

Supplier Sift – A Strategic Need of Modern Entrepreneurship

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Abstract—Supplier appraisal fosters energy in Supply Chain Management and helps in best optimization of viable business partners for a company. Many Decision Making techniques have already been proposed by researchers for supplier's appraisal. However, Analytic Hierarchy Process (AHP) is assumed to be the most structured technique to attain near-best solution of the problem. This paper focuses at implementation of AHP in the procurement processes. It also suggests that on what factors a Public Sector Enterprises must focus while dealing with their suppliers and what should the suppliers do to synchronize their activities with the strategic objectives of Organization. It also highlights the weak areas in supplier appraisal process with a view to suggest viable recommendations.

Keywords—AHP, MCDM techniques, Supply Chain Management (SCM), Supplier appraisal.

I. INTRODUCTION

SUPPLIER Relationship Management (SRM) is a proactive approach to enter into the arena of Supply Chain Optimization (SCO) [1]. It also helps in reducing wastes, costs, adoption of postponement strategy and negotiates Bullwhip affect. The operational integration of strategic partners during early phases of product development [2] helps in reducing costs of rework [3], reduces dwell time, increases cash flows and improves Aggregate Production planning resulting in improved performance. Keiretsu networks strategy also suggests 'has your suppliers become part of a company coalition?' Supplier selection is considered as a Multi Criteria Decision Making problem (MCDM) [4] which is being dealt by using various techniques by researchers. Among these, after thoroughly studying, Analytic Hierarchy Process (AHP) technique is applied to suggest a viable framework in procurement process of Public Sector Enterprises by critical supplier sift. AHP is the most structured technique which

decomposes a complex problem into a multi-level hierarchical sub criteria / alternatives, to help people for making complex decisions [5].

Through literatures, it can be inferred that the topic of Supplier selection through AHP technique is not given due importance in under developed countries. Lowest bid winner is a biggest barrier in improvement and results into low quality, opportunistic supplier, monopolistic markets and cost overrun. Suppliers when face shortage of work, are more likely to submit low bids just to remain in business which creates quality issues. The criteria for supplier sifting, is flexible as per the type of manufacturing, industry, demand (stochastic or deterministic) and type of item being purchased (critical, routine, bottleneck, leverage) [6] as shown in Fig. 1 in Supply Position Model (SPM).

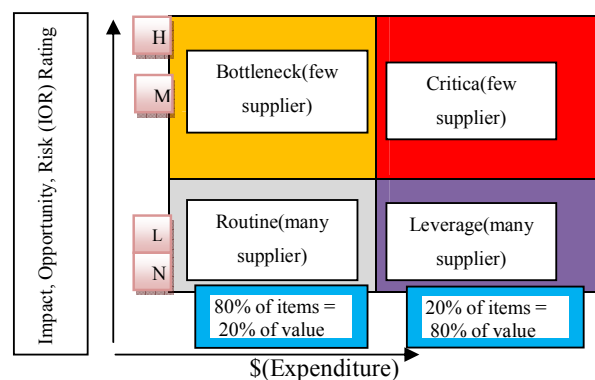


Fig. 1 SPM [6]

II. HYPOTHESES

- H1. Timely availability of supplies is extremely important for Organizations specially dealing with defense sector.
- H2. Independent variable (Price) is considered not to be a decisive factor in strategic organizations.
- H3. Dependent variable (Supplier appraisal) is internally consistent on sifted Independent variables (criteria)
- H4. Sifted Independent variables has significant affect on each other and are correlated positively.
- H5. Respondents are not well conversant about Supplier selection problem and MCDM methods available for sifting.

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III. METHODOLOGY

A. Introduction

The research is carried out focusing registered Public Sector Medium Enterprise. The supply chain requirements are mostly critical and deterministic. Problem of selection of supplier has been dealt with by using questionnaire based study.

