EFFECTS OF MANUFACTURING CAPABILITY CHOICES ON BUSINESS PERFORMANCE

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Özet: Çalışmanın amacı, firmaların üretim yeterlilikleri seçimlerinin performanslarına olan etkisini araştırmaktır. Bu amaçla, üretim literatürüne dayalı olarak model geliştirilmiştir. Modelin test edilmesi amacıyla imalat sanayinde faaliyet gösteren 199 firmaya anket uygulanmıştır. Anketin değerlendirilmesi aşamasında doğrulayıcı faktör analizi uygulanmıştır. Çalışma sonuçları, önerilen yapısal eşitlik modelini desteklemektedir. Analiz sonuçlarına göre kalite ve maliyet, firmaların performansını pozitif biçimde etkilemektedir.

Anahtar Kelimeler: Üretim Yeterlilikleri, Firma Performansı, Yapısal Eşitlik Modeli, Lirsel

Abstract: The aim of the paper is to investigate the effects of firm's manufacturing capability choices on business performance. For this reason, a proposed model was developed based on the manufacturing literature. To test the model survey instrument was conducted to 200 firms. Confirmatory factor analysis is used to evaluate the survey instrument. Study results supported the proposed structural equation modeling. According to the analysis's results cost and quality positively affect a firm's business performance.

Keywords: Manufacturing Capabilities, Business Performance, Structural Equation Modeling, Lisrel

I. Introduction

Manufacturing strategies contains various issues in the literature such as order winners, order qualifiers, manufacturing capabilities, speed of new product development, and development of infrastructural issues, etc (Skinner, 1969; Ward et al., 2000). However, there is general agreement in literature that the content of manufacturing strategy can be divided into two areas (Weir et al., 2000:832). The first is the performance objectives; cost, quality, flexibility, delivery, and the second, strategic decision areas; process technology, capacity, facilities and vertical integration, quality systems, production and inventory control systems, workforce management, manufacturing organization (Miller and Roth, 1994; Mills et al., 1995; Kathuria and Partovi, 2000; Brown, 1998).

Performance objectives within the manufacturing strategy content embody the choice of the most beneficial set of manufacturing capabilities for a company. These capabilities indicate the degree of strategic intent which provide a basis for testing the whether the business strategy and manufacturing strategy choices are consistent with this intent (Ward et al., 1996:598). Several

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researchers, by supporting this idea, claim that there must be a proper fit or congruence between the manufacturing strategies and business strategies for achieving superior performance for the firms (Miller and Roth, 1994; Mills et al., 1995; Papke-Shields and Malhotra, 2001). However, firms which are practicing new manufacturing practices can accomplish several manufacturing capabilities, such as lower cost, higher quality, faster product introduction and greater flexibility all at the same time (Hayes and Pisano, 1994:79). For this reason, some researchers defined this capabilities as a manufacturing strategy goals (Narasimhan and Jayaram, 1998), competitive priorities (Hayes and Pisano, 1994; Skinner, 1969), or competitive manufacturing capabilities (Ward et al., 1996) and included additional indicators such as “lead times” (Skinner, 1969), “time and customer service” (Kathuria and Partovi, 2000), “innovation and value” (Vickery et al., 1997), “after-sales service aspects” (Spring and Dalrymple, 2000; Dangayach and Desmukh, 2003), “technology and profit” (Krause et al., 2000), “broad distribution and broad line” (Miller and Roth, 1994). Based on these studies we considered four types of manufacturing capabilities, cost, quality, flexibility, and delivery, for the primary focus of the study and extracted these from the aforementioned literature.

As can be seen above, there are considerable researches in the literature. On the other hand, little empirical researches were done that examines the effects of firm’s manufacturing capability choices on business performance. Our contributions at this point are reviewing the literature and propose a model to investigate the relationships between manufacturing capability choices and business performance. In doing so, firstly we describe the purpose of the study. Secondly, we examine the linkages between the manufacturing capabilities and business performance. Finally, we present our study results and conclude some suggested researches about manufacturing capabilities affecting business performance.

