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Vendor selection with and without effect of risk cost

[1]Deepak Kumar, [2]Mr.A.R Ansari

[1]PG Scholar, [2]Assistant Professor, Department of PRODUCTION ENGINERRING, BIT Sindri, Dhanbad, India.

[1]deepakkumar.grh@gmail.com, [2]aransari@bitsindri.ac.in

Abstract - The vendor selection process plays vital role in reducing the most important variables quality, cost and productivity. The total cost of purchase is included in the decision making process. This total cost incorporates transportation ordering and storage cost. We calculate the Economic order quantities (EOQ) for single and multiple sourcing .We also calculate the Total annual production cost (TAPC) with risk and without risk then we compare both TAPC with risk and without risk. This analysis enables the management to reflect corporate strategies in the purchasing activities. The study examines that schedule for deliveries which tells the project manager when and how much should be purchased from each supplier.

Keywords—AOC,AHC,RFP,RFQ,TAPC,TC

I. INTRODUCTION

For surviving in this competitive global economy, it is important not only to develop but also to discover new vendor. For example a new vendor may have ingenious production technology which allows it to significantly reduce its production cost relative to predominate production technology. A new vendor may have a structural cost advantage over existing vendor because of lower labor cost or favorable import or export regulations in its home country. Some of the existing suppliers may go out of business or their costs may be increasing. The buyer may need additional vendors simply to drive competition. results in the fields of Engineering & Management.

The steps of supplier selection process, To identify suppliers, To solicit information from suppliers, To set contract terms, To negotiate with supplier and to evaluate supplier.

II. LITERATURE REVIEW

Narasimhan and Stoynoff et al. [1] applied a single objective, mixed integer programming model to a large manufacturing firm in the Midwest, to optimize the allocation procurement for a group of vendors. The objective of this model is to minimize the sum of the shipping and the penalty costs. The model constraints are related to vendors' production capabilities and demand. **Kingsman et al.** [2] stated that one of the most important problems which has received little attention from OR practitioners is the purchasing of materials whose prices are continually fluctuating in a stochastic manner over time. He discussed conceptually linear programming and dynamic programming as tools for purchasing raw materials with fluctuating prices.

Turner et al. [3] presented a single objective linear programming model for British Coal. This model minimized the total discounted price by considering the vendor capacity, maximum and minimum order quantities, demand, and regional allocated bounds as constraints.

Pan et al. [4] proposed multiple sourcing for improving the reliability of supply for critical materials, in which more than one supplier is used and the demand is split between them. Most purchasing managers agree that buying from more than one vendor will protect the buying firm in the case of shortages. Pan used a single objective linear programming model to choose the best suppliers, in which three criteria are considered - price, quality and service. The total cost is taken into account as an objective function and quality and service are considered as constraints.

Sharma et al.[5] proposed a non-linear, mixed integer, goal programming model for supplier selection. They considered price, quality, delivery and service in their model, in which all criteria are considered as goals. The cost goal is decreased in relation to the increase in purchased quantity and is raised in relation to the increase in quality level.

Seshadri et al.[6] developed a probabilistic model to represent the connection between multiple sourcing and its consequences, such as number of bids, the seller's profit and the buyer's price. Only one criterion, cost, is considered in this model and the authors stated that the user should transfer the other criteria such as quality, delivery, etc., into an equivalent price.

Kogut and Kulatilaka et al. [7] have also developed a stochastic dynamic programming for a two country

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production switching model with production function (issues 4 and 5). They have evolved a hysteresis band to analyze the hysteresis effect due to presence of switching costs.

Owen and Daskin et al. [8] have developed dynamic and stochastic location models (issues 1 and 2) using dynamic nature of facility location problem and the stochastic nature of the customers demand.

Huijun et al. [9] have considered the benefits of customers and logistics planning departments, a bi-level programming model is presented to seek the optimal location for logistic distribution centers. However, the availability of literature dealing with risks explicitly is scanty.

Suwanruji and Enns et al. [19] have studied the risk between inventory and delivery performance in a stochastic, multi echelon supply chain involving production and distribution functions.

III. PROCEDURE OF VENDOR SELECTION

Literature review showed that how an empirical study is done to evaluate the vendor selection process. We have clouds of vendors but we have to choose best possible vendor on following criterion

- **Identifying Potential Suppliers**
- **Information requests to suppliers**
    - Request For Information (RFI)
    - Request For Proposal (RFP)
    - Request For Quote (RFQ)
- **Contract terms**
- **Negotiation process**
- **Supplier evaluation**
- **Supplier monitoring**

