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**An Empirical Investigation of the Relationship between Product Nature and  
Supply Network Strategy**

*Sonia Ming-Shiow, Lo\**,

*and*

*Damien J., Power*

*Department of Management, The University of Melbourne*

5<sup>th</sup> Floor, Babel Building,  
The University of Melbourne  
Victoria 3010 Australia

\* Corresponding author: [m.lo3@pgrad.unimelb.edu.au](mailto:m.lo3@pgrad.unimelb.edu.au)

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**Key words:** Supply chain management (SCM), product nature, supply network strategy

#### **Introduction**

The term of “supply chain management (SCM)” was firstly introduced in the context of Logistics in the early 1980s (Oliver & Webber, 1982), and has gained tremendous attention in the following decades. Along with the development of the relevant research, the concept of “supply chain” has been evolving from a single dyadic relationship between customers and suppliers, to an external chain covering customers’ customers and suppliers’ suppliers, and further, a complex network model (C. M. Harland, 1996).

The concept of regarding supply chain as a complex inter-organisational network is widely accepted by researchers, and has provoked discussion in many different perspectives. In a great number of relevant research works, some of them traced the context of supply chain back to organisational design (Choi & Hong, 2002); some investigate a variety of network types developed under various business situations (e.g. (Achrol & Kotler, 1999, ; Campbell & Wilson, 1996, ; Cravens, Piercy, & Shipp, 1996, ; Grandori & Soda, 1995, ; Robertson & Langlois, 1995)); some examine the structure of such a network model in either practice or theory (Choi & Hong, 2002, ;

C. M. Harland, 1996, ; Lambert & Cooper, 2000, ; Phillips, Johnsen, Caldwell, & Lewis, 2006), and some others explore it from the management standpoint (Caputo, Cucchiella, Fratocchi, Pelagagge, & Scacchia, 2004, ; C. Harland, 1997, ; Moller, Rajala, & Svahn, 2005, ; Ojasalo, 2004).

In light of the growing body of literature on network-based supply chains, “supply network” is more broadly used in describing the complex inter-organisational relationships recently. According to some authors,

“Supply network encompass the mess and complexity of networks involving lateral links, reverse loops, and two-way exchanges, and include a broad, strategic view of resource acquisition, development, management, and transformation. Supply chain management tends to concentrate on more simplistic, linear, and unidirectional flows of materials and associated information, taking a less strategic, logistical perspective. (C. M. Harland, Lamming, Zheng, & Johnsen, 2001, p. 22)

By definition, a “supply network” carries more strategic meaning and represents better the complex bi-directional inter-organisational relationships. As a consequence, it is considered by some authors as a better term in describing the relationships between multiple businesses (BlackHurst, WU, & O'Grady, 2004, ; Choi & Hong, 2002, ; Lai, Ngai, & Cheng, 2004, ; Lamming, Johnsen, Zheng, & Harland, 2000).

The concept of “supply network strategy” was developed amidst the trend of an increasingly connected business world (C. M. Harland, 1996, ; C. M. Harland & Knight, 2001, ; C. M. Harland, Lamming, & Cousins, 1999). As pointed out by these authors, the competition in global markets is no longer on a firm-to-firm basis, but at a network-to-network level. Network members need to collaborate with each other

and jointly determine a priority across the firm level to pursue. Such a competitive priority set at the network level is called “supply network strategy”.

### **Supply Network Strategy**

Supply network strategy is viewed as an extension of operations strategy in the manufacturing management area (C. M. Harland & Knight, 2001, ; C. M. Harland et al., 1999). But, whilst operations strategy addresses competitive priorities pursued by a single firm unit, supply network strategy emphasizes the competitive priority to be adopted by the entire network, i.e. across inter-organisational boundaries. Because the success of the formulation and implementation of a supply network strategy is associated with the network structure and the degree of collaboration among network members (C. M. Harland & Knight, 2001) it is suggested that all actors should communicate on a mutual trust basis and in turn create a rational plan for organisations in the network. This rational plan can be formed from a fundamental priority which differentiates the network with other rivals in a particular manner, e.g. cost, quality, or flexibility. Having such a fundamental competitive priority, i.e. supply network strategy, appears to guide network members working towards a common objective and result in better network performance.