A. The Purpose of the Study

Vickery et al., (1997) investigated the manufacturing capabilities and firm performance linkages in the furniture industry in a sample of 65 firms and found that manufacturing performance positively influences firm performance. Similarly Kim and Arnold (1992) found supportive relationships between manufacturing competence and firm performance. Besides, Narasimhan and Jayaram (1998) examined a conceptual framework among the sourcing decisions, manufacturing goals, customer responsiveness, and manufacturing performance linkages. Also, Schroeder et al. (2002), explored the manufacturing strategy from the perspective of the resource-based view of the firm. Other researchers have demonstrated a positive link between the manufacturing executives’ roles in strategic decisions, especially business level strategic decision-making, and firm performance (Swamidas ve Newel, 1987; Miller and Roth 1994; Papke-Shields and Malhotra, 2001). The primary research question of the study is: Are there positive linkages between the firm's manufacturing capabilities and business performance? To find out the linkages we developed a proposed model and tested the model validity with Lisrel 8.2 software. The purpose of the study is to reveal the most influential manufacturing capabilities of firms, which positively effects on their business performance and state expressly how to sustain their strategic competitive advantage.

II. Manufacturing Capabilities: Definition of Variables and Hypotheses of Research

Based on the conceptual studies of Skinner (1969), Ward et al. (1996) Lynn (2000), Badri et al. (2000), manufacturing capability variables are selected and classified into the four categories of cost, quality, flexibility and delivery. Appendix 1, describes manufacturing capabilities as defined in the survey instrument.

A. Cost

Cost refers to the sum of all discounted costs to the firm involved in developing, producing, delivering, servicing, and disposing of the product (Badri et al., 2000:159). There are several dimensions associated with the cost measures. For example, low cost; reducing material, labor, capital and overhead cost, (Ward et al. 1996:600; Lynn, 2000:262; Badri et al., 2000:167), reducing inventory level and vendor's quality (Lynn, 2000). Realizing low inventory level, decreasing labor, material and overhead costs are all positive factors of the cost efficiency construct (Lynn, 2000:262). Above the all we can develop first hypothesis as follows:

H1: Low cost capability positively affects a firm's business performance

B. Quality

Quality can be defined as fitness for use and includes product performance, reliability, and durability (Tracey et al., 1999:415; Ward et al., 1996:600). Some researchers included additional variables to measure quality dimension such as improving presale, post sale and transactional services, and improving statistical quality control (Dangayach and Deshmukh, 2003; Lynn, 2000). Badri et al. (2000), included international quality certifications instead of statistical quality control. Also, Tracey et al., (1999:415) defined full dimensions of quality as performance, features (defective rates), reliability, conformance, durability, serviceability, and aesthetics. Quality is influenced by product design, manufacturing performance, incoming quality from suppliers (vendor's quality), and delivery performance. Above the all we can develop second hypothesis as follows:

H2: Quality capability positively affects a firm's business performance

C. Flexibility

Manufacturing flexibility is the ability to produce a variety of products in the quantities that customers demand and achieving good performance over this wide range of products (Spring and Dalrymple, 2000). As can be seen above this definition, flexibility is strategically important criteria not only for competitive position for the manufacturing firms but also responsiveness to customer expectations and business performance (Zhang et al., 2003). There are several dimensions associated with the flexibility measures. For example, product customization, mix changes, design changes, volume changes, and responsiveness to customer requirements (Dangayach and Deshmukh, 2003; Lynn, 2000; Zhang et al., 2003). Also, each dimension has three distinct attributes: range/variety, mobility/responsiveness, and uniformity (Zhang et al., 2003:176). Above the all we can develop third hypothesis as follows:

H3: Flexibility capability positively affects a firm's business performance

D. Delivery

Delivery is usually defined in a number of aspects of an organization's operations. Specifically, delivery implies dependable delivery promises and fast deliveries (Kathuria nd Partovi, 2000:221; Ward et al., 1996:600; Dangayach and Deshmukh, 2003; Lynn, 2000; Badri et al., 2000:167). Delivery reliability can be defined as the ability to meet delivery promises whereas delivery speed is defined as the ability to deliver faster than competitors (Kathuria and Partovi, 2000:221). Another aspect of delivery is how reliably the products or services are developed and brought to the market which implies improvements in products and process (Lynn, 2000:262). Badri et al. (2000:167) defined presale and after sales service and technical support as dimensions of delivery construct. Above the all we can develop fourth hypothesis as follows:

H4: Delivery capability positively affects a firm's business performance

III. Business Performance

Business performance measures are found a great extent in the literature. For example, Vickery et al. (1993) and Narasimhan and Jayaram (1998) used return on asset and growth (sales, market and productivity) measures in their studies. However, there is not a consensus concerned with which measures should be used effectively among the researchers. In the study, business performance was evaluated using two common financial measures based on the literature: sales growth and net profit (Tracey et al., 1999; Papke-Shields and Malhotra, 2001; Dangayach and Deshmukh, 2003; Badri et al., 2000). These measures were assessed by subjectively asking respondents the degree of which is their firm's performance over the past three years relative to its major competitors on a seven point likert scale. Thus, the firm's financial performance was obtained with an increasing or decreasing trend for the three consecutive years (2001, 2002, 2003).

