

A Supplier selection construct for exploring the supplier selection procedure in Indian Manufacturing Company

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ABSTRACT

In the present dynamically changing markets, for an efficient and effective supply chain to take place, it is necessary to focus on the stage of supplier selection. Supplier selection helps in reducing the costs, improve the quality and deliver the products on time, thereby enabling the organizations to survive the rising competition in the current scenario of global competing environment. This mainly increases the importance of effective supplier selection in manufacturing industry. In this study, in order to investigate the supplier selection in supply chain management, a questionnaire instrument is applied to companies of Indian manufacturing industry which is being mainly affected from the increasing global competition. A factor analysis is applied to the findings of questionnaire instrument to explore the supplier selection criteria of Indian manufacturing industries.

Introduction

It has become utmost important for any manufacturer to cut down the costs, improve the quality and deliver the goods on time to the end customer to survive in the competitive market. An effective and efficient supply chain must be there for this to happen. The success or failure of the supply chain depends on the satisfaction of the end customer. In any production process, raw material

and component costs themselves carry 70% of the total cost, according to Weber *et al.* (1991). Hence, supplier selection becomes the most important step in the supply chain to be taken care of by the manufacturer. It is the first stage in the supply chain and also the stage of paramount importance. Scholars and industrialists are forced to focus on supplier selection for a successful supply chain.

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Purchasing is an important function in the supply chain. It determines the lead time in launching a new product into the market. The major advantages of the purchasing function are considerable reduction in cost, improvement in delivery of the product, shorter cycle time, quality improvement and access to product and process technology. Sourcing is a function under purchasing. A proper sourcing strategy is essential for any supply chain. Supplier selection comes under sourcing. The sourcing strategy can be either single supplier sourcing or multiple supplier sourcing strategy. In a single supplier sourcing, only the supplier to whom the order is to be placed is to be found out, whereas in a multiple supplier sourcing, not only the selection of suppliers, but also the order allocation to each supplier. There are different criteria involved in the supplier selection process. The selection of the suppliers depends on the firm's sourcing strategy. The criteria may vary from firm to firm according to their requirements. In the initial days, only price, quality and time were considered the important criteria. Slowly, service was also added. Dickson (1966) first summarized 23 prominent criteria used for supplier selection by conducting survey in different industries. From then on, an extensive research has been going on to provide many other criteria involved in the supplier selection process.

Supplier selection is a complex multi-criteria decision making problem. In any supply chain, decision making is an important phenomenon taking place. Supply chain management is said to

be effective when the decisions taken are proper and well informed. Supply chain is the flow of materials or information between entities of various organizations or of the same organization. Each and every stage in the chain involves decision making. The decisions may be tactical, strategic or organizational depending on the stage and situation in the supply chain. This was deeply discussed by Shapiro (2000). A decision maker has to consider both the subjective and objective factors while evaluating a supply chain. The performance of the organization in the market depends on these decisions. They vary from supplier/vendor selection, supplier evaluation, production, distribution etc. But the process of decision making is complex due to the continuous changing nature of the various entities involved in each and every stage. The type of product, its life cycle etc also affect the decision making process.

Many analytical models for solving the multiple criteria decision making supplier selection problem have been proposed. An extensive research was carried out on the previous literature available about the different analytical models to solve the supplier selection problem. These models consider different criteria and help in selecting the best supplier for the manufacturer. These criteria are ranked and given weights according to their importance considered by the company or the organization, and scoring is done for each of the initial shortlisted suppliers. The supplier with the maximum score at will be selected at the end. Saaty T.L. (1988) proposed the Analytical Hierarchy

Process (AHP) to assist in multi-criteria decision making problems to overcome the difficulties associated with the categorical and simple linear weighted average criteria ranking methods. Fuzzy relationships were introduced in the analytical models to consider the vagueness involved in the supplier selection problem into account. Integration of two or more models, resulting in hybrid models was proposed to give a better and accurate result.

A vendor/supplier can either make the company or break the company by reaching up to the customers' demands or failing miserably in his process. Hence, selecting the most appropriate suppliers is considered important strategic management decisions that impact all areas of an organization. Because this reason, this study describes the extent to which factors are using as supplier selection criteria in the Indian manufacturing industry by using a questionnaire survey. It presents a factor analysis that describes which factors are using by the Indian manufacturer companies as supplier selection criteria in the present global competition environment.

