier, our sample included a maximum of three informants from each organisation, and we assumed that an informant’s ratings would reflect views shared within their organisation. If this assumption is valid, we would expect the ratings from different informants within the same organisation to be similar. We tested this expectation using the average inter-rater agreement coefficient, rwg (James, Demaree & Wolf, 1984). The scores of the informants from a single organisation were deemed to be sufficiently consistent, and subsequently averaged, when the mean rwg was .70 or above (James, Demaree, and Wolf, 1984; Klein and Kozlowski, 2000). On this basis, only one relationship was excluded from further analysis because the informants from one organisation showed too little consensus.
Control variables. We tested whether industry type, power, relationship length, distance between companies, number of employees at the buying company and number of employees at the supplying company had any effect on the results of our study. We used the SIC codes of participating firms as a basis on which to test whether industry type had any influence on the outcome of our study. A MANOVA test of SIC codes and supplier performance showed no significant association ($F = 1.92, p = .09$). Further, we used the difference score between buyer dependence and supplier dependence to measure power (e.g. Kumar et al., 1995) and to test whether power affected the results of our study. We looked at the correlation between power and supplier performance and found that power was not related to supplier performance ($r = .012, p = .91$). Further, correlations between supplier performance and relationship length ($r = -.084, p = .42$), distance between companies ($r = -.075, p = .47$), number of employees at the buying company ($r = .19, p = .07$) and number of employees at the supplying company ($r = -.08, p = .48$) were not significant. We thus conclude that these control variables did not affect the results of our study and, accordingly, that there is no reason to suppose that our results cannot be generalised to manufacturing dyads in general. We further decided not to include these factors as control variables in our analyses since this could lead to Type II errors (Becker, 2005) and because we wanted to avoid a loss of power.

Descriptive statistics. The means, the standard deviations and the Pearson correlations between the variables are presented in Table 4. The means indicate that, on the whole, suppliers perceive greater technology uncertainty than buyers. A paired sample t-test showed that this difference in means was statistically significant ($t = 2.49, p < .05$). Further, the correlation between supplier perceived technology uncertainty and buyer perceived technology uncertainty is low ($r = .02, \text{n.s.}$), which is similar to findings by Heide and John (1990). Further, the correlations between supplier perceived technology uncertainty and communication frequency ($r = .36, p < .001$), and between buyer perceived technology uncertainty and communication frequency ($r = .21, p < .05$) are both positive and significant.

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

4.3 Additional findings

Although we found that communication frequency was positively related to supplier performance
when both the supplier and the buyer perceive significant technology uncertainty, we also found
that communication frequency was strongly and negatively related to supplier performance when
buyers perceive much greater technology uncertainty than their suppliers. This finding was
contrary to our expectations. To obtain a better understanding of this finding, we explored further
what exactly occurs when communications increase in a situation where the buyer perceives
greater technology uncertainty than the supplier.

First, we determined the number of relationships in our sample that fitted each
combination involving supplier perceived technology uncertainty, buyer perceived technology
uncertainty and communication frequency. We looked at the number of cases where technology
uncertainty and communication frequency were rated above or below the mean (high and low
respectively). As can be seen from the summary presented in Table 6, the most common
combinations found were those where the three aspects (supplier perceived technology
uncertainty, buyer perceived technology uncertainty and communication frequency) were either all high or all low (18 instances of each); and the least common a situation in which supplier perceived technology uncertainty is low, buyer perceived technology uncertainty is high and communication frequency is high (4 instances). Although this latter situation is relatively uncommon (5% of evaluated cases), we explored it further because of its strongly negative relationship with supplier performance. As part of this process, we conducted telephone interviews with the respondents in these four relationships to obtain more background information. Below, we will describe one case in detail as an illustration.

One of the buyers that participated in our study is a yacht builder, and the relationship studied was with a supplier of electrical equipment. The yacht builder perceived significantly greater technology uncertainty than the supplier, and consequently contacted the supplier on an almost monthly basis to discuss technical modifications and related issues such as quality and costs. In this relationship the supplier’s performance was rated below average by the buyer. The situation as it was described to us is outlined below.

During the contract phase, the yacht builder and the supplier generally agreed on the specifications of the electrical installations to be delivered. However, while the yacht building was progressing, the buyer would often become aware of technological developments in the supplier’s field, and often want to integrate these latest technologies in the yacht under construction. As the yacht builder put it: “there are many technical modifications and innovations in the electrical installations market which we want to incorporate during the course of a project. This is also expected by our customers who want state-of-the-art technologies.” The supplier, however, sees less change in the market and only wants to consider modifications when a new project is started, rather than revise ongoing projects. The yacht builder, nevertheless, frequently initiates communications in order to push the supplier into modifying ongoing installations. The
supplier finds it difficult to realise this in practice, which explains the rather low perception of supplier performance.