IV. Methodology

A. Sample

The data for the empirical investigation of the model were obtained from the field study. Data were collected from participating firms via face-to-face interviews with the middle or high-level managers having a high level of responsibility in their companies (executives/managers in charge of the manufacturing function). Selected from 8 interviewers who have already 4 th class of administration students in our faculty (KTU-IIBF) helped us with the interviews and distribution of survey instrument. Also, companies located in Ankara and İstanbul were chosen for the survey instrument randomly.

As can be seen Appendix 1 questionnaire was sent by the interviewers to a random sample of 300 manufacturing executives who were employed in various manufacturing firms. The executives were asked to rate each manufacturing capability and business performance measures based on seven point likert scales. They indicated the relative importance attributed to each capability choices as “1= not important” and “7= critically important”. For the business performance variables, managers indicated the degree of importance as “1=decreased” and “7=critically increased”. However, out of 300 questionnaires, 199 questionnaires were taken into account after eliminating those that had an inaccuracy response. Consequently, the average response rate for survey items was 66 %. As can be seen table 1, profile of participating companies by industry and number of employees are presented.

Table 1: *Profile of Participating Companies By İndustry Type and Number Of Employees*

Type of industry	Number of respondents	Percent (%)
Food, drink and tobacco products	36	18.1
Textiles products	38	19.1
Furniture and wood products	36	18.1
Paper related products	2	1.0
Chemical, petroleum and related products	27	13.6
Metal, machine and equipment products	24	12.1
Automotive related products	3	1.5
Electricity products	4	2
Other products	29	14.6
Total	199	100
Number of employees		
Less than 50 (Small sized)	152	76.4
50-199 (Medium sized)	28	14.1
More than 200 (Large sized)	19	9.5

We listed company or sector profiles as defined in the Istanbul Chamber of Industry (ISO) 500 yearbook. However, survey results indicated that the major manufacturing sectors in this study are textile (19.1), food (18.1) and furniture and wood products (18.1). Also, study results showed us that the small and medium sized enterprises (SMEs) constitute a high density among the manufacturing firms. Only 9.5% of the respondents are employed in large-sized firms.

B. Data Analysis

For data analysis, firstly, exploratory factor analysis (EFA) was conducted on the initial set of items to ensure the unidimensionality of the measurement model. Unidimensionality is based on the traditional common factor model in which sets of items share only a single underlying factor (Gerbing and Anderson, 1988:187). Also, an assessment of reliability was made using cronbach's alpha. Secondly, ensuring that all items were unidimensional, a confirmatory factor analysis (CFA) with structural equation modeling (SEM) was done to verify if the measurement variables related to the latent variables (Anderson and Gerbing, 1988).

Appropriateness of factor analysis should be determined with the KMO (Kaiser-Meyer-Olkin) measure of sampling adequacy (Norusis, 1993:52). According to the exploratory factor analysis results, KMO and Bartlett's test value obtained within the acceptable limits. In this study, KMO was found to be 0.794, so, we can comfortably proceed with the factor analysis. Thus, the factor reduction can be applied to the manufacturing capability dimensions.

Principal components analysis and varimax rotation was used as a factor extraction method. In order to make sure that each item identified by EFA had only one dimension and loaded only on one factor, items that had factor loadings of lower than 0.40 and loading on more than one factor (because of not convenient for unidimensionality of the measurement model) with a loading score of equal to or greater than 0.40 were eliminated from the analysis (Gursoy and Gavcar, 2003:913-914). So, the remaining items were chosen as extracted ones. Also, as seen in Table 2, reliability of the remaining items, which sets the measurement model, is found to be acceptable (Norusis, 1993:148). Besides, average variance explained by four factors was found to be 62.71%. As a result, 10 manufacturing capability items was obtained. However, D1, Q4, F2 and C3 items were put out because of loading more than one factor. Also, F3 were put out for being beyond the minimum threshold of 0.40 (Table 2).