A number of studies have addressed the factors affecting the determination of supply network strategy. Fisher’s work is one of them. In 1997, Fisher demonstrated a framework in attributing supply network strategy to product type. (Although Fisher used the term “supply chain type” in his model, his discussion is based on the common objective pursued by network members. As a consequence, this article will use “supply network strategy” to represent the “supply chain type”, because “supply network strategy” carries more strategic meaning and is a better way in describing bi-

directional inter-organisational relationships). Fisher is considered to be one of the pioneers in associating supply network strategy with product type (Aitken, Childerhouse, & Towill, 2003).

The central issue investigated by this article is whether there is a particular relationship existing between supply network strategy and product characteristics. A conceptual model proposed by Fisher in 1997 is used in this study. This article attempted to provide quantitative empirical data in validating Fisher's model.

The following sections of this article are outlined as below. Fisher's model is firstly introduced. Then the methodology, research question and hypotheses of this research follow. The last part reports the findings and relevant discussion and conclusions.

### **Fisher's Framework**

Fisher explores two themes in his model. The first dimension is product nature. In this typology, Fisher firstly groups product nature into two different segments: functional product and innovative product. Functional product tends to have a stable demand pattern, with longer life cycle, lower product variety, lower contribution margin, and longer lead time. On the contrary, innovative products are those having shorter product life cycles, higher product variety, higher contribution margin, and shorter lead time. Their demand pattern is less predictable.

Secondly, Fisher examines the dimension of supply network strategy. Supply networks are categorised into efficient and responsive types, in accordance with the main priority they pursue. According to Fisher, efficient supply networks design their operational strategies from the perspective of cost. They aim to "supply predictable demand efficiently at the lowest possible cost" (Fisher, 1997, p. 108). In contrast, the objective of responsive networks is reacting to customers' needs in a quick and

efficient way. Cost is not a major concern in their operational strategy deployment. Fisher’s discussion on supply network strategy covers numerous internal function strategies within a firm when dealing with their partners, such as manufacturing strategy, inventory strategy, lead-time focus, and product-design strategy. Apart from that, some of his discussion concerns supplier selection criteria.

Building on the relevant observation and discussion of the two dimensions (product nature and supply network strategy), a four-cell model is introduced by Fisher (1997, shown as Figure 1). By Fisher’s definition, all products can be ultimately classified into primarily functional or primarily innovative groups. Each of them should adopt “efficiency” and “responsiveness” as their network strategy respectively. The mismatch of the product type and the network type will result in serious problems in business operations (Fisher, 1997).

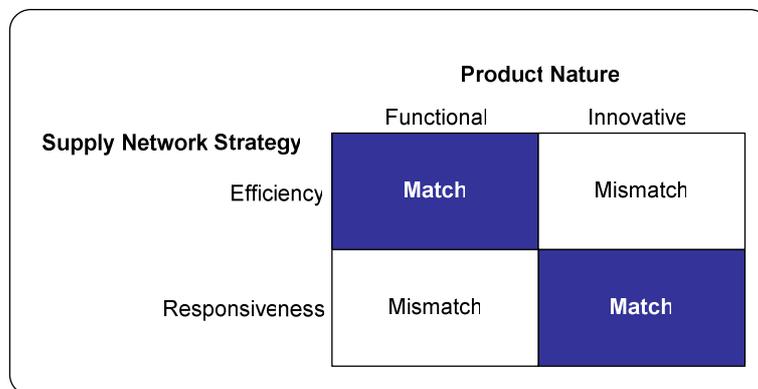


Figure 1 Matching supply network strategy with product nature (Source from: (Fisher, 1997))

### Works Extending Fisher’s Model

A great number of researchers have contributed their work in extending Fisher’s model. Some explore how these network types relate to management issues (Forman & Hunt, 2005, ; Holmström, Korhonen, Laiho, & Hartiala, 2006, ; Hau L Lee, 2002, ;

