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Applying genetic algorithm in selecting providers of supply chain in big stores

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ABSTRACT

Excess competition in offering the goods and services in two previous decades throughout the world, is an undeniable fact. By increasing the number of rivals in the world class, the organizations were forced to improve home processes (processes within the enterprise) to stay in global competition arena. During recent years, determining appropriate suppliers for supply chain has had extreme importance. A lot of manufactures were looking for cooperation with appropriate suppliers to improve the level of management and competitive performance. The main goal in the process of selecting suppliers is to decrease the risk of purchase, maximize the important values of client and create high and close connection between buyer and supplier. Therefore, determining appropriate supplier in supply chain is a strategic key for accessing to organizational competitiveness.

Indexing terms/Keywords

Process of selecting supplier; Manufacture; Competitive; Supply chain; Appropriate supplier; cooperation.

Academic Discipline And Sub-Disciplines

Determining appropriate suppliers for supply chain.

SUBJECT CLASSIFICATION

68T05, 68T20, 68T35, 68M07, 68M20, 68U05, 68U07, 97Q20, 93B51, 93C83.

TYPE (METHOD/APPROACH)

Determining appropriate suppliers for supply chain with using genetic algorithm.

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INTRODUCTION

During recent years, supply chain management and the process of choosing supplier have attracted much attention in business and management literature. In 1990s years, a lot of providers were looking for cooperation with appropriate suppliers to increase the level of competition and management performance in their organizations. The main goal in selecting supplier is to decrease the risk of purchase, maximize the important values of client and create high connection between buyer and supplier. A lot of qualitative and quantitative factors such as quality, price and flexibility and delivery performance should be considered to determine appropriate suppliers. In this paper, qualitative and quantitative variables will be used to evaluate factors weights and grades. By increasing the number of rivals in global class, the organizations had to improve within the enterprise process to stay in global competition arena. By arising some issues such as ISO9003, ISO9002, European excellence model, quality-4 management, update-5 producing and …, the criteria for selecting suppliers has faced to much complexity than before. Generally, a lot of qualitative and quantitative factors such as quality, price, the ability of flexibility and the method of goods delivery have to be considered to determine suppliers.

Optimal policy for supplier

Supplier's total cost is obtained from the sum of the costs of preparation, the costs of inventory keeping and the costs of goods delivery. The total cost is:

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

And in short form, we have:

$$TRC_s(q,m) = \frac{x_s(m)}{q} + y_s(m)\, q\,, \qquad (2)$$

where

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

$$y_s(m) = r_s C_s \frac{mq}{2}\left[1 - \frac{D}{p} - \frac{1}{m} + \frac{2D}{mp}\right] \qquad (3)$$

The optimal value of q_s for supplier is:

$$q_s(m) = \sqrt{\frac{x_s(m)}{y_s(m)}} \qquad (4)$$

To obtain q_s, we differentiate from relation (2) in terms of q and put it equal to zero. To determine the optimum of m, two cases exist which depend on demand rate and production rate.

1- If $p < 2\,d$, then optimal m is the closest integer number to m' which is obtained from the following relation:

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

And optimal size of consignment q_s will be obtained by substituting the value of m in relation (3) and putting it in (4). The optimal value for preparation quantity for supplier is $Q_s = m\, q_s$.

2- If $p > 2\,d$, then the optimal value for m is $m = 1$. In this case, the optimal size of consignment for supplier is obtained from the following relation:

$$q_s^* = \sqrt{\frac{2D\,(A_s + Z_s)}{r_s C_s D/p}}$$

If the buyer has more power and imposes his optimal policy to supplier, the supplier can select the size of his stock equal to an integer coefficient of quantity of purchaser's consignment, that is $\mathrm{Q_B} = \mathrm{n}\ \mathrm{q_B}$, in which m is the nearest integer number to m', which is calculated from following relation:

$$\mathrm{m}' = \frac{1}{\mathrm{q_B}} \sqrt{\frac{2\mathrm{D}\ \mathrm{A_S}}{r_s C_s \ \left[1 - \frac{D}{p}\right]}}$$

if the size of consignment is selected by supplier as $q = q_s$, then the best amount of order for purchaser is $\mathrm{Q_B} = \mathrm{n}\ \mathrm{q}_s$, where n is the nearest integer number to the following term:

$$\mathrm{n}^* = \frac{1}{\mathrm{q_s}} \sqrt{\frac{2\mathrm{D}\ \mathrm{A_B}}{\mathrm{L_B A_B}}}$$

