BUYER BEHAVIORS AND SUPPLY CHAIN PERFORMANCE:
AN INTERNATIONAL EXPLORATION

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Abstract

This paper studies the effects of buyer-supplier interaction in a supply chain environment. It focuses on the effects of buyer behaviors (such as supplier selection, number of suppliers, percentage of outsourcing, and frequency of production changes) on the performance of the supply chain. Using data collected from machine tool manufacturers around the world, we examine how various behaviors of buyers induce or mitigate the degree of uncertainty experienced by suppliers and thus effect suppliers’ delivery performance. In addition, we investigate how such buyer behaviors could further effect the supply chain’s ability to perform as expected. The statistical results suggest that many buyer behaviors that have no direct effect on the buyer’s performance can have a significant effect on their suppliers’ performance. Specifically, buyer behaviors directly manifest in supplier performance and only indirectly manifest in their own performance. This can give the buyer the false impression that the supply base is harming performance, when the real problem is the way the buyer manages the supply chain. Our results vary by region of the world, suggesting that any theory that links buyer behaviors to supplier performance will need to consider firm location.

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1. Introduction

Environmental uncertainty, in its many guises, has long been studied in all managerial fields. Research focusing on uncertainty is strongly grounded in a significant managerial issue. Specifically, to a manager increased uncertainty means a decreased ability to plan, hence a likely decrease in performance when unexpected events do occur.

In organizational fields authors have been suggesting responses to uncertainty for nearly 40 years. For instance Burnes and Stalker (1961) suggested that firms that operated in uncertain environments needed more organic structures, while firms should apply mechanistic structures in more predictable environments.

Environmental uncertainty also has a long history of study in the field of operations management. Many studies have investigated the effects of demand and/or supply uncertainties on manufacturing planning and control (e.g. Suresh and Chaudhuri 1993, Tang 1990). More recently, researchers began to address the relationship between environmental uncertainty and various operations strategy issues such as flexibility and competitiveness (e.g. Swamidass and Newell 1987, Gerwin 1993).

The present study intends to examine the effect of uncertainty in a supply chain environment. This study takes a different perspective on uncertainty, in that we examine how the behaviors of one member of a supply chain, the buying firm, can create uncertainty for other members of a supply chain, the buying firm’s suppliers. Specifically, buying firms take actions (e.g. schedule changes), for the purposes of improving their own manufacturing performance, without realizing the potential negative impact on their suppliers. The resulting decrease in supplier performance could ultimately affect the buying firm's performance. So buyer behaviors directly manifest themselves in supplier performance, and only indirectly manifest themselves in the buyer’s own performance. This can give the buyer the false impression that the supply base is harming performance, when the real problem is the way the
buyer manages the supply chain. We use the data collected from firms located all over the world, which provides the opportunity for making cross-national comparisons.

In summary, this research examines the performance implications of buyer behaviors for both suppliers and the supply chain. It first reviews how previous studies define uncertainty and buyer behaviors from the supply chain’s perspective. Next, this paper develops a model for empirically testing the relationship between buyer behaviors and supply chain performance. The data and the statistical methods applied are discussed. Lastly, the statistical results, managerial implications and conclusions are presented.

2. Literature review

Operations management has traditionally dealt with optimizing some or all of a company’s internal processes. However, academics and practitioners alike have recently shown interest in optimizing the entire set of processes that provide value to the end customer. The entire set of processes includes those that are both internal and external to the firm. This perspective is often referred to as Supply Chain Management and is a potentially powerful way for companies to ensure that customers are receiving the most value for their money. Quinn (1996) defines supply chain management as:

“… encompass[ing] all those activities associated with moving goods from the raw material stage to the end user. This includes systems management, sourcing and procurement, production scheduling, order processing, inventory management, warehousing and customer service. Successful supply chain management, then, coordinates and integrates these activities for sustainable competitive advantage” (p. 1).

This definition implies that attempts at optimizing a single process without considering the other process linked to it will not optimize the entire chain. For the purpose of this study, we will examine the buyer-supplier linkage in supply chains. While there are numerous articles on the buyer-supplier linkage (see, e.g., Monczka et al. 1998; Shin et al. 2000), our focus is to review previous
work that might provide some indication as to how the effects of uncertainty can be mitigated or perhaps exacerbated by various buyer behaviors. Specifically, the purpose of this study is to further our understanding of how behaviors of one chain member may create/mitigate uncertainty and hence effect the performance across the supply chain. Therefore, the literature review will focus on the following two areas:

- Defining those buyer behaviors that might create uncertainty in a buyer-supplier linkage
- Examining those buyer behaviors that might mitigate the effects of uncertainty on supplier performance

2.1. Buyer behaviors and uncertainty

Fundamentally the level of uncertainty in a system is related to the ability to predict what will happen to the system. However, the uncertainty construct has been used in many different ways in the literature. Organizational researchers (e.g. Child 1972) tend to view uncertainty as an external construct. Research in these fields often tries to match strategy or structure to a given level of environmental uncertainty (e.g. Venketramann 1990).