Li & O'Brien, 2001, ; Muckstadt, Murray, Rappold, & Collins, 2001, ; Ramdas, 2003, ; Schonsleben, 2000); some investigate the relationships between a particular market- or product-related factor and supply network strategy, through either case study or survey approaches (Childerhouse & Towill, 2004, ; Harrison & New, 2002, ; T. Randall & Ulrich, 2001, ; T. R. Randall, Morgan, & Morton, 2003, ; Thirumalai & Sinha, 2005, ; Towill, Childerhouse, & Disney, 2000, ; Turner & Williams, 2005, ; Remko I van Hoek, Harrison, & Christopher, 2001); some examine other factors that might also have influence on tailoring a supply network, e.g. product life cycle and supply uncertainty (Aitken et al., 2003, ; Catalan & Kotzab, 2003, ; Hau L Lee, 2002, ; Li & O'Brien, 2001); and another group of authors relate the efficient and responsive supply networks to the manufacturing paradigms of lean, agile, and leagile. (Childerhouse & Towill, 2000, ; Christopher & Towill, 2000, ; Huang, Uppal, & Shi, 2002, ; Mason-Jones, Naylor, & Towill, 2000a, , 2000b, ; Stratton & Warburton, 2003, ; Wang, Huang, & Dismukes, 2004)

### **Research Question and Hypotheses**

Although Fisher's propositions have been widely discussed in the past decade, very little research has been done to actually validate this model. In addition, most of these validations are based on a sub-set of Fisher's product-related factors. Consequently, in order to fill the gap in the relevant research area, this study uses Fisher's model as the framework to give it an overall justification. It aims to test if the association between supply network strategy and product nature proposed by Fisher reflects the real business world situation. The result is expected to facilitate the discussion on designing a supply network from both theory and practice standpoints.

The research question of this study is:

Does Fisher's model represent the association between product nature and supply network strategy appropriately?

To answer this research question, three hypotheses are formulated:

Hypothesis 1 The association between product nature and supply network strategy is significant.

Hypothesis 2 Firms with functional product type emphasize efficiency-related strategies more than firms with innovative product type.

Hypothesis 3 Firms with innovative product type emphasize responsiveness-related strategies more than firms with functional product type. .

### **Research Method**

A survey method was adopted in this study to undertake data collection. The research population were manufacturing firms within Australia, in an industry database (JAS-ANZ). Approximately 4,725 firms are classified in this sector. 2,000 participants were randomly drawn from the database. The respondents were senior managers holding positions at a strategic level in the company selected. The adjusted response rate (without calculating the non-deliverable subjects and an estimated database error) was 6.61 %.

The questionnaire was composed of three parts: organisation profile, product characteristics, and supply network strategy. The part concerning company profile asked questions related to organisation profile, to gather a background understanding of respondents. Questions in the following parts of product characteristics and

network strategy were developed from Fisher’s statements toward these themes. Detailed survey items are attached (see Appendix).

### Results and Findings

Respondent organisations were categorised into eight groups by the two dimensions of product nature (functional or innovative) and supply network strategy (efficiency, responsiveness, hybrid, and no category.). Firms were grouped into the functional segmentation if their major product family had a predictable demand pattern, e.g. having long product life cycle, low stockout rate, and low product variety. On the contrary, firms with major product families with an unpredictable demand pattern were grouped into the innovative segmentation. In terms of network strategy, firms were considered to be pursuing efficiency- and responsiveness- based strategy if their survey responses were identified as more cost- and responsiveness-focused respectively. If the survey responses identified that both efficiency and responsiveness pursuits were above the cut off points (as set by this study), they were labelled as having a “hybrid” supply network strategy. The group of “no category” represents a group of firms whose intentions in both cost and responsiveness pursuits were below the cut off point.

Under these definitions of product nature and supply network strategy, the population of survey responses is shown as Table 1 below.

<i>(Number of Respondents)</i>	<b>Functional Product (71)</b>	<b>Innovative Product (36)</b>
<b>Efficiency(25)</b>	17	8
<b>Hybrid(73)</b>	49	24
<b>Responsiveness (5)</b>	3	2
<b>No Category (4)</b>	2	2

Table 1 Data population of survey responses

H1 => Rejected

The survey result indicates that more than two thirds of surveyed firms (73 out 107, 68.22%) are adopting a hybrid strategy as their supply network strategy. The situations are similar in functional and innovative product groups (69.01% and 66.67% respectively). In other words, irrespective of the product type, most organisations regard **both** efficiency and responsiveness as critical strategies in dealing with their partners. The result therefore indicates that efficiency and responsiveness are not mutually exclusive in today's business environment. This finding does not support the situation observed by Fisher (1997) and others (Griffis, Cooper, Goldsby, & Closs, 2004). On the contrary, it represents a type of strategy called "leagile", which combines both efficiency and responsiveness (Naylor, Naim, & Berry, 1999, ; Turner & Williams, 2005).