B. Survey Design

On the basis of interviews with CEOs and survey form, four alternatives are taken for study to reduce complexity in the model. Suppliers in nearby vicinity, more experienced, at least 5 years of supplying period, good professional background were the factors given priority while sifting four suppliers. These 4 suppliers are then evaluated on the basis of 15 different independent variables identified after extensive literature review [7]-[13]. These are grouped under 5 headings to make a AHP model as:

Operational Delivery (D), Quality (Q), Performance Level (PL), Service Level (SL)

Economical Competitive Price (CP), Financial Stability (FS)

Administrative Location (L), Management Capability (MC), Reputation (R)

Technical Knowledge (TK), Use of Info Tech (UITT)

Social Relationship (R), Behavior (B), Motivation Level (ML), Responsiveness (Res)

A comprehensive questionnaire comprising of 28 questions (minimum 2 questions for each criteria) was served to obtain weights on a five-point Likert Scale as shown in Table I below:

TABLE I
LIKERT SCALE USED

Very Good	Good	Fair	Poor	Very Poor
5	4	3	2	1

C. Preliminary Shortlisting of Supplier for Ease of Research

Using descriptive stats in SPSS, responses on each supplier are analyzed. Available alternatives are ranked and four (S1,S2,S3&S8) are selected for evaluation on the basis of mean and mode to reduce complexity in study. All the respondents were then briefed and asked to fill in the questionnaire and weight each criterion only for these four suppliers. Mode values as shown in Table II, fluctuates mostly in between 3-5 on likert scale. It is because that the sifting of 4 suppliers is already carried out of 8. Hence, there is no chance that respondents weight them as low. The mean and mode values of all suppliers except S3&S6 are asymmetric and variations are observed in judgments causing +ve / -ve skewness. Responses received for S3 & S6 are symmetric and quite stable between mean & mode values. It means that people has generally shown mixed mood while rating all the suppliers. The variation pattern of response may be due to their frequency of interaction, availability of supplier in closer vicinity, experience, number of years glued.

TABLE II
SHORTLISTING OF SUPPLIER

	Sup 1	Sup 2	Sup 3	Sup 4	Sup 5	Sup 6	Sup 7	Sup 8
N	90	90	90	90	90	90	90	90
Mean	4.59	4.33	4.01	3.79	3.21	3.02	3.14	4.18
Mode	5.00	4.00	4.00	4.00	3.00	3.00	3.00	4.00

The respondents assigned weights to each supplier against each criterion. 6 criteria considered most appropriate by the Enterprise and are sifted with best values for ease of study. 4 Suppliers are then evaluated against 6 Criteria to develop AHP chart in the light of following generic model (Fig. 2).

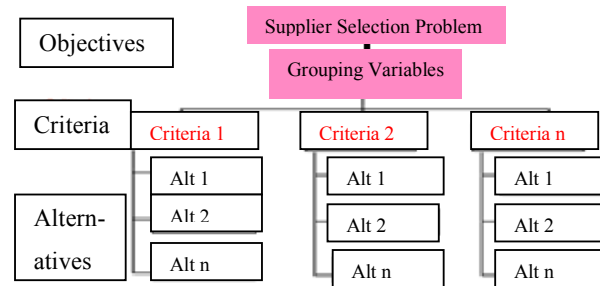


Fig. 2 Generic AHP Model [14]

D. Software Used / Test Applied

The collected data is analyzed using MS excel and Statistical Package for the Social Sciences (SPSS-20) also known as PASW Statistics 20. Four different tests are applied to check normal distribution of data, reliability for further analysis, correlation, and Analysis of Variance to check the sensitivity of each alternative against each 6 sifted criteria. A 5% level of significance is considered to represent statistically significant relationships in the data.

IV. DATA ANALYSIS AND RESULTS

Below Table III shows the number of questionnaires issued to the institution of respondents, number of questionnaire returned, and percentage of returned questionnaires.

