Supplier Selection through Analytical Hierarchy Process: A Case Study In Small Scale Manufacturing Organization

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Abstract – **This is an era of highly competitive environment. Small Scale Manufacturing Organizations should be very conscious, while selecting an effective supplier as such it increases the success and effectiveness of an organization. Supplier of a company increases not only its profitability but also its own economic strength. Both qualitative and quantitative factors are involved while selecting a supplier thereby making it a multi criteria decision making problem. So to choose the best supplier, one has to consider both tangible and intangible factors which might conflict. The proposed method involves the selection of criteria which is evaluated with the available literature and informal discussions with various industry professionals and academicians. This is a improved hybrid methodology, which uses the AHP for determining the global and local weights of criteria thereby selecting the best supplier. In this article a methodology has been developed using AHP for evaluating and selecting the best supplier for small scale manufacturing organizations.**

Keywords– *Analytic Hierarchy Process (AHP), supplier selection, qualitative and quantitative criteria.*

I. INTRODUCTION

In today's highly competitive environment, an effective supplier selection process is very important to the success of any manufacturing organization (Liu & Hai, 2005). In most industries the cost of raw materials and component parts constitutes the main cost of a product, such that in some cases it can account for up to 70% (Ghodsypour & O'Brien, 1998). Making of purchasing management can play a key role in cost reduction. In recent years, the small scale manufacturing industry has undergone revolutionary changes. The driving forces for these changes include increasing customer demand, technological advances, and a worldwide trend of deregulation.

These industries realize that the effort to obtain products at the right cost, in the right quantity, with the right quality at the right time from the right source is crucial for their survival (Oboulhas et al., 2004). Therefore, an efficient supplier selection process needs to be in place and of paramount importance for successful supply chain management (Sonmez2006). Supplier selection projects are one of the most important of quality, production, and logistics management for many firms. Factors such as qualitative and quantitative should be considered while analyzing the set of suppliers. In order to rank and select them to improve the effectiveness of the entire supply system. Supplier selection is becoming a very important factor for an organizational industry and also variety of methods were used for measuring the performance of the suppliers. Thus making it a multi criteria decision making (MCDM) problems. Supplier selection problem is affected by different tangible and intangible criteria such as quality, price, delivery, technical capability and many more. So selecting the right supplier for a decision maker with reduce purchasing cost improves competitive ability and increase customer satisfaction

II. LITERATURE REVIEW

Supplier selection problem is a group Multiple Criteria Decision-Making (MCDM) out of which quantities criteria has been considered for supplier selection in the previous and existing decision models so far (Chen-Tung, Ching-Torng & Huanget, 2006). In Multiple Criteria Decision-Making (MCDM), a problem is affected by several conflicting factors in supplying selection, for which a purchasing manager must analyze the trade off among the several criteria. MCDM techniques support the decision-makers (DMs) in evaluating a set of alternatives. Depending upon the purchasing situations, criteria have varying importance and there is a need to weigh them (Dulmin & Mininno, 2003). The analytic hierarchy process (AHP) has found widespread application in decision making problems, involving multiple criteria in systems of many levels (Liu & Hai,2005). This method has the ability to structure complex, multi-person, multi attribute, and multi-period problem hierarchically (Yusuff, PohYee & Hashmi,2001). The AHP can be very useful in involving several decision-makers with different conflicting objectives to arrive at a consensus decision

(Tam & Tummala, 2001). The AHP method is identified to assist in decision making to resolve the supplier selection problem in choosing the optimal supplier combination (Yu & Jing, 2004).