A Chi-Square test (Table 2) was further used to examine if the populations of each network group in each product type were significantly different. The result reveals that the distributions were based on the same pattern, meaning that the choice of supply network strategy was not significantly influenced by the nature of product.

**Test Statistics**

	Grouping
Chi-Square(a)	1.338
df	3
Asymp. Sig.	.720

a. 2 cells (50.0%) have expected frequencies less than 5. The minimum expected cell frequency is 3.9.

Table 2 Chi-square test result

A t-test was used to examine whether firms with different product types placed a different degree of emphasis on a particular supply network strategy.

The study firstly examined whether the degree of emphasis placed on efficiency-related strategy by firms providing functional products was higher than by firms providing innovative products. The result (see Table 3) indicates that there is not a significant difference on the mean values of these two groups of companies.

Subsequently this study examined whether the degree of emphasis placed on responsiveness-related strategy by firms providing innovative products was higher than by firms providing innovative products. The result (see Table 4) also indicates that there is not significant difference on the mean values of these two groups of companies.

Consequently, based on the survey result and relevant statistics analysis, Hypothesis 2 and Hypothesis 3 are rejected.

H2 and H3 => Rejected

## **Discussion**

The results of the survey conducted in this study do not support Fisher's (1997) propositions. The result indicates that the association between product nature and supply network strategy is not significant. In addition, irrespective of the product type provided by a firm, there appears to be no significant difference in the degree of emphasis placed on either efficiency- or responsiveness-related strategies.

The possible reasons can be discussed from the following perspectives.

Firstly, the product characteristics proposed by Fisher may not represent product nature completely. As stated by Fisher, these proposed characteristics originate from demand aspects. By reviewing other literature in the context of product type, it is evident that product nature should also cover many other aspects, such as the stage of product life cycle, supply uncertainty, and the complexity of the product

(Childerhouse, Aitken, & Towill, 2002, ; Hoekstra & Romme, 1992, ; Lamming et al., 2000, ; Naylor et al., 1999, ; Pagh & Cooper, 1998, ; Spens & Bask, 2002). Therefore, in investigating the impact of product nature on supply network strategy, more product characteristics may need to be incorporated apart from those proposed by Fisher. In addition, demand characteristics of a product are highly correlated with the position the firm located within a network (C. M. Harland, 1996, ; H. L. Lee, Padmanabhan, & Whang, 1997). The accuracy of demand prediction is decreasing as firms are further away from the customer side. (This is also known as the bullwhip effect.) As a result, it is questionable whether taking demand-related factors to represent the nature of product alone is sufficient.

Secondly, product nature is not the sole determinant of supply network strategy. As noted by a number of studies of supply networks, a supply network is composed of a number of elements, e.g. network members, tiers of network, number of members in each tier, the collaboration model among network members, and the location a firm holds in a network (Choi & Hong, 2002, ; C. M. Harland, 1996, ; Lambert & Cooper, 2000). In addition to the direct influence on its network structure, these factors also affect the success of a strategic approach adopted among the network members. In other words, understanding these components of a supply network is regarded as a fundamental but critical step in the formulation and implementation of a successful network strategy (Choi & Hong, 2002, ; C. M. Harland, 1996, ; Lambert & Cooper, 2000, ; Phillips et al., 2006). Thus, this article considers that, from the perspective of network management, Fisher's model is perhaps not comprehensive enough because it concerns only factor associated with product nature. A more inclusive discussion could contain other factors, e.g. network structure.

Thirdly, the features of network strategy have been changing in the past decade since Fisher's typology was proposed. In Fisher's framework, each network strategy has its own characteristics and organisations can only choose one from the two. They are represented as being mutually exclusive (Fisher, 1997, ; Griffis et al., 2004). However, the survey results indicate that most surveyed companies (73 out of 107, 68.22%) are pursuing both efficiency and responsiveness as their network strategy, irrespective of their product nature. A high proportion of respondents combining both strategies together also reflects the fact that the benefits resulting from the proposed operations strategies are not easily distinguished between efficiency and responsiveness.