Table 2: *Results of exploratory factor analysis for measurement model*

Items for measurement model	Factor 1	Factor 2	Factor 3	Factor4
C1	0.752			
C2	0.814			
C4	0.748			
D1	0.616			
Q4	0.529			
F2	0.503			
Q1		0.879		
Q2		0.872		
Q3		0.853		
F1			0.865	
F4			0.848	
C3			0.620	
D2				0.905
D3				0.470
F3				0.389
Eigenvalue	4.516	2.391	1.289	1.212
Average variance explained (%)	30.104	15.942	8.592	8.079
Bartlett's test of sphericity	X^2= 1095.730, sd:105, p:0,000			
Cronbach alpha	0.8700	0.7598	0.7416	0.6199

Structural Equation Modeling (SEM) is a useful tool in the theory development because it allows the researcher to propose and subsequently test theoretical propositions about interrelationships among variables in a multi-variate setting. SEM includes estimating the magnitude of the linkages between variables using path analysis and covariance structure analysis (Badri et al., 2000:162). We used covariance structure models as a mechanism for estimating path coefficients. For this purpose, secondly, confirmatory factor analysis

(CFA) was used to evaluate the purified measurement model. Confirmatory factor analysis tests the measurement scale developed according to the results of exploratory factor analysis. Additionally, CFA affords a stricter interpretation of unidimensionality than can be provided by EFA (Gerbing and Anderson, 1988:186).

The fit of the purified measurement model was tested using Lisrel 8.2 for Windows software with covariance matrices input. Table 2 illustrates the extracted items, maximum likelihood (MLE) values, standard errors, t values and indicator reliability of each manufacturing capability items respectively.

Table 3: *Reliability and Validity of The Measurement Model*

Dimension	Extracted Items	MLE	SE	t	Indicator Reliability
Cost		0.78[a]			0.82[b]
	C1	0.83	0.06	13.70	0.70
	C2	0.75	0.06	11.72	0.56
	C4	0.77	0.06	12.29	0.60
Quality		0.75[a]			0.79[b]
	Q1	0.74	0.06	11.45	0.54
	Q2	0.83	0.06	13.56	0.69
	Q3	0.69	0.07	10.51	0.48
Flexibility		0.66[a]			0.61[b]
	F1	0.59	0.08	7.37	0.30
	F4	0.74	0.11	6.72	0.35
Delivery		0,72[a]			0.69[b]
	D2	0.84	0.07	11.68	0.71
	D3	0.61	0.07	8.58	0.38

[a]Variance extracted estimate
[b]Composite reliability of each construct

Two types of reliability measures, composite reliability and the estimated percentage of variance extracted by each dimension were examined. The composite reliability, as calculated with Lisrel 8.2 software is analogous to a coefficient alpha, which shows the internal consistency of the indicators (items) assessing a given factor (Gursoy and Gavcar, 2003:916). Acceptable limit for composite reliability is between 0.60 and 0.70 (Shook et al., 2004:400). According to the analysis results, overall composite reliability value is 72.5 and composite reliability of each manufacturing capability dimension exceeds required level (Table 3).

The variance extracted estimate measures the amount of variance that is captured by one dimension. The desirable level of variance captured is 50% or higher (Gursoy and Gavcar, 2003:917). Table 3 shows that the variance extracted estimate for each dimension also exceeded the acceptable levels. So that, we can say purified measurement model with its manufacturing capability dimensions are within acceptable limits and measurement model is quite reliable.

Structural model for confirmatory factor analysis was developed according to measurement model results. Structural model consists of four dimensions with ten items (observed variables) and one dimension with two items (latent variables). The χ^2 of the structural model were found to be 89.31 (df:44, p:0.00006). χ^2 test is the most common fit measure, but it is only recommended with moderate samples (100 to 200). The test also is suspect when using small samples because some are not distributed as chi-square populations (Shook et all., 2004:401). For this reason, in this study we used 199 sample as moderate sized for proposed model. Goodness of fit indices for structural model is as follows:

Most of the values were between acceptable limits except adjusted goodness of fit index (AGFI). However even though the value of AGFI was below the recommended level (0.90), it was reasonably close to the recommended level by the value of 0.88. Root mean square error of approximation (RMSEA) was estimated as 0.072 and its preferred value that indicates a good fit to the data is below 0.10. So that it is within the recommended level. The simplest fit index provided by Lisrel is standardized root mean square residual (SRMR) and the value for this index is equal to 0.05. Generally for this index, values less than 0.05 are interpreted as indicating a good fit to the data (Kelloway, 1998:27).