More traditional examinations of uncertainty in operations management have been based on demand uncertainty. For instance Fine and Freund (1990) examined investments in flexible manufacturing capability in environments where demand was not certain. Kadipasoaglu and Sridharan (1995) studied the relationship between schedule instability and demand uncertainty. And many other authors have used demand uncertainty, or some derivative of it as a key control in simulation models. For instance Li and Kouvelis (1999) looked at supply contracts when there is price uncertainty (price influences supply and demand).

Uncertainty in the external environment has been examined in the operations strategy literature as well. Swamidass and Newel (1987) built off of the work in the organizational literature and found that flexibility was a useful response to increased environmental uncertainty. Ward et al. (1995)
examined the effects of environmental uncertainty on business strategy and found that there was a relationship between the level of uncertainty and the competitive priorities followed. Pagell and Krause (1999) returned to the work of Swamidass and Newel and reexamined the relationship between flexibility and uncertainty.

The theory underlying all of these works shares two common threads. First, as a manager’s ability to predict some element of their system decreases performance will also decrease unless the system is structured to handle uncertainty. Structuring a system to be better able to react to uncertainty (to be flexible or organic) has costs. Second the source of uncertainty in these studies tends to be external to the firm. In other words uncertainty is something to which the firm must react.

However, uncertainty can be internally created as well. Just-in-time (JIT) systems have demonstrated how various internal glitches and practices (e.g., production scheduling changes, engineering changes, lengthy setup, machine breakdowns, insufficient capacity, etc.) could create internal uncertainty. JIT firms have successfully attacked internal uncertainty with the implementation of preventive maintenance, uniform work loads, flexible workforces, etc. (Schonberger 1982). Newman et al. (1993) find that many companies respond to demand uncertainty by building buffers of capacity, lead time and or inventory. However, these buffers can in turn create additional (internal) uncertainty. In the case of inventory buffers lead times tend to increase, the chances of obsolescence increase, and it becomes harder to predict when any one unit will exit the system (Blocher, Garrett and Schmenner 1999). Pagell et al. (2000) build on this concept and note that many firm behaviors either increase or decrease their internal levels of uncertainty. For example, a firm could respond to demand uncertainty by moving toward more modular production. Such a move enables the firm to use the same input in many more outputs with a lower overall level of inventory. Modular production decreases internal uncertainty because there are fewer parts to manage at any given level of in stock performance. Finally Flyn and Flyn (2000) note that complexity/uncertainty can also be internally driven by issues such as process choice and the like.
For the purposes of this research we will address the issue of uncertainty from a supplier’s standpoint. The sources of uncertainty we examine are mainly driven by buyer behaviors such as the frequency of changes in engineering design, production scheduling, sales plans, and customer demand. This uncertainty is external for the supplier, but internal for the overall supply chain. In other words we focus on the uncertainty buyer behaviors create for suppliers and investigate how this uncertainty effects supply chain performance. For the rest of this section, we will review some supply chain management practices that may mitigate the effects of uncertainty on the suppliers’ (and hence the chain’s) performance.

2.2. Buyer behaviors and supplier performance

The supply chain management literature is full of ways that firms can improve their competitive advantage by working with their suppliers. Early supplier involvement in the design process (e.g. Hartley et al. 1997) is a way to leverage the supplier’s knowledge early in the design process to reduce costs and lead times. Strategic alliances or long term relationships (e.g. Choi and Hartley 1996) are also ways to leverage the supplier’s unique capabilities. Equally important close relationships are a way to share risk which is in a sense a way to reduce uncertainty.

More specifically the literature notes that in order to have relationships where risk is shared and all capabilities are leveraged it is necessary to change the way suppliers are chosen. Deming (1986) notes that choosing suppliers only on price tends to harm quality. Taken a step further many authors (e.g. Burt 1989) advocate that suppliers should be selected on the basis of total costs, not just price and quality. In other words suppliers should be selected based on how their actions will impact all competitive elements of the supply chain.

In order to have the types of collaborative relationships recommended and to make purchases on the basis of total costs it is imperative that firms reduce the number of suppliers they have in general (e.g. Kekre et al. 1995). The reduced number of suppliers induces various benefits such as the reduction of total costs and elimination of mistrust between buyers and suppliers (Treleven 1987,
Newman 1988). Many authors even propose that companies move to using one supplier per input (McMahon 1987, Hill and Friedman 1992), at least for strategic inputs. This brief review indicates that two factors that may matter a great deal in terms of the effects of buyer behaviors on supply chain performance are criteria used to select suppliers, and the number of suppliers selected per input. Accordingly, this study will include these two factors as buyer behaviors that could also affect supplier’s performance.