Analytic Hierarchy Process (AHP), since its invention, has been a tool at the hands of decision makers and researchers, and it is one of the most widely used multiple criteria decision-making tools (Omkarprasad & Kumar, 2006). Many outstanding works have been published based on AHP. They include applications of AHP in different fields such as planning, selecting best alternative, resource allocations, resolving conflict, optimization, etc., as well as numerical extensions of AHP (Vargas, 1990). Among applications of AHP method for the field of selecting the best alternative, the following publications are specified to supplier selection. Ghodsupour and O'Brion (1998) studied the conflicts between two tangible and intangible factors, based on AHP method, i.e. qualitative and quantitative, in order to choose the best suppliers. They integrated AHP and Linear Programming to consider both tangible and intangible factors in choosing the best suppliers and placed the optimum order quantities among them such that by using integrated AHP and LP the Total Value of Purchasing (TVP) becomes maximum. This model can apply to supplier selection with or without capacity constraints. Yahya and Kingsman (1990) used Saaty's (1980) AHP method to determine priority in selecting suppliers. Akarte (2001) used AHP to select the best casting suppliers from the group of evaluated suppliers. The evaluation procedure took care of about 18 different criteria. These were segregated into four groups namely: product development capability, manufacturing capability, quality capability, and cost and delivery. Out of 18 different criteria, six were of objective and twelve were of subjective types. The evaluation method of this model is based on relative performance measure for each supplier for subjective (qualitative) criteria which is obtained by quantifying the ratings expressed in quantitative terms. The supplier who has the maximum score is selected. Handfield, Walton and Sroufe (2002) studied Environmental criteria to supplier assessment by transforming purchasing in to a more strategic function. The authors integrated the environmental issues to make purchasing managers introduce dimensions in to their decisions, for which both qualitative and quantitative factors complicate the problem. By applying AHP in environmental criteria to supplier assessment, the authors were able to solve the above problem. AHP method may integrate environmental criteria in the sourcing decision process for supplier selection.

III. OBJECTIVE OF THIS PAPER

Following are the proposed objectives of this study:

1. To find out the various criteria for supplier selection. With this objective we would be able to find out the specific criteria for a specific industry.

2. To evaluate the identified criteria. Evaluation helps in finding the importance of criteria with respect to the goal.

3. To prioritize the various suppliers. This objective helps in finding the best supplier which follows all the criteria to the optimum level.

4. Development of model for supplier selection. The research bases on the development of a model for supplier selection which shall be helpful for the other industries of the same class.

IV. METHODOLOGY ADOPTED

1. *Identification of industry***:** A small scale manufacturing organization has been selected for this study.

2. *Criteria selection***:** Supplier selection criteria have been investigated with the help of literature available and informal discussions with various industry personnel and academicians.

3. *Questionnaire***:** Exploratory research approach has been adopted where focus group and interview sessions were conducted not only with company but also with its suppliers. Questionnaire is prepared in the form of tables which has to be filled up by the company and its suppliers.

4. *Data collection***:** Based on the interview conducted and the questionnaire prepared data is collected and represented**.**

5. *Application of AHP*: AHP method is then applied on that questionnaire survey collected from interview. Here first of all goals has been decided and then selection of some criteria with respect to decided goal, some alternatives has been considered that satisfy those criteria. Pair wise comparisons have been done of those alternatives satisfying the criteria. Then using the CGI software priorities of criteria has been calculated with respect to goal. The individual priority of the alternatives were calculated and after calculating their global priority finding the supplier, having highest priority is selected.

SUPPLIER SELECTION CRITERIYA

In the proposed model, the supplier selection criterion has been developed on the basis of literature review and a series of informal discussions with the academicians and industry personnel. The details of the criteria are given as follows (Table 1):

TABLE 1: CRITERIA

S.No	Criteria	Reference
1.	On-time delivery	Farzad Tahriri *et.al,* (2008), C. Elanchezhian et al.,(2010)
2.	Product quality	Farzad Tahriri *et.al,* (2008), C. Elanchezhian et al.,(2010)
3.	Price/cost	Farzad Tahriri *et.al,* (2008), C. Elanchezhian et al.,(2010)
4.	Facility and technology	Farzad Tahriri *et.al,* (2008), C. Elanchezhian et al.,(2010)
5.	Responsiveness to customer needs	Farzad Tahriri *et.al,* (2008), C. Elanchezhian et al.,(2010)
6.	Professionalism of salesperson	Farzad Tahriri *et.al,* (2008), C. Elanchezhian et al.,(2010)
7.	Quality of relationship with vendor	Farzad Tahriri *et.al,* (2008), C. Elanchezhian et al.,(2010)
8.	Performance History	Farzad Tahriri *et.al,* (2008)

V.   CASE STUDY

Present research work is based on the problem of supplier selection for a manufacturing firm. A firm is wishing to have a supplier which will satisfy the criterion mentioned in Table 1. The problem is going to be solved by using Analytical Hierarchic Process. As we know that in AHP, problem is classified by different criteria and then different alternatives are tested on these criteria. The criteria and alternatives are then pair wise compared and priorities are calculated. For the purpose of priority calculation, assistance of Online CGI Software was taken into consideration (Table 2-22). In this case number of alternatives is three.