Lisrel also reports the values of the other indices: Goodness of fit index (GFI)=0.93; Normed fit index (NFI)=0.91; None-normed fit index (NNFI)= 0.93; Comperative fit index (CFI)=0.95. All the fit indices exceed required level of 0.90 (Byrne, 1998:111-115). Consequently, we can say that all the fit indices satisfactory good results and meet suggested criteria.

Figure 1 shows the path coefficients of the structural equation model. According to the model, the box on the left-hand side illustrates the manufacturing capability items whereas right–hand side business performance items.

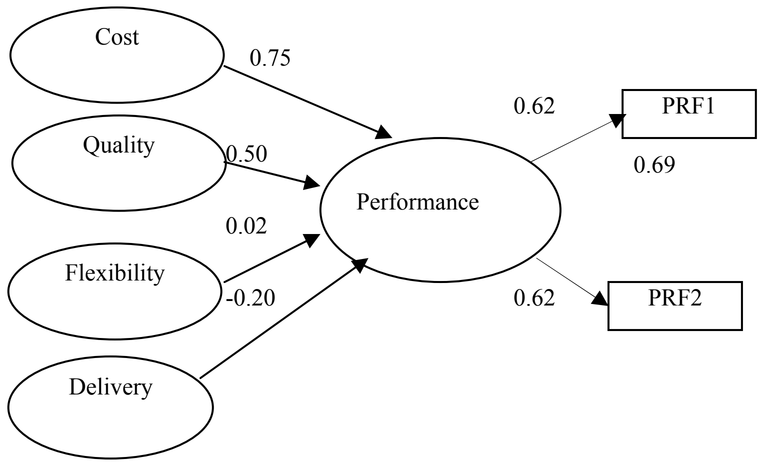

Figure 1: *Estimated Coefficients of Structural Model*

Structural equation modeling results revealed that only cost and quality path coefficients were significant. But flexibility and delivery dimensions were found to be insignificant ($p<0.05$). Thus, cost ($r=0.75$), and quality ($r=0.50$) dimensions have positive and direct impact on business performance. Also, average variance explained by observed variables was found to be 0.39 and 0.39. These indices provide evidence for the existence of the relationships between the manufacturing capability dimensions and business performance. (O'Cass and Julian, 2003:377). Table 4, shows the hypothesis results of the structural model.

Tablo 4: *Hypothesis Results of The Structural Model*

		t	MLE	St. Error	Hypothesis Supported?
Cost →	Prf	2.68^*	0.75	0.28	H1: Yes
Quality →	Prf	2.18^*	0.50	0.23	H2: Yes
Flexibility →	Prf	0.14	0.02	0.14	H3: No
Delivery →	Prf	-1.18	-0.20	0.17	H4: No

$^*p<0,05$

H1 tested the relationships between low cost capability and business performance. In respect of H1, low cost capability positively affects a firm's business performance. Because, path coefficient from low cost to business performance was found to be equal to 0.75 and significant at $p< 0.05$. This means that with a one-unit decrease in cost, holding everything else constant, business performance can be improved by 0.75 percent. The first result finding provides support for Hypothesis 1 suggesting that low cost capability could lead a firm to be highest business performance. Similarly, in respect of H2 supported the proposed model suggesting that quality positively affects a firm's business performance. This means that with one unit increase in quality, holding everything else constant, business performance can be improved by 0.50 percent. However, in respect of H3 and H4, flexibility and delivery dimensions have not been supported by the insignificance coefficients respectively ($r=0.02$, $r=-0.20; p>0.05$).

V. Results and Discussion

In this study we developed a proposed model for matching manufacturing capabilities and business performance, by integrating the concepts developed in the manufacturing strategy literature. The proposed model is based on the premise that a higher emphasis on a manufacturing capability in an organization requires certain business performance measures to be developed by the employees. For this reason, we selected main capabilities and business performance measures from the literature.