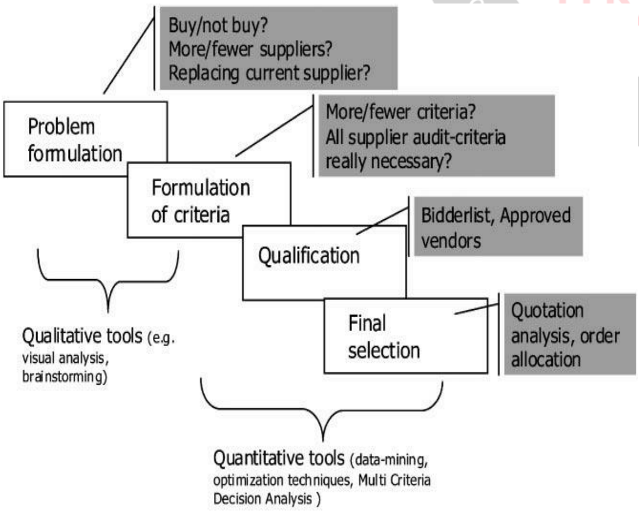

Fig.1Rough positioning of decision methods in vendor selection

IV. CASE STUDY

Kapson Ind.Pvt.Ltd,It manufacture various types of fans, motors,alternator.I am doing my case study on alternator Alternator has two component stator and rotor .These are made up from stacking of multiple pieces of designed sape of thin plate.The role of thin plate sheets are purchased by Hindalco,sail,Tata steal,Price is in lac

Suppliers	Price	Ordering cost	Perfect rate	On time delivery	capacity
Hindalco	9	9	0.91	0.93	700
sail	16	4	0.94	0.90	600
Tata steal	32	8	0.96	0.97	800

By using EOQ model we get total annual purchasing cost

$$TAPC = \sqrt{2Dr\left(\sum_{i=1}^{n} A_i Y_i\right)\left(\sum_{i=1}^{n} X_i^2 P_i\right)} + \sum_{i=1}^{n} X_i P_i D$$

Using GINO or EXCEL solver to find the best result

Microsoft Excel 12.0 Answer Report
Worksheet: [Book1]Sheet1
Report Created: 10/11/2018 2:23:16 PM

Target Cell (Min)

Cell	Name	Original Value	Final Value
B4	objetive function	11786.97521	18795.17342

Adjustable Cells

Cell	Name	Original Value	Final Value
B1	sup.1 percentage	0.2	0.490001
B2	sup.2 percentage	0.2	0.01
B3	sup.3 percentage	0.2	0.5

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
B5	capacity const.1	0.480001	B5>=0	Not Binding	0.480001
B6	capacity const.2	-0.109999	B6<=0	Not Binding	0.109999
B7	capacity const.3	0	B7>=0	Binding	0
B8	capacity const.4	-0.69	B8<=0	Not Binding	0.69
B9	capacity const.5	0.49	B9>=0	Not Binding	0.49
B10	capacity const.6	0	B10<=0	Binding	0
B11	capacity const.7	1E-06	B11=0	Not Binding	0

Fig.2 Excel generated Answer report

$$\text{QUALITY} = \sum_{i=1}^{n} X_i Q_i$$

= 0.15*0.92 + 0.7*0.95 + 0.15*0.98 = 0.95

Hence this case is feasible

TABLE 1 Optimum solution for the demand case q_a=.95

CASES	X_1	X_2	X_3	Q	TC	TQ
1	.15	.7	.15	154	17621	.95
2	.3	.7	0	-	unfeasible	.94
3	.5	0	.5	128	20764	.95
4	0	.7	.3	105	21026	.96

In case 2 quality is .94 but we have to take .95 so this is infeasible.

We are solving again this problem by reducing its quality equal to 92 percent. We get following result.

Table 2 optimum solution for demand case q_a=.92

CASES	X_1	X_2	X_3	Q	TC	TQ
1	.6	.39	.01	192	12178	.93
2	.6	.4	0	149	11973	.93
3	.6	0	.4	142	18438	.94
4	0	.7	.3	105	21026	.96

Comparing both conditions

Table 3 comparison for both case

Case	X_1	X_2	X_3	TC	TQ
q_a=.95	.15	.7	.15	17621	.95
q_a=.92	.6	.4	0	11973	.93

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Comparing both the cases, we get buyer has to pay more for getting better quality.

V. EFFECT OF RISK IN VENDOR SELECTION

Risk plays vital role in vendor selection so risk must be consider for choosing vendor. Till now we have calculated the TAPC but now we are incorporating three extra cost which are transportation risk cost, quality risk cost, purchasing risk cost.

Annual transportation risk cost=

$$\sum_{i=1}^{n} P(TC_i)\times TC_i \times X_i D$$

Annual quality risk cost=

$$\sum_{i=1}^{n}\left[\frac{X_i}{\sum_{\varphi_i^s} P(w)\times W}\right]\times (P_i)_{avg}$$