3. Model building and hypothesis

The purpose of this research is to examine how the behavior of a buying firm directly effects supplier performance and hence indirectly effects the performance of the supply chain. The basic premise of supply chain management is that if any one member of the chain is performing at a less than optimal level the entire chain will have lower performance. Therefore the most fundamental hypothesis we will address is:

H₁: The on-time delivery performance of the supply base effects the on-time delivery performance of the buying firm

H₁ is intuitive and is a proposition that has been supported by previous studies (e.g. Shin et al. 2000). The key relationship we are interested in is how buyer behaviors may drive supplier performance. Our sample is composed of make-to-order (MTO) machine tool makers. Time has been noted as one of the key competitive elements for MTO companies (Handfield 1993). Therefore we are interested in buyer behaviors that create uncertainty for suppliers, and hence may inhibit the suppliers’ delivery performance. Accordingly the second hypothesis we wish to test involves the effect of buyer behaviors that cause uncertainty for the supplier.

H₂: Supplier on-time delivery performance will decrease as uncertainty caused by the buyer increases.

H₁ and H₂ form the basis of the model we will test. Figure 1 shows that as uncertainty increases supplier performance decreases, and the performance of the overall chain decreases. Note that while
the uncertainty is caused by the buyer, we do not hypothesize a direct effect on buyer performance from these behaviors. Instead we posit that the buyer behavior will be manifested in the performance of the supply base. This distinction is important because it suggests buying firms may not see the direct effects of their behavior, and hence may not be aware of how they are harming overall chain performance. In addition, buyers who do not see a direct link between their behavior and performance may place the blame for poor supplier performance on suppliers, when the reality is that the buyer’s behavior is driving the supplier’s poor performance.

Insert Figure 1 about here

The literature review also noted that there are supply chain management practices that have been found to effect the ability of a supplier (and hence the chain) to reach the desired level of performance. Two key practices that have been noted are choosing suppliers based on total costs, as opposed to price and reducing the number of suppliers per input – often moving to a single source of supply. It is possible that either or both of these behaviors will counteract the effects of increased uncertainty. Therefore we propose the following hypotheses:

H₃: As the number of suppliers per input increases supplier on-time delivery performance will decrease.

H₄: As the Buyer’s supplier selection criteria focus more on overall supplier capabilities supplier on-time delivery performance will increase.

One construct not yet addressed that we also include in our model is the amount the firm outsources. On one hand we could argue that as the amount of outsourcing (in terms of percentage of cost of goods sold) increases, it is likely that a firm will be less able to manage any one relationship, hence overall performance will decrease. It is equally likely that as the amount a firm outsources increases that the firm will get better at managing purchasing processes, and hence supplier
performance will increase. The relationship between how much a buyer outsources and supplier performance may be important. However, we do not have any theory to guide us in terms of the direction of the relationship. In addition, we are equally able to posit reasons for a positive or negative relationship. Therefore we propose the following hypothesis:

H₅: There will be no relationship between the amount a firm outsources and the on-time delivery performance of its suppliers.

The complete model we will test is presented in Figure 2. The following sections describe the data and methods used to test the model.

4. Data collection

The data used for this analysis was a sub-set of the data collected for the Global Manufacturing Research Group (GMRG) manufacturing practices survey. GMRG is a multi-national community of researchers dedicated to the study of international operations management. Its primary goal is to promote an understanding of differences in manufacturing practices across international boundaries through joint research efforts. The GMRG data were primarily collected from two industries: non-fashion textiles and machine tools. Survey questions cover the areas of manufacturing activities such as sales forecasting, production planning and scheduling, shop floor control, purchasing and materials management, and manufacturing performance. This survey questionnaire has been previously validated in other studies. Full details about its development and the administration of the survey are available in Vastag and Whybark (1994).

We are examining 290 respondents from the data set (although we use a larger sub-sample of 779 for measure validation). Table 1 provides details on the sample used to test the model. Specifically we are examining all of the machine tool makers in the sample who produce at least
75% of their output in a MTO fashion. We chose to parse the sample in this manner for a number of reasons.

Ward and Durray (2000) note that a single industry study increases researcher control over variance in the external environment. In the present study such control is vital. We do not suggest that all of our respondents face the exact same external environment. However, having all of the plants in the same industry greatly reduces the likelihood that differences in performance will be due to large differences in the external environment. Therefore a single industry study allows us to focus on the effects of buyer generated uncertainty.