Literature Review

Supplier selection decision criteria have immense impact on the every task of operational decisions to strategic decision and its process of supplier selection is usually devised with multi criteria decision problem (Liu et al. 2000). In many number of research that has been conducted in the area of supplier selection protracts several supplier

selection criteria are used. Basically the supplier-selection is the process by which suppliers are reviewed, evaluated, and chosen to become part of the company's supply chain. The supplier-selection criteria are important for the organizations that apply various criteria that enable them to choose vendors (Fawcett and Fawcett 1995; Mason 1996; Morgan 1996). Turning the pages of the contribution of supplier selection, (Howard Lewis, 1943) states that the important aspect a procurement officer can look

all the above is sourcing of the suppliers. Decision related to vendor selection process is complicated with that of many criteria to be considered (C.A.Weber et al, 1991). The pioneering work by (Dickson, 1966) had provided a comprehensive view of the 23 criteria that both the academicians and the purchasing practitioners felt the importance of vendor selection decisions.

After his contribution, much research has been emerged in the field of supplier selection. Among all the research is been conducted so far states that the researchers often reverred to a very few criteria for selecting the vendor. This research has intensely probed with tangle background investigation related to the most often used supplier selection criteria. They are (i) Quality – (ii) Delivery (iii) Production facilities and capacities (iv)Price (v) Financial position (vi) Technical capacity (vii) Management and Organization and the snap shot of related literature review on these parameter is portrayed in the table -1

Table 1: Summary of literature support of supplier selection criteria

Authors	Quality	Price	Delivery	Technical capacity	Financial position	Production facilities and capacities	Management and Organization
Dickson 1966	✓	✓	✓	✓	✓	✓	✓
Edwards 1967							✓
Wind and Robinson 1968	✓	✓	✓	✓			
Hinkle et al., 1969	✓	✓	✓	✓			
Payne 1970					✓		
Cardozo and Cagley 1972	✓	✓	✓				
Moore and Fearon 1973	✓		✓				
Cooper 1977			✓				
Dempsey 1978	✓	✓	✓	✓	✓	✓	✓
Croell 1980	✓		✓				
Monczka et al. 1981	✓	✓	✓		✓	✓	
Shore 1981	✓	✓	✓				
Benton and whybark 1982		✓					
Bragg and Hahn 1982			✓			✓	
Jackson 1983	✓		✓				
Benton 1983		✓					
Hahn et al. 1983	✓	✓	✓			✓	
McFillen et al. 1983	✓	✓	✓				
Narasimhan 1983	✓		✓			✓	
Browning et al. 1983		✓	✓	✓		✓	
Kraljic 1983	✓	✓	✓	✓		✓	
Buffa and Jackson 1983	✓	✓	✓				
Monahan 1984		✓					
Manoochehri 1984	✓	✓	✓				
Mazurak et al. 1985	✓	✓	✓	✓			
Levy et al. 1985		✓					
LaForge 1985		✓					
Benton 1985		✓					

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Authors	Quality	Price	Delivery	Technical capacity	Financial position	Production facilities and capacities	Management and Organization
Bender et al. 1985	✓	✓	✓			✓	
Ansari and Modarress 1986	✓	✓	✓				
Gregory 1986	✓	✓	✓	✓		✓	
Hahn et al. 1986	✓	✓	✓	✓		✓	
B anerjee 1986		✓	✓				
Kingsman 1986		✓					
B anerjee 1986		✓					
Lee and Rosenblatt 1986		✓					
Timmerman 1986	✓	✓	✓	✓			
Narasimhan and Stoyhoff 1986		✓				✓	
Goyal 1987		✓					
Jacobson and Aaker 1987	✓						
Anthony and Buffa 1987		✓	✓				
Dada and srikanth 1987		✓					
Soukup 1987	✓	✓	✓	✓	✓	✓	✓
Jordan 1987		✓					
Treleven 1987		✓	✓	✓			✓
Ansari and Modarress 1988	✓	✓	✓				
Frazier et al. 1988		✓	✓	✓	✓		✓
Chakravarthy and martin 1988		✓					
Markowski and Markowski 1988		✓					
Newman 1988		✓					
Ronen and Trietsch 1988		✓	✓				
Newman 1988		✓	✓	✓	✓		✓
Ho and Carter 1988						✓	
Lamm and Vose 1988		✓					
Turner 1988		✓				✓	
Burton 1988	✓	✓	✓	✓		✓	✓