Purchasing risk cost=

$$\sum_{i=1}^{n} P(P_i)\times (P_i)_{avg}\times X_i D$$

Total annual cost with risk=

$$\left(\sum_{i=1}^{n} A_i Y_i\right)\frac{D}{Q} + \left(\sum_{i=1}^{n} X_i^2 P_i\right)\frac{rQ}{2} +$$

$$\sum_{i=1}^{n} P(TC_i)\times TC_i \times X_i D + \sum_{i=1}^{n}\left[\frac{X_i}{\sum_{\varphi_i^s} P(w)\times W}\right]\times (P_i)_{avg}$$

$$\sum_{i=1}^{n} P(TC_i)\times TC_i \times X_i D + \sum_{i=1}^{n}\left[\frac{X_i}{\sum_{\varphi_i^s} P(w)\times W}\right]\times (P_i)_{avg}$$

$$+\sum_{i=1}^{n} P(P_i)\times (P_i)_{avg}\times X_i D$$

Table 4 Transportation and quality risk cost and their probability

Vendor	TC and its probability	Quality and its probability
1	TC_1=5,$P(TC_1)$=.6 TC_2=7,$P(TC_2)$=.4	W_1=.97,$P(W_1)$=.3 W_1=.94,$P(W_1)$=.4 W_1=.95,$P(W_1)$=.3
2	TC_1=6,$P(TC_1)$=.7 TC_2=9,$P(TC_2)$=.3	W_1=.92,$P(W_1)$=.2 W_1=.96,$P(W_1)$=.5 W_1=.94,$P(W_1)$=.3
3	TC_1=5,$P(TC_1)$=.5 TC_2=7,$P(TC_2)$=.5	W_1=.94,$P(W_1)$=.5 W_1=.95,$P(W_1)$=.3 W_1=.98,$P(W_1)$=.2

Table 5 purchasing risk cost and their probability

Vendor	Purchasing cost and its probability
1	P_1=7,$P(P_1)$=.6 P_1=6,$P(P_1)$=.4
2	P_1=8,$P(P_1)$=.5 P_1=6,$P(P_1)$=.5
3	P_1=7,$P(P_1)$=.4 P_1=5,$P(P_1)$=.6

TC1 = transportation cost per product when product couldn't come within a specific time limit (rupees)

TC2 = transportation cost per product under lead time (rupees)

W = quality of product at a particular supplier

P1 & P2 = different purchasing price of a particular supplier (rupees) Ordering cost and capacity are in rupees.

VI. RESULT

Proposed algorithm

1- Make a list of all combinations of Yi s(at most 2n times).where Yi is binary variable.

2- Omit the cases, which can not satisfy the demand constraint.

3- Substitute the values of Yi s in the integer programming to change it to pure non-linear programming (PNP). If the set {S} is defined as the set of Yi s for their values are equal to 1 the pure nonlinear programming becomes linear programming

Once it become linear programming, it becomes very easy to solve it by excel solver and we have found the best solution for each case. Choosing the minimum TAPC from all the feasible cases as the best answer.

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B10	capacity const.6	0	B10<=0	Binding	0
B11	capacity const.7	1E-06	B11=0	Not Binding	0

Fig.3 Excel generated Answer report for incorporating risk

Table 6 optimum solution for demand case q_a=.95

Case	X_1	X_2	X_3	TC
1	.49	.01	.5	18795
2	.6	.4	0	20290
3	.5	0	.5	18777
4	0	.5	.5	19763

We conclude from the above table that in case 3 minimum cost occurred, i.e. total annual cost with risk is minimum.

VII. COMPARISON BETWEEN TAPC AND TOTAL ANNUAL COST WITH RISK

Table 7 TAPC without risk

CASES	X_1	X_2	X_3	Q	TC	TQ
1	.15	.7	.15	154	17621	.95
2	.3	.7	0	-	unfeasible	.94
3	.5	0	.5	128	20764	.95
4	0	.7	.3	105	21026	.96

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Table 8 TAPC with risk

Case	X_1	X_2	X_3	TC
1	.49	.01	.5	18795
2	.6	.4	0	20290
3	.5	0	.5	18777
4	0	.5	.5	19763

How price vary with risk and without risk it can be better understood from above table.

TAPC with risk case 1 gives better result i.e. vendor 1 has percentage of .15, vendor 2 has .70,vendor 3 has .15

TAPC without risk case 3 gives better result.

VIII. CONCLUSION

Supplier selection is one of the most important activities of purchasing managers in which cost, quality, delivery, etc., should be considered in selecting the best suppliers. Shortage of suppliers' capacity makes the problem difficult, and considering the total cost of purchasing makes it more complicated. a non-linear integer programming model which has been developed to help managers in this decision making. In order to solve the non-linear integer programming, it is necessary to solve 2^n pure non-linear programs. Although the model should be run 2^n times for *n* suppliers, the model solution should not take too long because in most practical cases there are usually a maximum of 12 vendors and also because some cases are omitted, as they cannot satisfy the demand constraint. Advantage of this model is:

[1] It considers multiple criteria such as cost, quality, risk etc. in supplier selection problems.

[2] The total cost of procurement rather than just price, can be included in the decision making process. Total cost contains transportation, quality , purchasing , ordering and storage costs.

[3] The model calculates the Economic order quantities (EOQ) for both single and multiple sourcing with and without constraints.

[4] The model can enable the management to reflect corporate strategies in the purchasing activities.

[5] A schedule for deliveries should be provided, which tells the buyer when and how much should be purchased from each supplier.

[6] As the model is solved using Solver from Microsoft Excel, it is user-friendly and easy to apply by the purchasing management

IX. FUTURE SCOPE

This analysis determines a single point or quantity and assuming a constant demand. But when our demand varies from period to period the results from the EOQ may be deceptive. We may go for Wagner and Whitin algorithms or not? it is a matter of concern.

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