In this example, the increased communication is initiated by the buyer and is aimed at making the supplier adapt its products to the buyer’s wishes. The supplier in this illustration was pushed into be flexible, something the supplier did not particularly aspire to. As a result, both the buyer and the supplier were of the opinion that the supplier’s performance was below optimum. This case shows what can happen when buyers perceive greater technology uncertainty than suppliers and increase communication. The overall picture that emerges is one where buyers perceive technology uncertainty in the industry of their suppliers because of the technology uncertainty in their own industry. Buyers then initiate frequent communications in order to urge their suppliers to follow the developments they perceive. Given the differences in perceptions of both technology uncertainty and, as a consequence, the importance of certain performance indicators, increased communication is likely to be counterproductive and lead to a decline in perceived supplier performance.

In the next section, we will return to these results and then discuss how future research could build on these findings.

5. Discussion
We found that increased communication between buyers and suppliers is only positively related to supplier performance when not only the suppliers but also their buyers perceive there to be significant technology uncertainty. Contrary to our expectations, increased communication is negatively related to supplier performance when suppliers perceive there to be little technology uncertainty but their buyers perceive much greater technology uncertainty. Although this combination is not very common, when it does occur it has a fairly strong negative effect. Moreover, the findings in this study demonstrate that it is important to take the distinct perceptions of technology uncertainty by buyers and suppliers 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 harmful when only one party sees the benefits of it. In such situations, the harmful effects of increased communication on supplier performance are quite strong.
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.
with the outcome (De Dreu et al., 2008). This could explain why we found that buyers are especially negative about the performance of suppliers in situations where only the buyer perceives a high level of technological uncertainty.

In light of this general pattern, perhaps the conclusion to draw from our findings is that attention should shift from the positive effects of collaborative communication to the negative effects of non-collaborative communication, since the latter seem to have a potentially greater impact on the buyer-supplier relationship.

5.2 Practical implications

Our study shows that it is important for both parties to know what level of technological uncertainty the other party perceives. If both suppliers and buyers perceive low levels of technological uncertainty, neither will see reasons to communicate about technological innovations or adaptations, and communication frequency is unlikely to affect supplier performance. Our findings show that higher levels of communication are only positively related to supplier performance when both buyers and suppliers perceive similarly high levels of technology uncertainty. That is, the reasoning that more communication is better if technological uncertainty is high only seems to apply when suppliers and buyers perceive similar high levels of technology uncertainty. Only then will both parties see the need for adaptations or innovations, and only then will increased communication about these issues be effective. Further, in such a situation, communication will probably increase in a fairly natural way and there is no need for any kind of intervention.

If one of the parties perceives a high level of technological uncertainty and the other not, the party with the concerns will probably want to communicate but should be aware that frequent communications could be detrimental to the relationship if this is used to force the other party to do things they find unnecessary. The present study should also help buyers to understand that non-collaborative communication can be very harmful to a relationship. The question arises of what is the best course of action should such perceptual differences become apparent. A good option might be to seek mediation by a third party, such as a consultant (Jehn, Rupert & Nauta, 2006). Such a mediator could facilitate the exchange of views and opinions about general developments in the markets, and about technological uncertainty in particular, as a step towards
aligning perceptions. If conflicts are already apparent, the mediator could encourage discussion about the way in which the communications have developed (i.e., metacommunication; Watzlawick, Bavelas & Jackson, 1967). Further, in such situations, it is much more important to emphasise the importance of high quality communication rather than simply the frequency of communication. The latter may serve only to strengthen the perceptions of both parties and, as such, be counterproductive. Earlier research has also found that, in order to overcome perceptual differences, it is preferable to use rich communication channels such as face-to-face meetings rather than less rich channels (Daft & Lengel, 1986), such as email. Another option in the event of a conflict is to look for common or super-ordinate goals (such as the possibility that high quality cooperation could enhance the performance of both the supplier and the buyer) that move both parties towards constructive cooperation (Hunger & Stern, 1976).

5.3 Limitations and future research

The cross-sectional design of our study makes it difficult to draw conclusions about causality, and a longitudinal research design would certainly help researchers to be more certain about our potential bidirectional effects. Moreover, a longitudinal design would not only add to the understanding of causality, it could also be used to examine how relationships develop. Specifically, a longitudinal study could address how the perceptions of buyers and suppliers develop over time, as a relationship develops, and how these influence the relationship between communication and supplier performance. In particular, the suggestion from our study that, if perceptions become more congruent that the technology uncertainty is significant, then increased communication can improve supplier performance (see also Ring & Van de Ven, 1994) could be tested through such a study.