The overall sample was composed mainly of machine tool makers and textile makers. We chose to examine the machine tool sample because of the higher level of technological complexity in these products. The increased complexity, is partially manifested in a much larger number of inputs in the average machine tool, meaning there is a greater opportunity to outsource.

Finally we chose to limit our discussion to respondents who were mainly operating in a MTO fashion. Competing on time has become very important for all firms in the last decade (Stalk 1988). However, for MTO firms time is of paramount importance (Handfield, 1993). By limiting ourselves to firms where time is of major import, we are able to avoid confounds with other elements of total cost. If we had included make to stock (MTS) firms it is possible that the results would not have been as clear because some of the MTS firms would be more concerned with other competitive elements besides time.

We note that our research is explicit in that we are studying a linkage in the supply chain that crosses organizational boundaries. To do so normally would require respondents from all organizations. However, the behaviors we are studying are all buyer driven. The only data we need on
the suppliers is their performance, data that can be supplied by the buyer. Hence we are in the unique position of being able to investigate a linkage in the supply chain, while only using data collected from half of the link.

5. Measures

The GMRG database is extensive. However, its construction can not possibly consider every conceivable use to which researchers will put the data. For the majority of the constructs we wish to examine there are specific items in the GMRG data set that correlate very well with what we wish to measure. Equally important all of the key constructs were included in the original survey. Table 2 summarizes the items used as well as reliabilities if appropriate.

Insert Table 2 about here

Both buyer and supplier performance were reported as percentages delivered late. Buyer performance on time was reported as the percentage of orders delivered after the promised delivery date. Supplier performance was reported as the percentage of purchase orders from suppliers that were delivered late. Both of these items were used without any type of modification in the subsequent analysis. Because both measures are of late deliveries, an increase in the score on either of these measures is actually a decrease in performance.

Also used without modification was the item to address the average number of suppliers per input. Our measure for how much outsourcing the company did was the percent of total manufacturing costs that were for purchased material.

The previous measures are all manifest with the item directly addressing the construct of interest. We also created two scales. These scales are latent in that the scale indirectly addresses the construct of interest. The scale for the uncertainty created by the buyer for the supplier (henceforth referred to as uncertainty) was made up of items that addressed the frequency of schedule changes. All
of the items addressed issues over which the buyer had at least some control. We addressed reliability of this scale (and the next scale) using all of the respondents in the overall sample for whom we had industry data \( n = 779 \) regardless of MTS / MTO production. Alpha for this scale was .66, above the minimum of .6 usually recommended for new measures (Nunnaly 1978). In addition we followed the suggestions of Flyn et al. (1990) and used factor analysis to determine if the scale is unidimensional. The results suggest that all of the items load on a single factor that explains a majority of the variance in the items. We formed a scale by summing the responses to these four items.

The scale used to address the way the firm selects suppliers (referred to as supplier selection criteria) was made up of items that addressed supplier capabilities in delivery, cost and quality. The alpha for this scale is .79 (once again addressed using the sample of 779 firms for whom we had industry data). This scale also meets the unidimensionality criteria. We formed a scale by summing the responses to these three capability items.

We note that one of the items in the supplier selection criteria scale involves lower costs. This item might have been interpreted as lower prices by some respondents. However, the high alpha indicates that when firms are selecting a supplier based on one capability, they are selecting them on all three capabilities addressed by the items simultaneously. Our initial aim was to differentiate between firms buying on price and those buying on total costs. We would argue that as the score on the supplier selection scale increases the emphasis on total costs, as opposed to any single criteria such as price, increases.

6. Statistical analysis and results

Our model is a causal model where the majority of the constructs are represented by manifest variables, so we tested it with path analysis. Before we ran the path analysis we examined the correlation matrix for the data set. The correlation matrix is displayed in Table 3. It should be noted that one of our key assumptions is that the behaviors of interest will not have direct effects on buyer performance. The correlation matrix supports such an assumption. The relationships between buyer
performance and the buyer behaviors of interest tend to be both small and insignificant. We also note that many of the behaviors of interest do have significant relationships with supplier performance. Finally it should be noted that the behaviors do covary with each other, suggesting it may be the bundle of behaviors as opposed to individual behaviors that matter.