TABLE 2: COMPARISON OF ALTERNATIVES

Finally the comparison of alternatives will be accomplished on the basis of different criteria. Table 2 shows the details.

FROM / TO	On Time Delivery	Product Quality	Price/ Cost	Facility And Technology	Responsiveness Of Customer Needs	Professionalism Of Sales Person	Quality Of Relation Ship	Performance History
On Time Delivery	1	1	2	5	4	6	2	9
Product Quality	1	1	2	1	2	1	1	5
Price/Cost	½	½	1	3	1	1/2	1	3
Facility And Technology	1/5	1	1/3	1	1/3	1	2	2
Responsiveness Of Customer Needs	¼	½	1	3	1	3	1/2	3
Professionalism Of Sales Person	1/6	1	2	1	1/3	1	1/3	2
Quality Of Relationship	½	1	1	½	2	3	1	5
Performance History	1/9	1/5	1/3	½	1/3	1/2	1/5	1

TABLE 22: COMPARISON OF ALTERNATIVES

Supplier	SUPPLIER SELECTION USING AHP								
	Criterion								
	On Time Delivery	Product Quality	Price /Cost	Facility And Technology	Responsiveness Of Customer Needs	Professionalism Of Sales Person	Quality Of Relation Ship	Performance History	TOTAL
	0.184	0.096	0.022	0.055	0.022	0.031	0.086	0.021	**0.517** ←
	0.03	0.039	0.022	0.009	0.009	0.008	0.014	0.003	**0.134**
	0.075	0.016	0.065	0.022	0.085	0.042	0.035	0.008	**0.348**
TOTAL	**0.289**	**0.151**	**0.109**	**0.086**	**0.116**	**0.081**	**0.135**	**0.032**	**1.00000**
	1.00000000								

VI. RESULT AND DISCUSSIONS

Table 22 shows the sum of priorities for the candidate S1 is 0.517. For supplier S_2 the sum is 0.134 and for supplier S_3 the sum of priorities is 0.348. It means that Supplier S_1 is satisfying all the criteria to the maximum level. After the supplier S_1, S_3 and S_2 are fulfilling the criterion. Therefore we can suggest that supplier S1 may be considered as the best supplier for the firm. After supplier S_1, the firm should choose suppliers S_3 and S_2 respectively. Choosing a supplier has always become a difficult task for a firm as it may involve many criteria of opposite nature. Many times cost determines the supplier. However, now – days, this trend is shifting towards other parameters also. In many firms, emphasis on quality, on time delivery and professionalism are also considered as determining criteria. Selection of criteria and number of criterion may vary from industry to industry and even from person to person In this research, selection of criteria was done on the basis of literature survey and a series of informal discussions with the industry personnel. Sometimes the industry personnel become unable to give the right definition of the criteria he is using. In present research work, all the necessary attempts were made for investigating criteria for supplier selection and originality of the work, yet extensive research may be done in this field. Sometimes, it becomes very difficult for a supplier to give numerical values to the criteria. A supplier selection criterion is a qualitative term and for the purpose of calculations it must be quantifiable. In order to quantify the criteria we assign the numerical values to the criteria. At this point human behaviour interferes. Many a times, due to fuzziness of our mind we cannot assign the numerical values to the qualitative terms. In order to quantify the qualitative data, different versions of AHP are being provided by the researchers but they are all in their early stages and are seeking further modifications. Therefore, a strong base should be investigated for assigning such numerical values.

REFERENCES

[1] Akarte, M.M. (2001). Web based casting supplier evaluation using analytic hierarchy process. Journal of the Operational Research Society 52 (5): 511-522.