From our additional findings from the follow-up interviews, it appears that in situations where buyers perceive greater technology uncertainty than their suppliers, communication will increase if buyers take the initiative and pressure their suppliers to communicate about technical modifications and innovations. However, this finding is tentative since, in our survey, we did not ask about which parties took the initiative to communicate in what situations. Therefore, we are unable to statistically test the proposition that, in this situation, it is the buyer that takes the lead in increasing communication. With hindsight, it is regrettable that we did not investigate this aspect since our results suggest that who takes the initiative to communicate, and how
communication patterns are established, has a bearing on the success of the relationship. Especially when one partner is forced to communicate about matters they find unimportant, the increased communication can prove harmful. Future research should therefore investigate how communication processes between buyers and suppliers are initiated in order to understand when frequent communication is beneficial, and when it becomes non-collaborative and harms performance.

Further, we only studied the frequency at which buyers and suppliers communicate about technical changes and innovation. Other aspects of communication patterns may also play an important role in establishing supplier performance and, possibly, reducing perceptual differences. For example, the additional interview findings suggest a need to examine in greater detail the quality of communication processes in buyer-supplier relationships. Not only because the quality seems to be particularly affected when perceptual differences exist, but also because an emphasis on communication quality may decrease or remove perceptual differences. Future research could determine whether and how perceptions could be aligned by enhancing the quality of communication between partners. It seems particularly useful to identify the interpersonal behaviour of the people who communicate and the media they use while communicating. Frequent communications between buyers and suppliers might be very effective when people act in a friendly and helpful way, but ineffective when people behave indifferently or are even hostile (Leary, 1957; Kiesler, 1983). As another option, future research could examine the way that the formality of communications influences supplier performance (Mohr and Nevin, 1990) and whether formal, i.e. structured and routine, communications suffer from perceptual differences in the same way as informal, i.e. unstructured and spontaneous, communications. Studying all these aspects of communication together may further enhance our understanding of the effectiveness of communication patterns between buyers and suppliers, and the development or removal of perceptual differences.

Our study could usefully be extended by including power differences in relationships since our results suggest that increased communication is particularly harmful when it is used to bully partners into do things. Since parties require power to force partners to carry out actions they do not see as necessary, this would suggest that a combination of incongruent perceptions and power differences is a potential source of non-collaborative communication, with all the accompanying detrimental consequences.
In conclusion, our study has important implications for future research on technology uncertainty and communication processes in buyer-supplier relationships. We have shown that it is crucial to take the sometimes distinct perceptions of buyers and suppliers into account when studying communication processes. In more concrete terms, we found that if both suppliers and buyers perceive significant technology uncertainty then an increase in communication is beneficial. Under these circumstances, increased communication is associated with higher levels of supplier performance. However, when buyers perceive greater technology uncertainty than their suppliers, our study showed that frequent communication can be very detrimental and is associated with lower levels of supplier performance.

6. References


Figure 1. Theoretical model.
Figure 2. The three-way interaction for supplier performance

(2a) Low Buyer perceived Technology Uncertainty

(2b) High Buyer perceived Technology Uncertainty
Table 1. Number of relationships for each combination of individual responses.

<table>
<thead>
<tr>
<th>Supplying firm respondents</th>
<th>Buying firm respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 2. Job descriptions of respondents.

<table>
<thead>
<tr>
<th>Buying firm respondents</th>
<th>Supplying firm respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Titles</strong></td>
<td><strong>Number</strong></td>
</tr>
<tr>
<td>Director</td>
<td>7</td>
</tr>
<tr>
<td>Purchasing manager</td>
<td>59</td>
</tr>
<tr>
<td>Senior Buyer</td>
<td>23</td>
</tr>
<tr>
<td>Buyer</td>
<td>59</td>
</tr>
<tr>
<td>Materials planner</td>
<td>44</td>
</tr>
<tr>
<td>Engineer</td>
<td>19</td>
</tr>
<tr>
<td>Other</td>
<td>14</td>
</tr>
<tr>
<td>Not specified</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>226</td>
</tr>
</tbody>
</table>
Table 3. Scale descriptions, factor loadings and reliability statistics.