Path analysis was initially performed for the entire data set on the model presented in Figure 2. Hair et al. (1998) note that when testing casual models researchers who have good theory are able to use more precise tests (one-tail tests as opposed to two-tail tests). For the majority of the links in our model we hypothesize a specific relationship, and hence will use one-tail tests for significance. Only H5 suffers from a lack of theoretical guidance, hence this relationship will be tested with a less precise two-tail test. Figure 3 shows the results of this analysis. Bollen and Long (1993) suggest that no one measure of fit can adequately describe the quality of a causal mode, so we report three recommended measures: CFI, Normed Fit Index (NFI) and Non-Normed Fit Index (NNFI). Based on these criteria the model has good fit. However, the path from number of suppliers per input to supplier performance is not significant. Therefore we re-estimated the model after removing this path. The new model, which (as expected) also displays acceptable fit is presented as Figure 4. The model in Figure 4 is the one we will discuss for the remainder of the manuscript due to its fit and parsimony.

Based on Figure 4 we find strong support for H1. The relationship between suppliers’ ability to deliver on time and the buyers’ ability to meet due dates is significant in the expected direction. In
addition we find strong support for H2 because as uncertainty (as we have defined and measured it) increases so does the percentage of late supplier deliveries.

H3 is not supported because there is no relationship between the number of suppliers per input and on time delivery. H4 requires a bit more discussion. Our original hypothesis suggested that as emphasis on these supplier selection criteria increased supplier performance should also increase. We find no support for this hypothesis. Instead we find that as buyers increase their focus on suppliers’ capabilities the delivery performance decreases. This counter-intuitive result will be discussed in detail later in the paper. Finally H5, which posited no relationship between the amount of outsourcing and supplier performance, is rejected because there is a significant relationship between the amount a firm outsources and the ability of suppliers to deliver on time.

Once we had an initial model for the entire sample we were interested in seeing if the model held globally or if there were regional variations. The vast majority of the companies in the sub-sample we were using were from one of three regions in the world; North America, Asia or Europe. Therefore we divided the sample into these three groups and did not include the few firms from other parts of the world (for instance there was a firm from Israel).

Prior to running the path models for each region it was necessary to determine how / if the regions differed on the constructs of interest. In order to test for regional differences we performed regression analyses with the regions represented by dummy variables. We addressed these relationships in this manner because dummy variable regression allowed us to determine if there was a relationship between region and the constructs of interest. In addition, dummy variable regression allows us to determine if there are differences among the three regions (see Hardy, 1993 for a complete discussion of regression using dummy variables). We used North America as our reference group.

Table 4 displays the results of the regression analysis that were significant. The three regions were not statistically different in terms of buyers’ on-time delivery performance, supplier selection criteria, uncertainty, or number of suppliers per input. However, region was a significant predictor of
supplier performance. Equally important there are significant supplier performance differences among all three regions. Asian firms (6.7% of orders delivered late) have significantly better performance on delivery than North American firms (17.6% of orders delivered late) who perform significantly better than European firms (23.4% of orders delivered late). Region was also a significant predictor of the percentage outsourced. And once more there were significant differences between the regions. Asian firms (22.5%), in this sample, outsource less than North American firms (34%), who outsource less than European firms (44%).

Based on the results displayed in Table 4 it is not surprising that when we ran the path analysis for each region we got very different results. Figures 5, 6 and 7 display the models for each of the regions. Note that while the model showed good fit for the overall sample, it only showed good fit for the North American sub-sample.

Figure 5, the North American sub-sample shows results very similar to the overall model, although the relationships are generally stronger. In addition the model displays good fit for this sub-sample. For North American firms buyer’s performance is strongly related to supplier performance. And supplier performance is strongly influenced by buyer behavior, with increases in uncertainty and outsourcing leading to decreased supplier performance on delivery. Once more the relationship between selection criteria and supplier performance is not in the predicted direction, although this path is not significant for this sub-sample.
Figure 6, the European sub-sample does not match the overall model nearly as well as the North American sub-sample. And the model does not display good fit for this sub-sample. However, the results show some support for the basic model we propose in Figure 1, with uncertainty being a significant driver of supplier performance, which in turn is a significant driver of buyer performance. However, selection criteria and percent outsourced are not significantly related to supplier performance, which is somewhat surprising given the fact that on average the European firms outsourced more than the other firms, and had the worst supplier performance.

Finally Figure 7 shows that the Asian sub-sample is very different from the other sub-samples and the overall sample. The model does not fit this data well, and there is not a significant linkage between supplier performance and buyer performance. This result is probably related to the fact that on average Asian firms had very low levels of supplier lateness (6.7% on average), which may create a restriction of range problem. In addition this means that in general Asian firms do not have a delivery problem with their suppliers, suggesting that the model may not apply, at least for the Asian firms where time is a critical competitive priority. The only significant linkage for this sub-sample is between selection criteria and supplier performance, and once more this relationship is in the opposite direction from what we predicted.