TABLE III
FREQUENCY OF RESPONSE

Respondent s	No of Questionnaire s Issued	No of Questionnaire s Returned	Accepte d	Percentag e
PSE	120	100	90	75%

A. Job Title of the Respondents

The floor level hierarchy was invited more to respond, considering them better judge as shown in Fig. 3 using Ms Excel, whereas experience of stakeholders is given in Fig. 4 which shows that more experienced people were asked to respond.

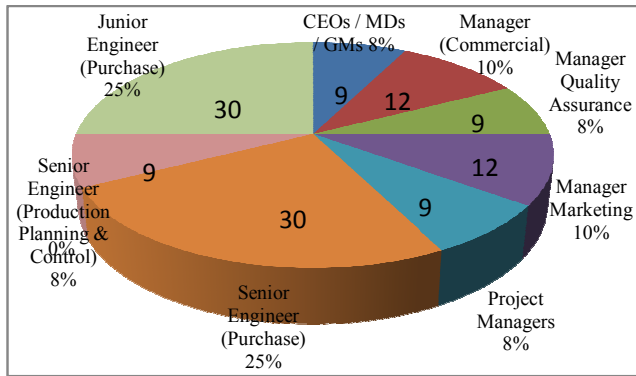


Fig. 3 Positions of Respondents

B. Experience of the Stakeholders in the Industry

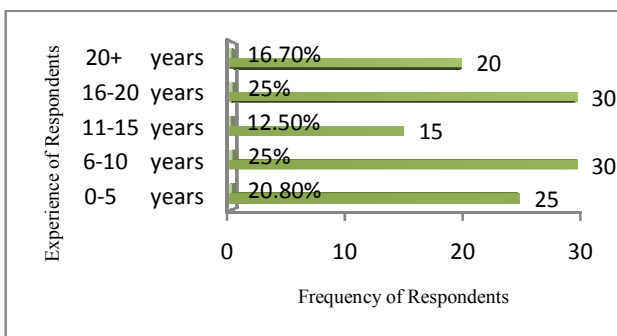


Fig. 4 Experience of Respondents

C. Reliability of the Sample

Internal consistency of data is measured through Cronbach's alpha. If Cronbach's Coefficient Alpha value is higher than 0.7, this means that the data is acceptable for analysis [2] and is highly consistent. The value of α is 0.71 in Table IV for dependent variable and is 0.73 for independent variable in Table V, shows that all variables of our study are consistent and data is reliable for analysis. This shows that the weights given by the respondents to each criterion on likert scale for taking subsequent purchasing decisions are justified.

TABLE IV
RELIABILITY STATISTICS OF SUPPLIER'S DATA

Cronbach's Alpha	Based on Standardized items	N of items
.71	.71	4

TABLE V
RELIABILITY STATISTICS OF CRITERIA DATA

Cronbach's Alpha	N of Items
.73	15

D. Normalcy Tests

Respondents have quite mixed match opinions while rating the suppliers as shown in Histograms. Albeit it is normal but +ve / -ve skewed as shown in Fig. 5. Such behavior in response is might be due to their frequency of interaction, experience and no of years the supplier is doing business.