Authors	Quality	Price	Delivery	Technical capacity	Financial position	Production facilities and capacities	Management and Organization
Chapman 1989		✓		✓			✓
Pan 1989		✓	✓	✓			
Wagner et al. 1989		✓	✓	✓			
Bernard 1989		✓		✓			✓
Hwang et al.1990		✓					
Sharma et al. 1990		✓	✓	✓			
Benton and Krajewski 1990	✓		✓				
Chapman and Carter 1990	✓		✓				
Thomas Y.Choi et al. 1996	✓	✓	✓	✓	✓		
Siying Wei et al. 1997		✓	✓	✓	✓		
Forker et al. 1997		✓	✓	✓			
Hartley et al., 1997		✓	✓	✓			
Krause et al. 1998		✓	✓	✓			
Tracyan d Vonderembse, 1998	✓	✓	✓				
Hojung Shin et al. 2000		✓	✓	✓			
Vrijhoef and Koskela 2000			✓				
Michael Tracey et al 2000	✓	✓	✓				
Kuei and Madu, 2001		✓	✓				
Michael Tracey and Chong Leng Tan 2001		✓		✓			✓
Tan, Keah Choon 2002		✓	✓	✓	✓	✓	✓
Chinho Lin et al. 2005		✓	✓				
Pi & Low 2005		✓	✓	✓			
Wing S. Chow2005		✓	✓				
Christian N. Madu 2005	✓	✓					
Kreng & Wang 2005		✓	✓	✓			
Chu-Hua Kuei, Pei Pei Yu,2005	✓	✓					
Vijay R,Kannan et al. 2006	✓		✓	✓		✓	
ZHANG Fu-jiang et al. 2006	✓	✓	✓			✓	
G.kannan et al. 2006		✓	✓	✓	✓	✓	✓
I.H.YIGIN et al. 2007		✓	✓	✓	✓		
Chang, Wang et al.,2007	✓		✓	✓			
TAS Vijayaragan et al. 2008	✓	✓	✓	✓		✓	

Methodology

The population for this study consists of manufacturing firms in India. An instrument was developed to collect data for this analysis. A copy of this questionnaire was sent to 550 professionals of well-reputed organizations who know all the activities of supplier selection. A total of 262 responses were obtained. However, only 241 copies were usable.

Content validity and Face validity

Mostly the 12 criteria namely Cost, Quality, Delivery, Technical capability, Production facilities and capacities, Financial position, Management and organization, Service, Relationship, Cooperation, Safety and environment concern, and Quality improvement rewards are often discussed in most of the journals in the field of management as well as supply chain management. The author also referred other sources like referred text books in supply chain management, Quality management, and academic studies conducted in the related areas, website and so on.

Among the 12 criteria and 182 sub-criteria, further refinement is carried out. To do so, the researcher met directly with the top professionals of well-reputed organizations, highly qualified and well-experienced teaching experts and research experts frequently with prior appointments. In their detailed and in-depth discussions, 6 criteria and 136 sub-criteria are identified and omitted because of repeated and super-imposed sub-criteria and also, based on the importance of criteria and sub-criteria for the selection of supplier through their knowledge and experiences.

Finally concluded with 6 criteria and 46 sub-criteria that they feel most important for supplier selection. The following paragraph discusses the questionnaire development with help of the refined 6 criteria and 46 sub-criteria.

A new instrument incorporating refined 6 criteria and 46 sub-criteria was developed. The developed questionnaire was given to the above-said experts and again, they were briefed about the purpose of the study and its scope. The experts were asked to scrutinize the questionnaire and to give their impressions regarding its relevance and contents. They were also asked to critically examine the questionnaire and to give objective feedback and suggestions with regard to comprehensiveness/coverage, redundancy level, consistency and number of items in each variable.