7. Discussion

The analysis suggests that our initial model can offer insights into the relationship between buyer behavior and supplier performance, but only in specific situations and regions of the world. This result is not surprising. We have presented this work as theory testing, however, many of the hypotheses that we tested have not been addressed explicitly in the literature before. The knowledge building process is an interactive one. We propose theories, test them, and then refine theory based on the results. Therefore this section will discuss the results with an aim of building a more complete model of the relationships of interest.
Our initial supposition was that buyers may perform in ways that do not directly harm the buyers performance, but which could harm supplier performance. We do find evidence of these phenomena. As buyers create more uncertainty for their suppliers, the supply bases performance suffers. This holds for the overall sample, as well as the European and North American firms. This result matters a great deal because the uncertainty we have measured is internal uncertainty, which the buyer has some control over. Newman et al. (1993) and Pagell et al. (2000) both suggest that increases in internal uncertainty will lead to increased internal costs. Our results suggest that increased internal uncertainty in one member of the supply chain will raise costs in other parts of the chain, decreasing overall supply chain performance. Once again this finding has significant practical implication because the buyer is not directly impacted by their behavior, and hence may not be cognizant of how they are harming supply chain outcomes.

Previous research (e.g. Shin et al. 2000) has shown that decreasing the size of the supply base should improve performance. Our data set did not directly address supply base size, so we measured the number of suppliers per input, under the assumption that the more sources used for each input the harder it is to communicate with any one source, which could harm performance. This hypothesis is not supported. We would suggest that our measure might not have been precise enough. Many models of supply base optimization (e.g. Venkatesan 1992) suggest that strategic inputs need to be single sourced, while commodities should be supplied by multiple suppliers. Our measure does not make distinctions between commodities and strategic inputs which may explain this result.

As the overall amount of the product that is outsourced increases, it is no surprise that supplier performance (in general) decreases. However, we would note that this relationship was strongest for North American firms, and not significant for the other two regions. The insignificant relationship for Asian firms may be due to Asian firms outsourcing less, on average than the rest of the sample. Therefore, their suppliers had generally smaller effects on performance than the overall sample. However, the European firms outsourced more, on average, than the rest of the sample, and there was
no relationship between level of outsourcing and performance for this sub-sample as well. At a simple level these findings suggest that for North American firms the amount outsourced is negatively related to the ability of suppliers to deliver on time, while companies located in other regions of the world do not see a relationship between the amount of outsourcing and supplier performance. At a deeper level these findings seem to suggest that more than the amount outsourced matters. Specifically how outsourcing is done is probably of greater import than the overall level of outsourcing. We base this conclusion on the fact that Asian firms (especially Japanese firms) have a long history of strong buyer supplier linkages (see for example Nishiguchi 1994) that may be responsible for the generally high levels of performance that these firm’s suppliers display in this sample.

The final relationship is that between supplier selection criteria and supplier performance. This relationship was significant for the overall model, as well as for the Asian firms, but not in the hypothesized direction. One shortcoming of survey research is that it is much better at testing what than whys, so we are left to postulate as to this relationship. However, the Asian firms offer a vital clue to our findings. These firms generally had very good supplier performance, yet they also had the strongest relationship between increased emphasis on buying on total cost and decreased supplier performance. This suggests that the relationship may be somewhat recursive, with buyers increasing selection of suppliers on total cost criteria, only when suppliers perform poorly.

Perhaps one of our most important findings is the regional differences. Our literature base is mostly North American. And many of the large sample studies of these relationships have also been done using surveys of North American firms. Hence it is not surprising that the model fits the North American firms very well. And the model also seems to have some global validity based on the overall results. But there are regional differences. The strongest being the generally high performance (on delivery) of Asian suppliers. Therefore supply chain theories are going to have to be developed that account for regional differences. For instance we would suggest that future research that examines
supplier performance and includes Asian firms would need to use measures beyond time to avoid a
restriction of range problem.

Conclusions

Our findings show that buyers can create uncertainty for their supply base, and that this
uncertainty has performance implications across the supply chain. In addition supplier performance is
driven by the amount buyers outsource as well as their selection criteria. Finally there are significant
regional differences among the firms, even though our sample was pretty restrictive in that all firms
were in the same industry and making the majority of their output in a MTO fashion.

Like all research, this work suffers from some shortcomings. The largest being our reliance on
an existing data set that was not created to test the exact questions we have asked. Our results for the
number of suppliers per input are an example where our data set limits our results. Our results are also
limited by the use of a single respondent at each firm. Additionally we are conducting supply chain
research using data from a single member of the chain. As we note earlier this is justified since most of
the behaviors we are interested in are buyer driven. However, a stronger test of the model could
include a measure of uncertainty as perceived by the supplier.

Future research could also address the issue of supplier selection criteria. Many authors (e.g.
Choi and Hartley 1996) have looked at this issue but not in the context we did. It is possible that a
different measure of supplier selection criteria would shed more light on the phenomena of interest.