The main findings are that most organizations surveyed in this study believed that manufacturing capabilities positively affect firm's business performance (Tracey et al., 1999:424). However, the link between manufacturing capability choices and business performance measures was found to be significant entirely on two dimensions of capabilities: cost and quality. These results are consistent with the proposed models reported from the studies of Kim and Arnold (1992), and Miller and Roth (1994). Consequently, cost efficiency and high quality is seen main determining factors in improving business performance. Besides, these results obviously reflect that production managers adopt a serious attitude towards cost and quality capabilities.

The lower cost and high quality capabilities will decrease demand uncertainty problems resulting from needs of customers and simultaneously lower entry barriers to new markets (John et al., 2001:156). Also low cost manufacturing provides the elimination of wasted time and materials associated with excessive inspection, scrap and rework. (Ward et al., 1996:600).

The second finding, contrary to literature, model have not supported that flexibility and delivery dimensions of manufacturing capabilities positively affect firm's business performance. In this study, results which were founded empirically, indicates that a firm will gain more advantages by focusing its resources on improving a few (cost and quality) capability variables, rather than attempting to improve across all dimensions. On the other hand, flexibility, which includes responsiveness to the customer requirement for improving existing products, increasing product variety and new product development, is vital to the increase of sales and net profit growth (Zhang et al., 2003:175). Flexibility also appeared to directly contribute to other competitive capabilities, such as cost reduction, delivery speed, quality and customer satisfaction. For example, flexibility in lot size can increase delivery speed, and reliability. Flexibility in production volume also can help to reduce inventory levels so as to reduce costs. In short, customizing products to the expectations and needs of customers through emphasizing flexibility is a pivotal manufacturing capability to sustain competitiveness (Lynn, 2000:267-268). However according to the study results, we can say that manufacturers produced pre-planned products in a fixed quantity, and did not need to be concerned about customizing their products to fit customers' needs. Shortages of skilled labor, and inadequate business processes or technologies may be attributed a major reason for not pursuing an operations flexibility strategy (Badri et al., 2000:170). On the other hand, availability of new technologies, business processes and various manufacturing techniques enable manufacturers to emphasize flexibility to meet the demand of customers (Lynn, 2000:266). Additionally, manufacturers did not have the incentive to improve delivery efficiency. Innovation in products and services forces, using capable intermediaries and flexible distribution channels provide manufacturers to improve delivery speed and reliability so as to gain a good sales share and improve their net profit. These results may be attributed to small and medium sized enterprises surveyed in this study.

This study provides valuable information for researchers who must make decisions about manufacturing capabilities in the face of changing environmental conditions. However the fast change of environmental conditions and market requirements for new product/service and new manufacturing processes are forcing manufacturers develop high flexibility and quality, fast delivery and low cost capabilities. But small and medium sized manufacturers examining in Ankara and İstanbul regions compete on mostly cost efficiency and high quality, such as labor, inventory and material cost reduction and low scrap and defect rates, product reliability/durability. On the contrary, to be more responsive to the market requirements, manufacturers should emphasize flexibility and delivery as well as cost and quality capabilities.

The ideas presented in this article provide a good starting point for further theoretical as well as empirical research in manufacturing strategy. It may be possible to collect data from several manufacturing companies that emphasize various manufacturing capabilities or combinations thereof. Also further examination of the proposed model can be tested for service organizations since manufacturing capabilities emphasized in service organizations are different.

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Appendix A*: Items for Manufacturing Capability*

Dimensions	Items
Cost	
C1: Labor cost	Ability to offer low labor costs
C2: Material cost	Ability to provide low material costs
C3: Inventory cost	Ability to provide low inventory costs
C4: Overhead cost	Ability to provide low overhead costs
Quality	
Q1: Scrap and defect rate	Ability to offer consistently low scrap and defect rates
Q2: Product quality, reliability	Ability to provide reliable/durable products
Q3: Vendor's quality	Ability to reduce waste of purchased material
Q4: ISO 9000 certificates	Ability to obtain international quality certifications
Flexibility	
F1: Product variety	Ability to offer a broad product line
F2: New product development	Ability to introduce new products quickly
F3: Existing products	Ability to improve existing products
F4: Increase size variety	Ability to make rapid volume changes
Delivery	
D1: Delivery reliability	Ability to make reliable delivery promises
D2: Delivery speed	Ability to provide fast deliveries
D3: Post sale services	Ability to provide after-sales service