Again the experts were asked to read each statement and indicate the relevance of each item on the questionnaire on a seven-point scale. In the initial questionnaire there were 6 constructs and 46 items. Based on the feedback from the experts, 6 constructs and 46 items were retained in the questionnaire for the study. The respondents were asked to rate the significance of each item on a seven-point Likert scale, where "1" represents "very negligible", "2" represents "negligible", "3" represents "not negligible", "4" represents "neither important/nor negligible", "5" represents "slightly important", "6" represents "important", and "7" represents "very important". Thus the content validity and face validity have been ensured in the initial stages of questionnaire development itself.

Table 3. Findings about Supplier Selection Variables

	Variables	1	2	3	4	5	6	7	N	M	S.D
1.	Social and Cultural circumstance	2(1.3)	6(4.0)	7(4.6)	23(15.2)	35(23.2)	46(30.5)	32(21.2)	151	5.31	1.406
2.	Performance History	1(0.7)	-	5(3.3)	20(13.2)	23(15.2)	35(23.2)	67(44.4)	151	5.89	1.260
3.	Sharing of sensitive information	-	1(0.7)	6(4.0)	19(12.6)	31(20.5)	39(25.8)	55(36.4)	151	5.76	1.220
4.	Environment protection system certificate	3(2.0)	1(0.7)	5(3.3)	16(10.6)	25(16.6)	46(30.5)	55(36.4)	151	5.76	1.345
5.	Usage of PPE's (Personal Protective Equipments)	1(0.7)	4(2.6)	9(6.0)	10(6.6)	26(17.2)	40(26.5)	61(40.4)	151	5.78	1.390
6.	Incident and Accident Records	2(1.3)	1(0.7)	5(3.3)	11(7.3)	19(12.6)	42(27.8)	71(47.0)	151	6.01	1.278
7.	Hazard and Risk Assessment Records	-	5(3.3)	1(0.7)	11(7.3)	30(19.9)	39(25.8)	65(43.0)	151	5.93	1.231
8.	Competitive Price	2(1.3)	6(4.0)	6(4.0)	10(6.6)	21(13.9)	39(25.8)	67(44.4)	151	5.83	1.469
9.	Logistics Cost	3(2.0)	3(2.0)	7(4.6)	9(6.0)	34(22.5)	46(30.5)	49(32.5)	151	5.66	1.385
10.	Payment terms	3(2.0)	6(4.0)	5(3.3)	15(9.9)	23(15.2)	41(27.2)	58(38.4)	151	5.68	1.508
11.	Process flexibility	6(4.0)	3(2.0)	1(0.7)	8(5.3)	21(13.9)	49(32.5)	63(41.7)	151	5.87	1.462
12.	Volume flexibility	3(2.0)	3(2.0)	4(2.6)	12(7.9)	25(16.6)	52(34.4)	52(34.4)	151	5.76	1.355
13.	Promotion of JIT concept	-	3(2.0)	2(1.3)	14(9.3)	30(19.9)	39(25.8)	63(41.7)	151	5.91	1.194
14.	Facilities for measurement, calibration and testing	1(0.7)	5(3.3)	3(2.0)	7(4.6)	30(19.9)	59(39.1)	46(30.5)	151	5.79	1.236
15.	Handling and packaging capability	1(0.7)	1(0.7)	5(3.3)	12(7.9)	21(13.9)	44(29.1)	67(44.4)	151	5.99	1.216
16.	Design Capability	2(1.3)	5(3.3)	1(0.7)	6(4.0)	29(19.2)	50(33.1)	58(38.4)	151	5.89	1.287
17.	Technology and Innovativeness	3(2.0)	1(0.7)	5(3.3)	8(5.3)	35(23.2)	49(32.5)	50(33.1)	151	5.77	1.278

