An Exploration of Suppliers Selection in Mall’s Supply Chain Applying Genetic Algorithm (GA)

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Abstract: Excessive competition in the world to supply goods and services is an undeniable fact during the last two decades. By increasing the number of rivals, organizations were forced to improve their intra-organizational processes to survive in international competition scene. During the recent years, determining appropriate suppliers in supply chain have highly been considered. Many producers have searched for cooperating with appropriate suppliers to increase their organizations’ management and competitive performance. The main goal of supplier selection process is to decrease purchasing risk, maximizing critical values for customer and making close relation between purchaser and supplier. There are a lot of qualitative and quantitative factors that should be taken into consideration to determine appropriate suppliers. Quality, price, flexibility and delivery performance are of these critical factors. In the present study, qualitative and quantitative variables are used to evaluate the factors’ weight and ranks. By increasing the number of rivals, organizations were forced to improve their intra-organizational processes to survive in international competition scene. The criteria of supplier selection have been complex by emerging the issues such as ISO 90013, ISO 9002, European foundation for quality management 4, just-in-time system and so forth.

Key words: Supply chain • Evaluation • Multi-criteria decision making • Supplier

INTRODUCTION

During the recent years, supply chain and supplier selection process has highly been focused in management and business literature. During the 1990s, many producers have searched for cooperating with appropriate suppliers to increase their organizations’ management and competitive performance. The main goal of supplier selection process is to decrease purchasing risk, maximizing critical values for customer and making close relation between purchaser and supplier. There are a lot of qualitative and quantitative factors that should be taken into consideration to determine appropriate suppliers. Quality, price, flexibility and delivery performance are of these critical factors. In the present study, qualitative and quantitative variables are used to evaluate the factors’ weight and ranks. By increasing the number of rivals, organizations were forced to improve their intra-organizational processes to survive in international competition scene. The criteria of supplier selection have been complex by emerging the issues such as ISO 90013, ISO 9002, European foundation for quality management 4, just-in-time system and so forth.

Optimal Policies for Supplier:

Total supplier cost can be computed from the sum of preparation costs, inventory maintaining costs and delivery costs. Total supplier cost is expressed as follow:

\[ TRC_s(q,m) = A_s \frac{D}{mq} + r_sC_s \frac{mq}{2} \left[ 1 - \frac{D}{p} - \frac{1}{m} + \frac{2D}{mp} \right] + Z_s \frac{D}{p} \]  

(1)

And shortly:

\[ x_s(m) = D \left( \frac{A_s}{n} + Z_s \right) \]  

(2)

Where:

\[ y_s(m) = r_sC_s \frac{mq}{2} \left[ 1 - \frac{D}{p} - \frac{1}{m} + \frac{2D}{mp} \right] \]  

(3)

The optimal value of \( q_s \) of supplier is:

\[ q_s(m) = \frac{x_s(m)}{y_s(m)} \]  

(4)

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To compute $q^*$, the derivative of equation 1 is taken with respect to $q$ and the result equal to zero. To determine the optimal value of $m$, there are two modes depending on production rate and demand rate:

- If $p < 2d$, the optimum is the nearest number to $m'$ computed as follow:

$$m' = \sqrt{\frac{A_s (2D - p)}{Z_s (p - D)}}$$  \hspace{3cm} (5)

And the optimal value of goods size $m$ is computed by substituting $m$ value in equation 2 and placing it into equation 3. The optimal quantity of preparation for supplier is

$$Q_r = mq$$

- If $p > 2d$, the optimal value of $m$ will be $m = 1$ in this case, the optimal value of goods size for supplier can be computed as follow:

$$q^* = \sqrt{\frac{2D (A_s + Z_s)}{r_s C_s D / p}}$$  \hspace{3cm} (6)

If purchaser is more powerful and imposes his optimal policy to supplier, supplier can select his/her accumulated size as an integer multiple of purchaser’s goods quantity ($Q_n = n q_a$) in which $m$ is the nearest integer to $m'$ computed as follow:

$$m' = \sqrt{\frac{2D A_s}{r_s C_s [1 - D / p]}}$$  \hspace{3cm} (7)

**Case Study:** To collect the data, a questionnaire has been provided to determine appropriate criteria of supplier selection and then, the questionnaires have been completed by experts of order and purchase sections of considered product in Iran Khodro. After investigating the views of the experts and reviewing them, accurate criteria have been selected to evaluate supplier selection. Table 1 presents the matrix of decision making obtained from the importance of each supplier relative to each criterion.

![Simulation system](image)

**Table 1: Supplier selection in supply chain**

<table>
<thead>
<tr>
<th>Supplier</th>
<th>After sale services</th>
<th>Progress time</th>
<th>Price</th>
<th>Geographical situation</th>
<th>EDI capability</th>
<th>Quality</th>
<th>Capacity and productive facilities</th>
<th>Customer orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier1</td>
<td>6</td>
<td>3</td>
<td>120</td>
<td>20</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Supplier2</td>
<td>6</td>
<td>4</td>
<td>150</td>
<td>20</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Supplier3</td>
<td>7</td>
<td>3</td>
<td>130</td>
<td>20</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Supplier4</td>
<td>5</td>
<td>5</td>
<td>170</td>
<td>14</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Supplier5</td>
<td>6</td>
<td>7</td>
<td>140</td>
<td>15</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Criteria weights</td>
<td>0/041</td>
<td>0/041</td>
<td>0/53</td>
<td>0/089</td>
<td>0/069</td>
<td>0/195</td>
<td>0/081</td>
<td>0/072</td>
</tr>
</tbody>
</table>