With these limitations in mind we reiterate that our basic model finds support. Therefore
buying firms, through their behaviors, create uncertainty for their suppliers, which in turn harms
supply chain performance. From a managerial standpoint this finding matters a great deal because
buying firms can change their behaviors in ways that should increase supply chain performance. Better
supply chain management should lead to less uncertainty for suppliers, improving all members’ of the
chains performance.
REFERENCES


Hill, R.C., and Friedman, S.M., 1992, Managing the quality process: lessons from a Baldrige Award winner, Academy of Management Executive, 6(1), 76-88.


Quinn, F. J. (1996). The sustainable competitive edge, Supply Chain Management Review, 1, 1


Table 1
Characteristics of sample

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Sample Size (Machine tool industry – firms with over 75% of production done in a MTO fashion)</td>
<td>290*</td>
</tr>
<tr>
<td>North American Firms</td>
<td>77</td>
</tr>
<tr>
<td>Asian Firms</td>
<td>56</td>
</tr>
<tr>
<td>European Firms</td>
<td>156</td>
</tr>
<tr>
<td>Average Employment</td>
<td>485</td>
</tr>
<tr>
<td>Average percentage of orders that manufacturing (buyer) deliver late</td>
<td>18.7%</td>
</tr>
<tr>
<td>Average percentage of orders that suppliers deliver late</td>
<td>19.8%</td>
</tr>
<tr>
<td>Average number of suppliers per input</td>
<td>7.8</td>
</tr>
<tr>
<td>Average percentage of manufacturing costs outsourced</td>
<td>37.6%</td>
</tr>
</tbody>
</table>

* note regional totals do not equal 290 because an Israeli firm did not fit into any region
Table 2
Items used for analysis

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Alpha (if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Buyer Performance</strong></td>
<td>On average, what percentage of the company’s orders are delivered to customers after the promised delivery date?</td>
<td></td>
</tr>
<tr>
<td><strong>Supplier Performance</strong></td>
<td>What proportion of the company’s purchase orders are delivered by suppliers late?</td>
<td></td>
</tr>
<tr>
<td><strong>Uncertainty</strong></td>
<td>How often does the following change the company’s production schedule priorities after the plant has started an order? (1= never, 5 = very often)</td>
<td>Alpha = .66*</td>
</tr>
<tr>
<td></td>
<td>(1) Insufficient machine capacity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2) Change in sales plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3) Change in demand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4) Engineering design change</td>
<td></td>
</tr>
<tr>
<td><strong>Percentage Outsourced</strong></td>
<td>What percent of the company’s total manufacturing cost is for purchased materials?</td>
<td></td>
</tr>
<tr>
<td><strong>Number of Suppliers per Input</strong></td>
<td>About how many suppliers does the company have, on average, per part?</td>
<td></td>
</tr>
<tr>
<td><strong>Supplier Selection Criteria</strong></td>
<td>How often does the company consider the following when subcontracting work? (1 = never, 5 = very often)</td>
<td>Alpah = .79</td>
</tr>
<tr>
<td></td>
<td>(1) Subcontracting allows an earlier delivery date</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2) Subcontractor’s costs are lower</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3) Subcontractor’s quality is higher</td>
<td></td>
</tr>
</tbody>
</table>

* reliabilities and unidimensinality were tested using the 779 firms in the sample for which we had industry data
Table 3
Correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>Buyer Performance</th>
<th>Supplier Performance</th>
<th>Uncertainty</th>
<th>Supplier Selection Criteria</th>
<th>No. Suppliers per Input</th>
<th>% Outsourced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyer Performance</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier Performance</td>
<td></td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncertainty</td>
<td>.05</td>
<td>.157</td>
<td>.157</td>
<td></td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Supplier Selection Criteria</td>
<td>-0.036</td>
<td>.123</td>
<td>.131</td>
<td></td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>No. Suppliers per Input</td>
<td>-0.05</td>
<td>-0.018</td>
<td>.088</td>
<td>.113</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>% Outsourced</td>
<td>-0.001</td>
<td>.175</td>
<td>.092</td>
<td>.120</td>
<td>-0.035</td>
<td>1.0</td>
</tr>
</tbody>
</table>
### Table 4
Dummy variable regression to test for differences in regions – only significant models are displayed*

<table>
<thead>
<tr>
<th>Construct</th>
<th>F-sig</th>
<th>R squared</th>
<th>P -Europe</th>
<th>P-Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of supplier orders delivered late</td>
<td>&lt;.001</td>
<td>.119</td>
<td>.014</td>
<td>.001</td>
</tr>
<tr>
<td>Percentage outsourced</td>
<td>&lt;.001</td>
<td>.18</td>
<td>&lt;.001</td>
<td>.001</td>
</tr>
</tbody>
</table>

* Note – our reference group was North America so significant p values show that the region differs significantly from North American firms on the construct. A significant F value shows that region was a significant predictor of the construct.
Figure 1
Basic model

Uncertainty to Suppliers
Driven by buyer behaviors such as:
• Schedule changes
• Engineering changes
• Machine breakdowns
• Etc.