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	Variables	1	2	3	4	5	6	7	N	M	S.D
18.	Collaboration details with Research Institute	2(1.3)	4(2.6)	4(2.6)	8(5.3)	33(21.9)	54(35.8)	46(30.5)	151	5.73	1.291
19.	Quick response capacity of R&D	2(1.3)	3(2.0)	5(3.3)	10(6.6)	27(17.9)	51(33.8)	53(35.1)	151	5.79	1.308
20.	Product durability	2(1.3)	2(1.3)	5(3.3)	15(9.9)	26(17.2)	51(33.8)	50(33.1)	151	5.74	1.299
21.	Product performance and conformance to standards	-	3(2.0)	4(2.6)	11(7.3)	37(24.5)	46(30.5)	50(33.1)	151	5.78	1.177
22.	ISO standards	-	2(1.3)	5(3.3)	16(10.6)	33(21.9)	40(26.5)	55(36.4)	151	5.78	1.216
23.	Total Quality Management	-	2(1.3)	6(4.0)	11(7.3)	33(21.9)	47(31.1)	52(34.4)	151	5.81	1.182
24.	Rejection Rate in Incoming Quality control	2(1.3)	1(0.7)	4(2.6)	11(7.3)	34(22.5)	56(37.1)	43(28.5)	151	5.74	1.191
25.	Repair and Return Rate	1(0.7)	3(2.0)	7(4.6)	21(13.9)	39(25.8)	40(26.5)	40(26.5)	151	5.48	1.311
26.	Addressing of feedback from customers	1(0.7)	2(1.3)	4(2.6)	16(10.6)	23(15.2)	51(33.8)	54(35.8)	151	5.83	1.237
27.	Physical size	-	4(2.6)	3(2.0)	15(9.9)	27(17.9)	50(33.1)	52(34.4)	151	5.80	1.222
28.	Geographical location & Transportation	2(1.3)	1(0.7)	3(2.0)	19(12.6)	38(25.2)	51(33.8)	37(24.5)	151	5.59	1.207
29.	Reputation Position in Industry	1(0.7)	2(1.3)	6(4.0)	14(9.3)	23(15.2)	48(31.8)	57(37.7)	151	5.83	1.272
30.	Education Qualifications of Human Resources	2(1.3)	2(1.3)	8(5.3)	15(9.9)	34(22.5)	47(31.1)	43(28.5)	151	5.58	1.328
31.	Ethical standards	1(0.7)	2(1.3)	12(7.9)	26(17.2)	32(21.2)	49(32.5)	29(19.2)	151	5.31	1.312
32.	Supplier management	2(1.3)	5(3.3)	8(5.3)	22(14.6)	30(19.9)	44(29.1)	40(26.5)	151	5.42	1.435

The values in parenthesis at table 3 are percent values and the others are frequency values. "N" is response value, "M" is median, "S.D" is standard deviation.

Results

Demographic and Descriptive Statistics

The estimated confidential interval from the pilot study is 4.8 and maintaining the confidential level at 95% as arbitrary value, the population size estimated to near 1500 firms, the estimated sample size is 358. The target respondents for the survey are middle and top level managers who actively take decisions related to procurements and supplier selection decision in the organization which ranges from 125 to 5000 employees.

The sixth numbered variable "Incident and Accident Records" is the most important criteria within the 6.01 median according to responses. Another important supplier selection criteria is "Handling and packaging capability" (15th variable) within the median 5.99. The other important supplier selection variables are 7th, 13th, 2nd, 16th, 11th, 8th, and 23rd. The less important variables are first variable "Social and Cultural circumstance" and 31st variable "Ethical standards".

Analysis

The reliability and factor analyses were conducted by the help of SPSS 11.0 before assessing the impact of supplier selection. Reliability analysis is widely applied as a tool in evaluating the stability and reliability of the questionnaires. The reliability of a measurement instrument is the extent to which it

yields consistent, reproducible estimates of what is assumed to be an underlying true score. There are several methods to establish the reliability of a measuring instrument, these include test-retest method, equivalent forms, split –halves method, and internal consistency method. Out of the above mentioned methods, internal consistency method is considered the most effective. In this study, the Reliability is evaluated by assessing the internal consistency of the items representing each construct using Cronbach's alpha. Internal consistency reliability refers to the degree of homogeneity of items in an instrument or scale—the extent to which responses to the various components of the instrument (i.e., its individual items or its subsections) correlate with one another. The reliability of each construct is as shown in Table: 4

The table: 4 exhibits that six constructs used in study show high internal consistency as indicated by high Alpha coefficients (ranges from 0.76 to 0.85), which exceed the recommended level of 0.70 (Lewis, 1995).