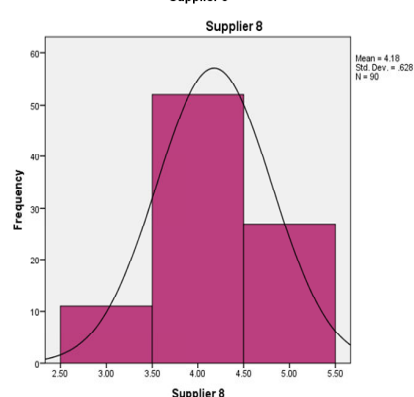
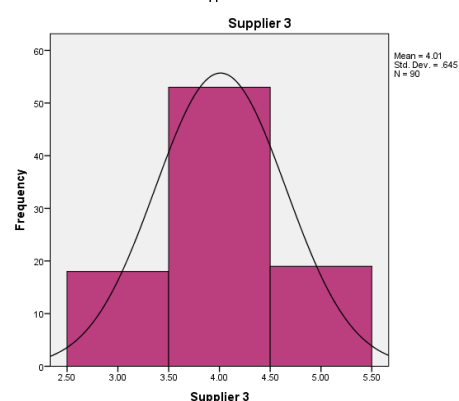
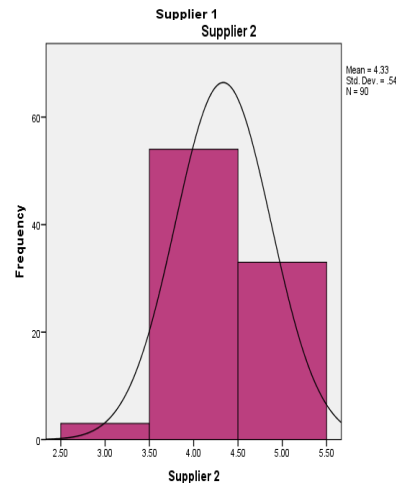
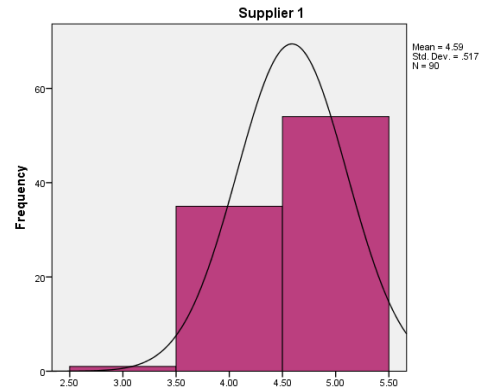


Fig. 5 Histograms

Shapiro Wilk Test is applied as our data size < 2000 , to check normalcy and to observe the trend of respondents while weighing suppliers. Sig value should be $> 5\%$ for a data to be normally distributed. Ho (Null Hypothesis) – Data is normal, Ha – Not Normal. Since sig value in Table VI > 0.05 , the null hypothesis is accepted. It means that people have shown 95% confidence in their opinion and skewness in data is only due to mixed match opinion.

TABLE VI
SHAPIRO WILK TEST

	Shapiro-Wilk		
	Statistic	df	Sig.
Relationship	.831	4	.171
Quality	.831	4	.170
Delivery	.887	4	.367
Performance level	.911	4	.486
Competitive price	.870	4	.296
Financial Stability	.916	4	.512

E. Supplier / Criteria Priority Matrix

The suggested AHP model is built on the basis of priority matrix. Table VII shows a wholesome picture of sifted criteria Vs suppliers. The response of majority of population lies more in “Good” region which may be due to reason that good suppliers are already chosen out of 8. The criteria are ranked and sifted to only six for ease as shown in Table VI. Top 3 rated criteria are Delivery (D), Quality (Q) & Price (P). The ranking of alternatives is also done in the same table on the basis of criteria.

TABLE VII
PRIORITY MATRIX

Criterion	S1	S2	S3	S4	Mean	Ranking
R	4.28	4.24	3.92	3.96	4.1	4
Q	4.36	4.42	4.02	4.05	4.21	2
D	4.47	4.45	4.09	4.23	4.31	1
PL	4.34	4.21	3.74	3.85	4.04	6
CP	4.23	4.24	4.07	3.99	4.13	3
FS	4.23	4.17	3.87	3.96	4.06	5

F. Criteria – Criteria Matrix

In order to check whether the correlation between sifted 6 independent variables, is positive and significant, the probability (p-value) is obtained as shown in Table VIII, through Spearman correlation. It rejects null hypothesis, when the p-value is ≤ 0.05 or 0.01 .

Null Hypothesis (Ho) – Positive significant Correlation exists between Independent variables.

Alternate Hypothesis (Ha) – No significant correlation exists.

The results show that; P – value of ‘CP’ ≥ 0.05 with all other 5 variables which shows no sig correlation of CP with other variables which is due to reason that respondents find price as a low criteria than others. While remaining 5 variables are positively significantly correlated to each other, so Ho is accepted. Respondents have shown 95% confidence in their opinion. The firms should identify criteria before supplier appraisal.