[2] Chen-Tung, C., L. Ching-Torng & S F. Huanget. (2006). A fuzzy approach for supplier evaluation and selection in supply chain management. Production Economics 102: 289–301.

[3] Dulmin, R. & V. Mininno. (2003). Supplier selection using a multi-criteria decision aid method. Journal of Purchasing and Supply Management 9: 177-187.

[4] Farzad Tahriri, M. Rasid Osman, Aidy Ali, Rosnah Mohd Yusuff and Alireza Esfandiary (2008), "AHP approach for supplier evaluation and selection in a steel manufacturing company", Journal of Industrial Engineering and Management,Vol.1(2): 54-76.

[5] Ghodsypour, S. H. & C. O'Brien(1998). A decision support system for supplier selection using an integrated analytical hierarchy process and linear programming. International Journal of Production Economics 56-67: 199-212.

[6] Handfield, R., S. V. Walton & Sroufe, R. (2002). Applying environmental criteria to supplier assessment: A study in the application of the Analytical Hierarchy Process. European Journal of Operational Research 141: 70-87.

[7] Liu, F.H. F.& H. L. Hai. (2005). The voting analytic hierarchy process method for selecting supplier. International Journal of Production Economics 97(3): 308-317.

[8] Oboulhas O., Xiaofei X., and Zhan D. (2004). "A decision support system for supplier selection process", International Journal of Information Technology & Decision Making Vol. 3, No.3 453.470 World Scientific Publishing Company.

[9] Omkarprasad, S. V. & S. Kumar. (2006). Analytic hierarchy process: An overview of applications. European Jurnal of Operational Research 169: 1-29.

[10] Saaty, T. L. 1980. The Analytical Hierarchy Process, Mc Graw Hill, New York.

[11] Sonmez, Mahmut (2006) "A Review and Critique of Supplier Selection Process and Practices." Occasional Papers Series, Loughborough University, UK.

[12] Tam, M. C. Y. & V. M. R. Tummala. (2001). An Application of the AHP in vendor selection of a telecommunications system. Omega 29(2): 171-182.

[13] Vargas, L. (1990). An overview of analytic hierarchy process: Its applications. European Journal of Operational Research 48(1): 2-8.

[14] Yahya, S. & B. Kingsman. (1999). Vendor rating for an entrepreneur development programme: a case study using the analytic hierarchy process method. Journal of the Operational Research Society 50: 916-930.

[15] Yu, X. & S. Jing. (2004). A Decision Model for Supplier Selection Considering Trust. Chinese Business Review 3(6): 15-20.

[16] Yusuff, R. d., K. PohYee & M.S.J. Hashmi. (2001). A preliminary study on the potential use of the analytical hierarchical process (AHP) to predict advanced manufacturing technology (AMT) implementation. Robotics and Computer Integrated Manufacturing 17: 421–427.

APPENDIX TABLES

TABLE 3: PRIORITIES OF CRITERIA

S.NO	LOCAL PRIORITY	GLOBAL PRIORITY
1.	0.289489	0.289489
2.	0.150334	0.150334
3.	0.108806	0.108806
4.	0.0874715	0.0874715
5.	0.115892	0.115892
6.	0.081465	0.081465
7.	0.135365	0.135365
8.	0.0311773	0.0311773
CR= 0.098< 0.10		