Supplier Performance

Buyer Performance
Figure 2
Complete hypothesized model

- Uncertainty created by buyer: $H_2$, -
- Number of suppliers per input: $H_3$, +
- Supplier selection criteria: $H_4$, +
- Percentage Outsourced: $H_5$, ?

Supplier performance on time $\rightarrow$ Manufacturing performance on time: $H_1$, +
Figure 3
First test of model

Uncertainty created by buyer → .13, P=.012
Number of suppliers per input → -.03, P=.4
Supplier selection criteria → .09, P=.06
Percentage Outsourced → .15, P=.01
Supplier performance on time → .32, P<.001
Manufacturing performance on time

Model fit

<table>
<thead>
<tr>
<th>Measure</th>
<th>Recommended</th>
<th>actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFI</td>
<td>&gt;.9</td>
<td>1.00</td>
</tr>
<tr>
<td>NFI</td>
<td>&gt;.9</td>
<td>.950</td>
</tr>
<tr>
<td>NNFI</td>
<td>&gt;.9</td>
<td>1.05</td>
</tr>
</tbody>
</table>

* From Hatcher 1994
Figure 4
Revised model

Uncertainty created by buyer → .13, P=.012

Supplier selection criteria → .09, P=.06

Supplier performance on time

Percentage Outsourced → .15, p=.01

Manufacturing performance on time → .32, P<.001

Model fit

<table>
<thead>
<tr>
<th>Measure</th>
<th>Recommended</th>
<th>actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFI</td>
<td>&gt;.9</td>
<td>1.00</td>
</tr>
<tr>
<td>NFI</td>
<td>&gt;.9</td>
<td>.951</td>
</tr>
<tr>
<td>NNFI</td>
<td>&gt;.9</td>
<td>1.002</td>
</tr>
</tbody>
</table>

* From Hatcher 1994
Figure 5
North American firms

Uncertainty created by buyer

Supplier selection criteria

Percentage Outsourced

Supplier performance on time

Manufacturing performance on time

Uncertainty created by buyer → Supplier performance on time: 0.24, P = 0.013

Supplier selection criteria → Supplier performance on time: Not significant

Percentage Outsourced → Supplier performance on time: 0.21, P = 0.03

Supplier performance on time → Manufacturing performance on time: 0.46, P < 0.001

Model fit

<table>
<thead>
<tr>
<th>Measure</th>
<th>Recommended *</th>
<th>actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFI</td>
<td>&gt;.9</td>
<td>1.00</td>
</tr>
<tr>
<td>NFI</td>
<td>&gt;.9</td>
<td>0.968</td>
</tr>
<tr>
<td>NNFI</td>
<td>&gt;.9</td>
<td>1.32</td>
</tr>
</tbody>
</table>

* From Hatcher 1994
Figure 6
European firms

Uncertainty created by buyer → Supplier selection criteria → Supplier performance on time → Manufacturing performance on time

- 0.11, P = 0.1
- 0.04, Not significant
- 0.03, Not significant
- 0.26, P < 0.001

<table>
<thead>
<tr>
<th>Model fit</th>
<th>Recommended</th>
<th>actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFI</td>
<td>&gt;.9</td>
<td>.909</td>
</tr>
<tr>
<td>NFI</td>
<td>&gt;.9</td>
<td>.83</td>
</tr>
<tr>
<td>NNFI</td>
<td>&gt;.9</td>
<td>.70</td>
</tr>
</tbody>
</table>

* From Hatcher 1994
Figure 7
Asian firms

- Uncertainty created by buyer
  - .09, Not significant

- Supplier selection criteria
  - .23, P=.04

- Percentage Outsourced
  - -.09, Not significant

- Supplier performance on time
  - .26, P<.001

- Manufacturing performance on time

<table>
<thead>
<tr>
<th>Measure</th>
<th>Recommended *</th>
<th>actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFI</td>
<td>&gt;.9</td>
<td>.909</td>
</tr>
<tr>
<td>NFI</td>
<td>&gt;.9</td>
<td>.71</td>
</tr>
<tr>
<td>NNFI</td>
<td>&gt;.9</td>
<td>.53</td>
</tr>
</tbody>
</table>

* From Hatcher 1994