Case study

In this paper, based on special studied cases, the Table 1 shows the decision making matrix of the importance of each of suppliers respect to each criteria:

Criteria / Supplier	The after sale services	Process time	Price	Geographical location	EDI capability	Quantity	Capacity and manufacturing facilities	Customer favoritism
Supplier(1)	6	3	120	20	4	6	7	7
Supplier(2)	6	4	150	20	3	4	5	5
Supplier(3)	7	3	130	20	4	5	5	5
Supplier(4)	5	5	170	14	4	3	7	6
Supplier(5)	6	7	140	15	3	4	6	5
The weight of criteria	0.041	0.401	0.53	0.0894	0.069	0.195	0.081	0.072

Table1. Decision making matrix

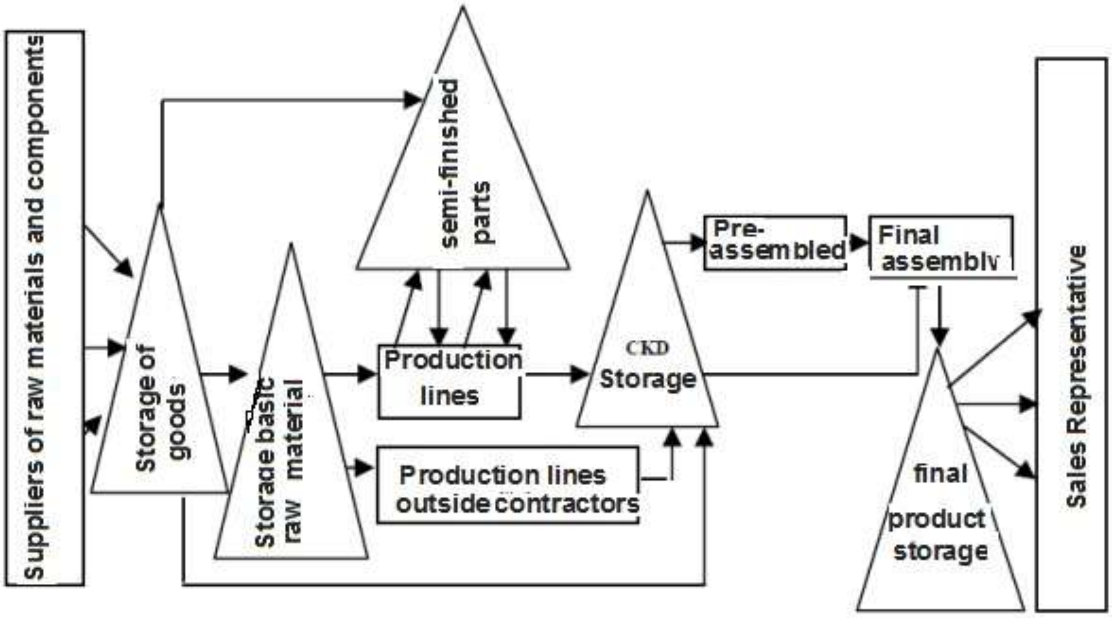

Figure1. Supply chain

Presented Genetic Algorithm

From 1960, imitation of live creatures has been considered for using in powerful algorithms to solve complicated optimization problems which were called technics of evolutionary computation. For first time, the fundamental principles of genetic algorithm were created by John Holland, in Michigan University while he was teaching a lesson under the title of "theory of adaptive systems". Genetic algorithm is one of the important creative algorithms which is used for optimizing the direction of functions which have been defined on limited domain. In this algorithm, according to being inherited in extracted algorithm, the past data are used in searching process. The notions of genetic algorithms were developed in 1989 by Golbarg. In this paper, the genetic algorithm has been offered to find satisfactory amounts of variables in the problem with emphasis on minimizing the costs of the chain (continuum).

To present the algorithm, different operators have been developed and to study the efficiency of operators, a lot of experiments have been done on problems with different sizes.

The structure of genetic algorithm is as follows:

1- **Chromosome**: the basis of genetic algorithm is to transform each solution set to a coding. This coding is called chromosome. In fact, the encrypted form is probable solution of the problem. In this problem, each chromosome is a solution which could be feasible or not.

2- **Fitting function**: is a function that the value of variable of problem has been put in it, in this way, the utility of each solution will be determined. In the optimization problems, the objective function is used as fitting function.