TABLE 4: COMPARISON OF SUPPLIERS – ON TIME DELIVERY

FROM/TO	S1	S2	S3
S1	1	5	3
S2	1/5	1	1/3
S3	1/3	3	1

TABLE 5: PRIORITIES OF SUPPLIERS- ON TIME DELIVERY

S.NO	LOCAL PRIORITY	GLOBAL PRIORITY(*0.289)
S1	0.636986	0.184
S2	0.104729	0.03
S3	0.258285	0.075
CR=0.03 < 0.10		

TABLE 6: COMPARISON OF SUPPLIERS- PRODUCT QUALITY

FROM/TO	S1	S2	S3
S1	1	3	5
S2	1/3	1	3
S3	1/5	1/3	1

TABLE 7: PRIORITIES OF SUPPLIERS – PRODUCT QUALITY

S.NO	LOCAL PRIORITY	GLOBAL PRIORITY (*0.150)
S1	0.636986	0.096
S2	0.258285	0.039
S3	0.104729	0.016
CR= 0.032< 0.10		

TABLE 8: COMPARISON OF SUPPLIERS- PRICE/COST

FROM/TO	S1	S2	S3
S1	1	1	1/3
S2	1	1	1/3
S3	3	3	1

TABLE 9: PRIORITIES OF SUPPLIERS- PRICE/COST

S.NO	LOCAL PRIORITY	GLOBAL PRIORITY (*0.108)
S1	0.2	0.022
S2	0.2	0.022
S3	0.6	0.065
CR= 0 < 0.10		

TABLE 10: COMPARISON OF SUPPLIERS - FACILITY AND TECHNOLOGY

FROM /TO	S1	S2	S3
S1	1	5	3
S2	1/5	1	1/3
S3	1/3	3	1

TABLE 11: PRIORITIES OF SUPPLIERS- FACILITY AND TECHNOLOGY

S.NO	LOCAL PRIORITY	GLOBAL PRIORITY

		(*0.087)
S1	0.636986	0.055
S2	0.104729	0.009
S3	0.258285	0.022
CR=0.032< 0.10		

TABLE 12: COMPARISON OF SUPPLIERS- RESPONSIVENESS OF CUSTOMER NEEDS

FROM/TO	S1	S2	S3
S1	1	3	1/5
S2	1/3	1	1/7
S3	5	7	1

TABLE 13: PRIORITIES OF SUPPLIERS - RESPONSIVENESS OF CUSTOMER NEEDS

S.NO	LOCAL PRIORITY	GLOBAL PRIORITY (*0.115)
S1	0.188394	0.022
S2	0.0809612	0.009
S3	0.730645	0.085
CR= 0.055 < 0.10		

TABLE 14: COMPARISON OF SUPPLIERS PROFESSIONALISM OF SALES PERSON

FROM/TO	S1	S2	S3
S1	1	3	1
S2	1/3	1	1/7
S3	1	7	1

TABLE 15: PRIORITIES OF SUPPLIERS – PROFESSIONALISM OF SALES PERSON

S.NO	LOCAL PRIORITY	GLOBAL PRIORITY (*0.081)
S1	0.387948	0.031
S2	0.0974973	0.008
S3	0.514555	0.042
CR= 0.068< 0.10		

TABLE 16: COMPARISON OF SUPPLIERS – QUALITY OF RELATIONSHIP

FROM/TO	S1	S2	S3
S1	1	5	3
S2	1/5	1	1/3
S3	1/3	3	1

TABLE 17: PRIORITIES OF SUPPLIERS – QUALITY OF RELATIONSHIP

S.NO	LOCAL PRIORITY	GLOBAL PRIORITY (*0.135)
S1	0.636986	0.086
S2	0.104729	0.014
S3	0.258285	0.035
CR=0.032 < 0.10		

TABLE 18: COMPARISON OF SUPPLIERS – PERFORMANCE HISTORY

FROM/TO	S1	S2	S3
S1	1	7	3
S2	1/7	1	1/3
S3	1/3	3	1

TABLE 19: PRIORITIES OF SUPPLIERS – PERFORMANCE HISTORY

S.NO	LOCAL PRIORITY	GLOBAL PRIORITY (*0.031)
S1	0.669417	0.021
S2	0.0879462	0.003
S3	0.242637	0.008
CR= 0.005< 0.10		

TABLE 20: COMPARISON OF SUPPLIERS – PERFORMANCE HISTORY

FROM/TO	S1	S2	S3
S1	1	7	3
S2	1/7	1	1/3
S3	1/3	3	1

TABLE 21: PRIORITIES OF SUPPLIERS – PERFORMANCE HISTORY

S.NO	LOCAL PRIORITY	GLOBAL PRIORITY (*0.031)
S1	0.669417	0.021
S2	0.0879462	0.003
S3	0.242637	0.008
CR= 0.005< 0.10		