An example of this is, in the regard of product-design strategy, where Fisher claims that modular design coupled with a postponement strategy will contribute substantially to responsiveness, instead of efficiency. In related research works, however, some hold the same opinion as Fisher's (Bi & Zhang, 2001, ; Hau L Lee & Tang, 1997, ; R I van Hoek, 2001), while others argue that these strategies can also improve business performance in cost related areas (Pagh & Cooper, 1998, ; Remko I van Hoek & Weken, 1998). To test whether today's businesses view the benefits of these operations strategies in a different way with Fisher's, this research further employed the data reduction method of Factor Analysis to unveil the underlying structure of the network strategy characteristics. It can be seen from the preliminary result (as shown in Table 5) that the postponement strategy is highly correlated with the efficiency-related factor and the modular design strategy is highly correlated with both the efficiency- and responsiveness-related factors. This evidence is different to what was proposed by Fisher. As a consequence, it is argued that the network strategy characteristics have perhaps changed in the past decade, and that this is also possibly one of the reasons that Fisher's framework was not supported by the survey result.

## Conclusions

Modern business management on inter-organisational relationships has shifted from the traditional uni-directional supply chain to the multi-directional supply network model. More and more researchers tend to use the term of “supply network” to represent the complex inter-organisational relationships. In order to succeed in this dynamic and competitive business environment, it is suggested to collaborate with upstream and downstream partners and formulate a common objective to pursue, characterised as developing “supply network strategy”. Having an adequate supply network strategy is expected to lead all network participants to attain better performance.

In the research of supply network strategy, a school led by Fisher suggests tailoring supply network strategy to match the nature of the product provided by the organisation. Fisher (1997) proposed a framework, segmenting products into functional and innovative groups, and argues that each group of product is appropriate to pursue efficiency and responsiveness as their network strategy, respectively.

A survey method using self-administrated questionnaires was carried out in this research to validate Fisher’s model. The result indicates that the influence of product nature on the selection of supply network strategy is not significant. The reasons can be discussed from three viewpoints, including: whether the product characteristics proposed by Fisher reflect product nature adequately; in spite of product nature, what the other factors are influencing network strategy; and over the past decade, if there is any change to the features of the two network strategies proposed by Fisher.

In total, Fisher’s model of supply network strategy proposed from the factors of product nature is facing challenges in the current business environment. The association between supply network strategy and product nature in this study is not

found to be significant. Further, firms with different product types do not appear to place a significant different degree of emphasis on a particular supply network strategy. As a consequence, it may be that firms need to consider factors influencing the supply network strategy from a broader perspective. A more comprehensive understanding of product nature and the network structure is expected to contribute to a more successful supply network management.

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### Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Mean_Effi	Equal variances assumed	.465	.497	.790	105	.431	.09809	.12415	-.14808	.34426
	Equal variances not assumed			.780	68.043	.438	.09809	.12576	-.15286	.34904

Table 3 T-test result (Efficiency-related strategies)

### Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Mean_Resp	Equal variances assumed	.042	.838	.226	105	.822	.02882	.12765	-.22428	.28192
	Equal variances not assumed			.225	69.629	.823	.02882	.12820	-.22688	.28452

Table 4 T-test result (Responsiveness-related strategies)

	Component				
	R1	E1	E2	R2	R3
P1.1 Our primary purpose in dealings with partners is pursuing lowest total cost.	-.131	-.073	.728	.278	.316
P1.2 Our primary purpose in dealings with partners is pursuing quickest response to customers' demand.	.176	.120	.087	.035	.814
P2.1 Our manufacturing focus/inventory strategy in dealings with partners is maintaining high average utilization rate.	.099	.620	.251	.269	-.024
P2.2 Our manufacturing focus/inventory strategy in dealings with partners is generating high turns and minimizing inventory throughout the chain.	-.013	.801	.076	-.101	.107
P2.3 Our manufacturing focus/inventory strategy in dealings with partners is developing the use of excess buffer production capacity.	.066	.332	.199	.751	-.160
P2.4 Our manufacturing focus/inventory strategy in dealings with partners is developing significant buffer stocks of parts or finished goods.	.262	.056	-.020	.792	.127
P3.1 Our lead-time focus in dealings with partners is shortening delivery lead-time as long as it does not increase cost.	.273	.488	.284	.087	-.226
P3.2 Our lead-time focus in dealings with partners is investing aggressively in ways to reduce delivery lead-time irrespective of cost.	.358	.389	-.076	.257	-.199
P4.1 Our product design strategy is focused on producing low cost product.	.040	.463	.471	.182	.065
<b>P4.2 Our product-design strategy is using modular design.</b>	.427	.602	-.200	-.010	.016
<b>P4.3 Our product-design strategy is to postpone product differentiation for as long as possible.</b>	.010	.729	-.033	.172	.228
P5.1 Our approach to choosing suppliers is primarily based on their cost.	.089	.107	.860	-.143	-.076
P5.2 Our approach to choosing suppliers is primarily based on their quality.	.448	.079	.342	-.369	-.099
P5.3 Our approach to choosing suppliers is primarily based on their delivery speed.	.602	.271	.040	-.173	.417
P5.5 Our approach to choosing suppliers is primarily based on their product flexibility.	.844	-.027	-.042	.076	.207
P5.6 Our approach to choosing suppliers is primarily based on their volume flexibility.	.866	.067	.043	.184	-.127
P5.7 Our approach to choosing suppliers is primarily based on their process flexibility.	.781	.174	.058	.230	.140