RESULTS

Since 1960, imitating living organisms to be used in powerful algorithms have been considered to solve the problems of optimization and have been called as evolitional computation. Basic principles of Genetic Algorithm (GA) were proposed by John Holland in 1975 at University of Michigan. GA is one of the most important initiative algorithms to optimize defined functions over a limited range. In GA, previous information is extracted with respect to inherent aspect of the algorithm and is used in search trend. GA concepts were developed by Gelberg in 1989. In the present study, a Genetic Algorithm has been presented to find acceptable amounts of the problem variables with an emphasis on minimizing chain costs. To present the algorithm various operators have been developed. Also, various experiments have been done on the problem with different size. The structure of proposed GA is as follow:

**Chromosome:** The base of GA is to invert each set of solutions to a coding. This coding is so called chromosome. In fact, the coded form is the solutions of the problem. In this problem, every chromosome is a solution which can be reasonable or unreasonable.

**Population:** Set of the chromosomes are called a population. One feature of GA is that it focuses on a population rather than focusing on a point in search space. The considered model has been solved with the amount of 1000, 2000, 5000 and 10000 chromosomes.

**Fitness Function:** Fitness function is a function in which variable value of the problem is put and the desirability of each solution is determined. Optimizing objective function is applied as fitness function in the problems.

**Genetic Operators:** Creating new chromosomes (offspring) from combining tow chromosomes (parents) is a main part in genetic algorithm. This process is done by genetic algorithm.

**Crossover Function:** The main operator to create new chromosome is crossover operator. It creates new chromosomes which are the exact copies of the parents.

**Mutation Function:** Mutation is a random change in the gen content by substitution of one gene with another leading to a new genetic structure. The mutation probability is very small, ranging between 0/001 - 0/01.

Table 2: Supplier selection in supply chain

<table>
<thead>
<tr>
<th>Policy</th>
<th>Purchaser</th>
<th>Supplier</th>
<th>Common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goods size ((q))</td>
<td>22/4</td>
<td>539</td>
<td>47</td>
</tr>
<tr>
<td>Goods number ((n))</td>
<td>39</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Order size ((Q_b))</td>
<td>872/1</td>
<td>1077/5</td>
<td>847/9</td>
</tr>
<tr>
<td>Number of accumulated goods ((m))</td>
<td>19</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Size of accumulated production</td>
<td>424/9</td>
<td>538/8</td>
<td>471</td>
</tr>
<tr>
<td>Purchaser’s loss</td>
<td>0</td>
<td>1002</td>
<td>26/1</td>
</tr>
<tr>
<td>Total cost of supplier</td>
<td>662</td>
<td>387/9</td>
<td>553/7</td>
</tr>
</tbody>
</table>

**Generation:** Every reiteration of algorithm leading to a new generation is called as generation. In the present study, new generations have been generated 100 times. Limitations of the study have been treated by penalty coefficient strategy in which unjustified responses are not avoided but have a less presence. To his end, Paul’s formula has been used. In this model’s strategy, each justified response is better than unjustified responses.

**Simulation:** To analyze quantitatively and obtain numerical results, a number should be assign for each parameter. A numerical example is used to obtain numerical results.

<table>
<thead>
<tr>
<th>(D)</th>
<th>(Z_u)</th>
<th>(r_c)</th>
<th>(C_u)</th>
<th>(A_u)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>4.5</td>
<td>0.18</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>2500</td>
<td>0.03</td>
<td>1</td>
<td>0.2</td>
<td>20</td>
</tr>
</tbody>
</table>

The following numerical results have been obtained by substituting the numbers in above equations.

According to Table 2, numerical results indicate that increasing supplier cost due to imposing goods policy behalf powerful purchaser is 274 dollars per year, i.e. supplier undergoes 71% of loss in proportional to supplier policy. Numerical analyses also show that accepting supplier’s optimal policy causes purchase undergo a loss of 1002 Dollars more than accepting his own optimal policy.

The following diagram determines the amount of supplier cost with respect to the number of goods in any accumulated size if “policy = optimal” is considered for
purchaser. According to the diagram, in \( m = 19 \) total supply costs is 662 which is an optimal value for supplier. The horizontal axis indicates the number of goods and the horizontal axis indicates supplier’s cost expressed by \( T(s) \).

CONCLUSION

The cost of raw material and product’s constitutes consist a main part of marginal cost of the product which is true in most of industries. This cost also allocates up to 70% of the product’s final price to itself. In such conditions, appropriate supplier selection can considerably decrease purchasing costs and increase competitiveness of organization. In the present study, suppliers selection in Mall’s supply chain was investigated applying Genetic Algorithm (GA). The cost of dealing, based on supplier, is pertained to a period in which goods is ordered. The cost of inventory maintaining, based on products, is considered in each period for each unit of product carried in that period and considered in planning. Generally, supplier selection inherently faces with imprecise and vague data and using fuzzy set theories seems appropriate to investigate this kind of uncertainty. In other words, using verbal expressions and variables are very appropriate to state the values of indices when performance indices cannot be stated by other numerical values. However, solving this problem using classic research methods in operations is very complex and time-consuming with respect to the model’s non-linear and complex nature. Therefore, malls have been studied using initiative Genetic Algorithm method since the goal of supplier selection is to decrease purchasing risk, increase the value for customer and the relation between purchaser and supplier. During the research, total cost of supply was determined first and then, an optimal value was determined with respect to the production and its demand.

REFERENCES