TABLE VIII
CORRELATION MATRIX

	R	Q	D	PL	CP	FS
R	Sign 1	.978*	.973*	.993**	.930	.990*
		.022	.027	.007	.07	.01
Q	P -	.978*	.954*	.949	.943	.953*
	value	.022	.046	.051	.057	.047
D	P -	.973*	.954*	.978*	.829	.990**
	value	.027	.046	.022	.171	.01
PL	P -	.993**	.949	.978*	.887	.997**
	value	.007	.051	.022	.113	.003
CP	P -	.930	.943	.829	.887	.868
	value	.07	.057	.171	.113	.132
FS	P -	.990*	.953*	.990**	.997**	.868
	value	.01	.047	.01	.003	.132

G. ANOVA / Sensitivity Analysis

We need to test whether any similarity exists between the suppliers for each criterion with following hypotheses:

Ho: All Suppliers are same on the basis of responses for each criterion.

Ha: All Suppliers are not same on the basis of responses for each criterion

Results are significant when a probability (p-value) ≤ 0.05 and it rejects the null hypothesis. Table IX, shows that all suppliers are not same even for a single criteria as sig value is 0.00. Hence, Ho is rejected. If we change the values of any variable in the table, the ranking of supplier changes, so we can have analyzed the relative sensitivity.

TABLE IX
SUMMARIZED ANOVA RESULTS

		Sum of Squares	Df	Sig.
R	Between Groups	10.338	3	.000
	Within Groups	52.651	356	
	Total	62.989	359	
Q	Between Groups	15.350	3	.000
	Within Groups	64.606	356	
	Total	79.956	359	
D	Between Groups	8.892	3	.000
	Within Groups	116.106	356	
	Total	124.997	359	
PL	Between Groups	16.751	3	.000
	Within Groups	97.956	356	
	Total	114.707	359	
CP	Between Groups	3.390	3	.000
	Within Groups	49.548	356	
	Total	52.938	359	
FS	Between Groups	7.891	3	.000
	Within Groups	73.575	356	
	Total	81.466	359	

H. Tukey Test

To check which supplier differs from other, we have applied Tukey test. The Tukey test is most effective when testing a large number of pairs of means. The Tukey test is used to make all pairwise comparisons between groups and within groups. If sig value > 0.05 , it is sufficient to reject null hypothesis.

TABLE X
RELATIONSHIP (R) TUKEY HSD

Supplier	N	Subset For Alpha = 0.05	
		1	2
3.00	90	3.9167	
2.00	90		4.2370
1.00	90		4.2852
4.00	90		4.3611
Sig.		1.000	.135

Ho: All 4 suppliers are same on the basis of R

Ha: At least one supplier is different from others

S3 is different from S2, S1 & S4 thus rejecting Ho. S1, S2, S4 are apparently similar in R between the group but different within group.

S3 should improve his relations with the enterprise.

TABLE XI
QUALITY (Q) TUKEY HSD

Supplier	N	Subset for alpha = 0.05	
		1	2
2.00	90	4.0167	
3.00	90	4.0500	
1.00	90		4.4222
4.00	90		4.4667
Sig.		.953	.897

Ho: All 4 suppliers are same on the basis of Q

Ha: At least one supplier is different from others

All the suppliers are not providing same quality. The pairs of S2 & S3 and S1 & S4 are providing same quality. However S1 & S4 are apparently better than S2 & S3 but there is a difference between the quality of S1 & S4. Hence, Null hypothesis (Ho) is rejected.

TABLE XII
DELIVERY (D) TUKEY HSD

Supplier	N	Subset for alpha = 0.05	
		1	2
3.00	90	4.0778	
4.00	90	4.2333	4.2333
1.00	90		4.4500
2.00	90		4.4500
Sig.		.262	.055

Ho: All 4 suppliers are same on the basis of D

Ha: At least one supplier is different from others

S3 & S4, S1 & S2 are same in D between groups but are different within group. S1 & S2 are best between groups, S3 is lowest and S4 can be included in any of subset.