3- **Population**: a set of chromosomes is called population. One of the properties of genetic algorithm is that instead of concentrating on a point of searching space with one chromosome, it works on a population of chromosomes. Desired model, in this problem has been solved with an initial population with 500 chromosomes.

4- **Genetic operators**: an important part in genetic algorithm is to create new chromosomes nee children, through some old chromosomes called the parents. This important process is done by genetic operators.

● **Cross (intersection) operator**: the main operator to produce new chromosomes in genetic algorithm, is cross operator. This operator similar to its counterpart in the nature produces new individuals that are formed from the components (genes) of their parents.

● **Mutation operator**: in the natural evolution, mutation is an stochastic process in which the content of a gene is replaced with another gene to generate a new genetic structure.

● **Generation**: each iteration of the algorithm which leads to creation of a new population is called a generation. In this survey, producing new generations has been done 100 times. The strategy which has been considered in this paper to deal with constraints is the strategy of penalty factor. In this method, unlike the other methods which prevent entering infeasible solutions, the infeasible solutions can have presence, with low probability. In the strategy of this model, each feasible solution is much better than each infeasible solution.

Simulation

To quantitative analysis and obtain numerical results, one has to assign numbers to parameters. We utilize an example to gain numerical results.

D	Z_s	r_s	C_s	A_s	P	L_B	Z_B	r_B	C_B	A_B
1000	4.5	0.18	10	100	2500	0.03	1	0.2	20	225

Table2: parameters simulation

After substituting numbers in the above relations, following results have been obtained:

Type of policy	Common optimum	Supplier's optimum	Purchaser's optimum
size of consignment	22.4	539	47
Number of consignments	39	2	18
Number of orders	872.1	1077.5	847.9
Number of cumulative consignments	19	1	10
Size of cumulative production	424.9	538.8	471
Loss of purchaser	0	1002	26.1
Total cost of supplier	662	387.9	553.7

Table3: Numerical results

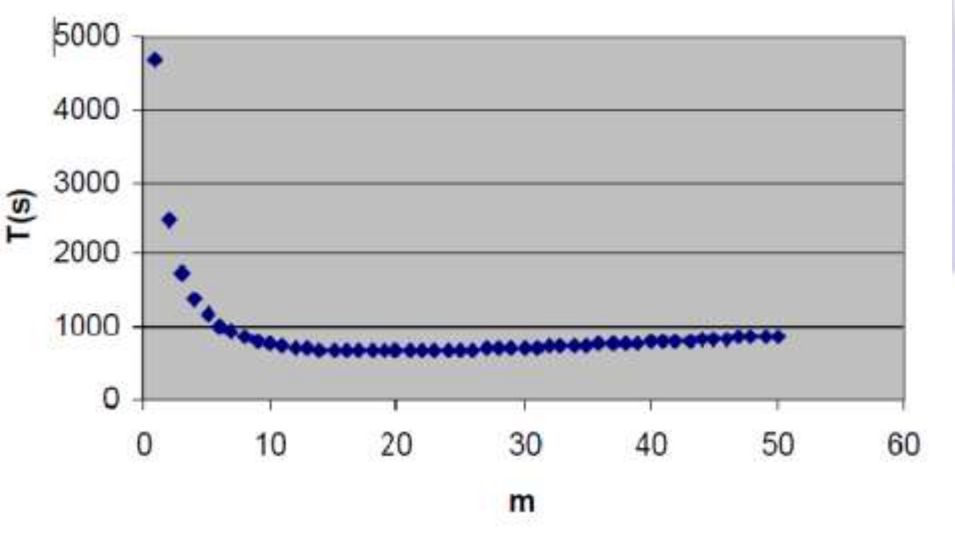

Figure2. The cost of supplier according to the amount of consignment (horizontal axis(m) shows the number of consignments and vertical axis (T(s)) shows the cost of supplier)

Conclusion

Numerical results in Table 3 show that the increase of the supplier's cost on imposition of policy of the consignment from the purchaser, is 274$ in the year which leads to 71% loss of producer, with respect to the supplier's optimal policy. Also these results show that by accepting the supplier's optimal policy, the purchaser sustains 1002$ greater losses respect to choosing his own optimal policy. Figure 2 specifies the cost of supplier based on the number of consignments in each stock, in the case that on considers the optimal policy for the purchaser. As the figure shows, in m=19, the total cost of supplier is 662, which is the optimal value for the supplier.

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