Extraction Method: Principal Component Analysis.  
Rotation Method: Varimax with Kaiser Normalization.  
a Rotation converged in 6 iterations.

\* A cut-off point of .32 was set, as suggested by (Tabachnick & Fidell., 2001).

\*\* E1, E2: Efficiency-related factors, R1, R2, R3: Responsiveness-related factors.

Table 5 Preliminary factor analysis result of supply network strategy characteristics

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## Appendix -- Survey Items

### Product Characteristics

	Mean	Std. Deviation
P2_1 Product life cycle (1: < 3 months, 2: 3-12 months, 3: 1-2 years, 4: > 2 years)	3.56	.838
P2_2 Contribution margin (1: <5%, 2: 5-20%, 3: 20-40%, 4: 40-60%, 5: >60%)	2.39	.882
P2_3 Product variety (1: <10, 2: 10-20, 3: 20-50, 4: 50-100, 5: >100)	2.53	1.454
P2_4 Average margin of error (1: <10%, 2: 10-30%, 3: 30-50%, 4: 50-80%, 5: 80-100%)	1.77	.931
P2_5 Average stockout rate (1: <2%, 2: 2-10%, 3: 10-30%, 4: 30-50%, 5: >50%)	1.52	.696
P2_6 Average forced end-of-season markdown (1: <5%, 2: 5-10%, 3: 10-25%, 4: 25-50%, 5: >50%)	1.35	.776
P2_7 Lead time required for make-to-order products (1: 1-14 days, 2: 2-12 weeks, 3: 3-6 months, 4: 6-12 months, 5: > 1year)	1.80	.909

### Supply Network Strategy

(1-5: Not Important at All – Very Important)	Mean	Std. Deviation
P1.1 Our primary purpose in dealings with partners is pursuing lowest total cost.	3.91	1.069
P1.2 Our primary purpose in dealings with partners is pursuing quickest response to customers' demand.	4.40	.799
P2.1 Our manufacturing focus/inventory strategy in dealings with partners is maintaining high average utilization rate.	3.66	1.094
P2.2 Our manufacturing focus/inventory strategy in dealings with partners is generating high turns and minimizing inventory throughout the chain.	3.74	1.190
P2.3 Our manufacturing focus/inventory strategy in dealings with partners is developing the use of excess buffer production capacity.	2.80	1.174
P2.4 Our manufacturing focus/inventory strategy in dealings with partners is developing significant buffer stocks of parts or finished goods.	2.67	1.293
P3.1 Our lead-time focus in dealings with partners is shortening delivery lead-time as long as it does not increase cost.	4.19	1.001
P3.2 Our lead-time focus in dealings with partners is investing aggressively in ways to reduce delivery lead-time in respective of cost.	3.13	1.237
P4.1 Our product design strategy is focused on producing low cost product.	3.42	1.269
P4.2 Our product-design strategy is using modular design.	2.73	1.329
P4.3 Our product-design strategy is to postpone product differentiation for as long as possible.	2.61	1.236
P5.1 Our approach to choosing suppliers is primarily based on their cost.	3.95	.925
P5.2 Our approach to choosing suppliers is primarily based on their quality.	4.65	.600
P5.3 Our approach to choosing suppliers is primarily based on their delivery speed.	3.97	.884
P5.5 Our approach to choosing suppliers is primarily based on their product flexibility.	3.16	1.088
P5.6 Our approach to choosing suppliers is primarily based on their volume flexibility.	3.33	1.053
P5.7 Our approach to choosing suppliers is primarily based on their process flexibility.	3.00	1.219