Analysis: All suppliers are providing timely but there is a non significant correlation between all. This also proves H1 that D is a most likely criterion for the firm. Here, Null hypothesis is rejected

TABLE XIII
PERFORMANCE LEVEL (PL) TUKEY HSD

Supplier	N	Subset for alpha = 0.05	
		1	2
2.00	90	3.7389	
3.00	90	3.8500	
1.00	90		4.2111
4.00	90		4.2259
Sig.		.487	.998

Ho: All 4 suppliers are same on the basis of PL

Ha: At least one supplier is different from others

S2 & S3, S1 & S4 are same between the groups for PL, but different within group. The respondents consider that S2 & S3 are lacking in their performance and services. Hence, Ho is rejected.

TABLE XIV
COMPETITIVE PRICE (CP) TUKEY HSD

Supplier	N	Subset for alpha = 0.05	
		1	2
3.00	90	3.9926	
4.00	90	4.0167	
2.00	90	4.0667	
1.00	90		4.2407
Sig.		.543	1.000

Ho: All 4 suppliers are same on the basis of CP

Ha: At least one supplier is different from others

S1 is different from others. Respondents think that S3 is not good in CP and only S1 is highly competitive. S2, S3, S4 are same between group but differs within group

Hence, Ho is rejected.

TABLE XV
FINANCIAL STABILITY (FS) TUKEY HSD

Supplier	N	Subset for alpha = 0.05	
		1	2
3.00	90	3.8722	
4.00	90	3.9611	
2.00	90		4.1722
1.00	90		4.2333
Sig.		.556	.804

Ho: All 4 suppliers are same on the basis of FS

Ha: At least one supplier is different from others

S3 & S4, S1 & S2 are same between groups but different within group. S1 & S2 seems to be quite stable financially but S1 is better than S2. S3 & S4 are not so FS, and S3 is lagging S4. Ho is rejected.

V. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. Respondents have given more weights to Operational aspects (Delivery, Quality & Performance Level) as compared to social, economical aspects, thus proving H1.
2. Price consciousness is found to be over shadowed by Delivery & Quality, thus proving H2.
3. Cronbach's value (0.71 & 0.73) proved our Hypothesis H3 i.e. suppliers appraisal and sifted 6 dimensions (criteria) are internally consistent and highly reliable.
4. ANOVA test has enabled us to carry out sensitivity analysis with rejection of Null Hypothesis as significance value decided that all suppliers are different. The degree of difference between all suppliers on a particular criteria are analyzed through Tukey test. Tukey test is good when comparing two means and it enabled us for opting a supplier on the basis of certain criteria.
5. Spearman correlation shows that all the six sifted criteria have a 95% confidence level and are positively significantly correlated to each other except CP thus

accepting H4. The Sig value of $CP > 0.05$, so no significant correlation exists with other variables. This test also enabled us to have a mix & match criteria based supplier appraisal (say a supplier may be good in quality, delivery but lagging in price). This proves H4.

6. Shapiro Wilk normalcy test has shown 95% confidence level of people by accepting Null Hypothesis i.e data is normally distributed, however the data is found to be drifted from normal and skewed. which shows that respondents has shown a mixed attitude while weighing alternatives perhaps due to less knowledge about the subject, thus proving H5.

B. Recommendation

Before making purchasing decisions and supplier selection following points are recommended:

1. SPM be the start point of making Purchasing Decisions subsequent Supplier appraisal.
2. Personnel in procurement be trained to understand the Supplier Selection Problem and MCDM techniques like AHP.
3. Low Bid selection criteria as in vogue, needs to accommodate other criteria as proved in study.
4. Supplier Performance Index (SPI) be maintained on the websites of procuring agencies as well as in each Organization.
5. Supplier's Database Management System (SDMS) be maintained, Product Category wise for a quick view of all competitors.

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