<table>
<thead>
<tr>
<th>Scales and associated indicators</th>
<th>Standardized factor loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communication frequency (suppliers; Cronbach’s α = .83; CR = .85; AVE = .59)</strong></td>
<td></td>
</tr>
<tr>
<td>How frequently did your company communicate with customer A during the past year about:</td>
<td></td>
</tr>
<tr>
<td>Technical adaptations of parts</td>
<td>.85</td>
</tr>
<tr>
<td>Innovation of parts</td>
<td>.81</td>
</tr>
<tr>
<td>Adaptations of the supplier’s production process</td>
<td>.61</td>
</tr>
<tr>
<td>Market developments</td>
<td>.79</td>
</tr>
<tr>
<td><strong>Communication frequency (buyers; Cronbach’s α = .73; CR = .83; AVE = .56)</strong></td>
<td></td>
</tr>
<tr>
<td>How frequently did your company communicate with supplier A during the past year about:</td>
<td></td>
</tr>
<tr>
<td>Technical adaptations of parts</td>
<td>.92</td>
</tr>
<tr>
<td>Innovation of parts</td>
<td>.86</td>
</tr>
<tr>
<td>Adaptations of the supplier’s production process</td>
<td>.55</td>
</tr>
<tr>
<td>Market developments</td>
<td>.60</td>
</tr>
<tr>
<td><strong>Supplier perceived technology uncertainty (suppliers; Cronbach’s α = .69; CR = .69; AVE = .44)</strong></td>
<td></td>
</tr>
<tr>
<td>The following statements refer to the parts your company delivers to customer A. Please indicate to what extent each statement is applicable.</td>
<td></td>
</tr>
<tr>
<td>In order to remain competitive, our company frequently needs to carry out technical product modifications.</td>
<td>.73</td>
</tr>
<tr>
<td>These parts are characterized by a lot of technical modifications.</td>
<td>.53</td>
</tr>
<tr>
<td>The rate of process obsolescence is high in the industry of these parts.</td>
<td>.70</td>
</tr>
<tr>
<td>The production technology necessary to produce these parts changes frequently. (dropped)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Buyer perceived technology uncertainty (buyers; Cronbach’s α = .82; CR = .81; AVE = .59)</strong></td>
<td></td>
</tr>
<tr>
<td>The following statements refer to the parts your company buys from supplier A. Please indicate to what extent each statement is applicable.</td>
<td></td>
</tr>
<tr>
<td>In order to remain competitive, this supplier frequently needs to carry out technical product modifications.</td>
<td>.76</td>
</tr>
<tr>
<td>These parts are characterized by a lot of technical modifications.</td>
<td>.96</td>
</tr>
<tr>
<td>The rate of process obsolescence is high in the industry of these parts.</td>
<td>.53</td>
</tr>
<tr>
<td>The production technology necessary to produce these parts changes frequently. (dropped)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Supplier performance (buyers; Cronbach’s α = .77; CR = .80; AVE = .44)</strong></td>
<td></td>
</tr>
<tr>
<td>Please indicate to what extent supplier A realized improvements in the past year with regard to:</td>
<td></td>
</tr>
<tr>
<td>Quality of parts</td>
<td>.62</td>
</tr>
<tr>
<td>Price of parts</td>
<td>.65</td>
</tr>
<tr>
<td>Innovation of parts</td>
<td>.65</td>
</tr>
<tr>
<td>Volume flexibility</td>
<td>.62</td>
</tr>
<tr>
<td>High delivery reliability</td>
<td>.76</td>
</tr>
</tbody>
</table>
Table 4. Means, standard deviations and correlations.

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Communication frequency</td>
<td>2.00</td>
<td>0.77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Supplier perceived Technology Uncertainty</td>
<td>2.20</td>
<td>0.83</td>
<td>.34**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Buyer perceived Technology Uncertainty</td>
<td>1.91</td>
<td>0.68</td>
<td>.23*</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td>4 Supplier performance</td>
<td>3.25</td>
<td>0.57</td>
<td>.09</td>
<td>.10</td>
<td>.13</td>
</tr>
</tbody>
</table>

n = 83 (buyer-supplier relationships).

* p < .05; ** p < .01; *** p < .001
Table 5. Results of the regression analyses for the mediated moderation model.

<table>
<thead>
<tr>
<th>Step</th>
<th>Variables</th>
<th>Supplier performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Main effects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Communication frequency</td>
<td>-.05</td>
</tr>
<tr>
<td></td>
<td>Supplier perceived technology uncertainty (STU)</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>Buyer perceived technology uncertainty (BTU)</td>
<td>.08</td>
</tr>
<tr>
<td>2</td>
<td>Two-way interactions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Communication frequency x STU</td>
<td>.09</td>
</tr>
<tr>
<td></td>
<td>Communication frequency x BTU</td>
<td>-.12</td>
</tr>
<tr>
<td></td>
<td>STU x BTU</td>
<td>.00</td>
</tr>
<tr>
<td>3</td>
<td>Three-way interaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Communication frequency x STU x BTU</td>
<td>.24 **</td>
</tr>
</tbody>
</table>

$R^2$ | .03 | .09 | .18 * |
Adjusted $R^2$ | -.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

<table>
<thead>
<tr>
<th>Supplier TU</th>
<th>Communication freq. low</th>
<th>Communication freq. high</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>low</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>high</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>high</td>
<td>8</td>
<td>18</td>
</tr>
</tbody>
</table>