Table 4. Factor Analysis of Supplier Selection

	Variable Number	Cronbach's alpha	Mean	Standard deviation	Factor Loadings
Factor Groups of Supplier Selection					
Factor I: Management & Organisation					
Social and Cultural circumstance	1	0.901	5.31	1.406	0.527
Performance History	5		5.89	1.260	0.642
Sharing of sensitive information	6		5.76	1.220	0.659
Physical size	31		5.80	1.222	0.806
Geographical location & Transportation	32		5.59	1.207	0.665
Reputation Position in Industry	33		5.83	1.272	0.654
Education Qualifications of Human Resources	34		5.58	1.328	0.796
Ethical standards	35		5.31	1.312	0.712
Supplier management	36		5.42	1.435	0.762
Total Variance					15.284
Factor II: Safety & Environment Concern					
Environment protection system certificate	7	0.743	5.76	1.345	0.736
Usage of PPE's (Personal Protective Equipments)	8		5.78	1.390	0.788
Incident and Accident Records	9		6.01	1.278	0.603
Hazard and Risk Assessment Records	10		5.93	1.231	0.550
Total Variance					12.359
Factor III: Production Facilities & Capacities					
Process flexibility	15	0.822	5.87	1.462	0.775
Volume flexibility	16		5.76	1.355	0.652
Promotion of JIT concept	17		5.91	1.194	0.687
Facilities for measurement, calibration and testing	18		5.79	1.236	0.731
Handling and packaging capability	19		5.99	1.216	0.635
Total Variance					9.084

	Variable Number	Cronbach's alpha	Mean	Standard deviation	Factor Loadings
Factor IV: Cost					
Competitive Price	12	0.854	5.83	1.469	0.750
Logistics Cost	13		5.66	1.385	0.777
Payment terms	14		5.68	1.508	0.718
Total Variance					8.931
Factor V: Technical Capability					
Design Capability	20	0.832	5.89	1.287	0.794
Technology and Innovativeness	21		5.77	1.278	0.790
Collaboration details with Research Institute	22		5.73	1.291	0.656
Quick response capacity of R&D	23		5.79	1.291	0.528
Total Variance					7.594
Factor VI: Quality					
Product durability	24	0.856	5.74	1.109	0.624
Product performance and conformance to Stds.	25		5.78	1.177	0.753
ISO standards	26		5.78	1.216	0.728
Total Quality Management	27		5.81	1.182	0.645
Rejection Rate in Incoming Quality control	28		5.74	1.191	0.701
Repair and Return Rate	29		5.48	1.311	0.748
Addressing of feedback from customers	30		5.83	1.237	0.623
Total Variance					7.207

Factor analysis was carried out to reduce each scale to smaller number of underlying factors. The Principal components factor analysis with varimax rotation was conducted to extract factors and to obtain a more interpretable factor matrix. With few exceptions, variables had factor loadings of at least 0.50. The 32 remaining supplier selection criteria were reduced to six underlying factors (table 4). The six factors accounted for 61 percent of total variance in the data.

Conclusions

A plenty of conclusions can be drawn from this paper. This paper demonstrates the importance supplier selection factors in manufacturing industry. It is apparent from these findings that in Indian manufacturing industry the most important supplier selection factor is Management & Organization. These factor consist of Social and Cultural circumstance, Performance History, Sharing of sensitive information, Physical size, Geographical location & Transportation, Reputation Position in Industry, Education Qualifications of Human Resources and Ethical standards. With the increasing global competition in markets companies willingness to have strategic partner than a supplier in their supply chains. This factor shows us that Indian manufacturing companies want to make a long term relationship with their suppliers by developing closer ties, share confidential information. Also supplier must serve the buyer's long term needs by obeying the delivery agreements with higher technical production level.

Selecting the most suitable suppliers is considered an important strategic management decision that impact all areas of an organization because of this manufacturing companies gives more important financial stability, technical expertise level and honest communication. Companies give less weightage to price and quality level because they want to make strategic alliances with the most

excellent suppliers. If the selected partner has a future prospective than the price and quality level can be easily improved by the supplier development program.

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