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Research Paper

Providing a Mathematical Model of Selecting a Production Supplier in the Supply Chain with the Approach of Bee Algorithm and Comparison with Genetic Algorithm

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Abstract **Selecting suitable suppliers and assigning orders to them, is one of the most important strategic supply chain management activities. Therefore, first, in this research, a mathematical model for choosing the supplier in the supply chain in the framework of the operational research methods was proposed. Linear programming model with consideration of purchase costs and transportation costs with the meta-heuristic bee algorithm approach using MATLAB software was solved and analyzed. Therefore, the research method is applied in terms of purpose, and in terms of method is a descriptive mathematical type that was implemented in the form of a library and field studies. Information gathering tools, such as documentation tools, interviews with experts and production managers were used in relation to production. According to the nature of the research, which is modeling and solving by the algorithm, to determine the sample size were selected by cluster sampling method and random sampling method. Then to validate the mathematical model, lingo and Winqsb software was used, the solution obtained by both software, which is the optimal answer and optimal objective function, indicates the validity of the mathematical model.**

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Introduction

In the present era, the supply chain plays an important role in the activities of organizations, especially manufacturing companies that have the most reliance on suppliers of materials and parts needed. In this regard, some experts have stated that approximately 50% to 70% of production costs are allocated to the cost of materials and parts (Lima Junior, et al., 2016). In the concept of supply chain management, the decision to choose a supplier is a key issue that executive managers and purchasers face in order to stay in today's highly competitive world (Amiri et al., 2017). Therefore, purchasing management and proper selection of suppliers in supply chain management, has a significant impact on the success of the organization to reduce costs and stay in a competitive environment (Bai, et al., 2010). Selecting a supplier is the process of finding the right vendors to provide the buyer with quality products / services, good prices and on-time delivery (Dargi, et al., 2014). Supplier performance measurement has attracted much attention from researchers. In the supply chain concept, supplier performance measurement results reveal the effects of methods and potential opportunities for selection improvement. Performance measurement is an indispensable management tool. Many quantitative and qualitative factors such as quality, and flexibility and delivery performance must be considered to determine suitable suppliers (Hamidi, 2015).The selection and evaluation of suppliers is examined through several different quantitative and qualitative indicators such as cost, quality, on-time delivery, after-sales service, etc. As a result, companies need to select key indicators and appropriate suppliers; because the appropriate supplier reduces purchasing costs and also increases the quality of products and ultimately the success of the organization in achieving its goals (Omurca, 2013). On the other hand, an inappropriate supplier selection can degrade the financial and operational position of the company (Amid, et al., 2006). As a result, wrong decision making on supplier selection will have many negative consequences for companies. Choosing the appropriate supplier in supply chain management is a challenging issue; because evaluation requires criteria or characteristics that are complex and questionable in nature (Mohammadnejad Chari, 2016). In the present era of globalization and the resulting development of virgin areas, the procurement of demands is the most vital and busiest activity; one that places SC at a position further than the economical discussions.Therefore, to sustain the SC, companies must take measures related to each indicator to improve. For example, for financial performance index and market share, it is necessary to strengthen the ability of supplying products at reasonable prices to gain more profit by obtaining more market share (Alahyari & Pilevari, 2020).

Backgroud

Since raw materials and parts are the most important part of a company's costs, Proper purchasing management is of paramount importance to the efficiency, effectiveness and profitability of an organization. On the other hand, today, due to new concepts of supply chain management, suppliers and customers are no longer known as competitors of the organization. Rather, they are members of a core group called the supply chain, each of which aims to maximize profits and increase productivity throughout the chain. Therefore, in view of the above, it seems necessary to examine and apply new concepts in the selection of suppliers (Talebi and Malataifeh, 2010, 42-27). Recently, supply chain management and supplier selection process have been given special attention in management texts and reducing the cost of production is one of the important factors in survival in a highly competitive environment today. Choosing suitable suppliers can greatly reduce the cost of purchasing and increase the competitiveness of the organization, because in most industries, the cost of raw materials and components of the product includes a large part of the cost of the product. (Nezhadi, 2014).Considering the increase in the dynamics of logistics, sales markets and hence the uncertainty associated with planning, companies should be capable of make informed decisions under risk. The key characteristic of risks involved in supply chain is that the risks extend beyond the corporate boundaries. Furthermore, these extended boundaries can, in themselves, provide the source for the supply chain risks (Honarvar, et al., 2015).in such circumstances, the logistics department can play a key role in the efficiency and effectiveness of the organization and have a direct impact on cost reduction, profitability and flexibility of a company(Ghodsipour and Ebrain, 2001). The problem arises from the fact that, with a large numbers of suppliers, for the purchase of raw materials on the one hand and the capacity limitations of the supplier of raw materials, how to design a model that minimizes the cost of supply? Of course, in most of the manufacturing units of our country, there is still a traditional view in planning the operations of units related to the preparation of a product. Therefore, the production units of the dairy industry of Maku city and, in the case of the Lighvan cheese factory and the dairy factory and the pasteurized milk of the cooperative company, with a large number of suppliers for the purchase of raw milk On the one hand, and the limitation of the capacity of the supplier of raw milk supplier, how to design a math model, which minimizes both the cost of purchasing milk and the cost of transporting milk, which reduces the total cost of milk supply. And based on the applications of the literature that have been proposed, the importance of supplier selection is determined, which in this research, the issue of supplier selection has been modeled in the operational research approach. And on the other hand, this issue is also raised in a space with more milk suppliers, how can the proposed model be solved? Using the meta-heuristic approach of the bee algorithm to solve the proposed model is the problem of supplier selection**.** In the 1990s, meta-heuristic algorithms began with nature patterns, and the use of these algorithms began to solve complex problems. The meta-heuristic algorithms achieve approximate solutions in neighborhoods of optimal points, although, one cannot claim that the answer is optimal, however, it will be optimal in the neighborhood and can be measured the validity and efficiency of the algorithm. Considering the goal of companies' profitability and increasing competition in the field of business, the study of various aspects of how to create a competitive advantage for companies is increasingly discussed. To achieve customers better and more effectively than competitors, you must have the appropriate tools and techniques, one of the most appropriate methods is to use the supply chain (Hejazi, 2011). “The supply chain is a network of processes, so that their ultimate goal is to supply the goods and services of customers and includes suppliers, manufacturers, distributors, wholesalers and retailers that co - operate in a consistent and coherent way to satisfy customers (Kurd and Jamshidi, 2016, 15).Supply chain is a chain that includes all activities related to the flow and conversion of goods from the stage of import of raw materials, production of parts, and assembly of parts to delivery to the final consumer(Errtugrul Karsak & Dursun., 2015) Therefore, supply chain management involves a wide collection of all processes between raw material suppliers (upstream) and downstream consumers (downstream). These processes are categorized into three groups: transportation of goods (downstream flow), finding sources of upstream flow of information and internal activities (for example: production, assembly, storage, and monitoring) (ponte, et al, 2017).Supply chain management is developed by the global supply chain faction (GSCF), supply chain management, integration of key user business processes through major suppliers that provide products, services and information that create value added to customers and other stakeholders (Rimienė, 2011).In the supply chain, suppliers act as a key component of success because selecting the right supplier can improve the following factors: reduce costs, increase profits, improve quality, and ensure on-time delivery(Nezhadi, 2014).Since the performance of suppliers has a major impact on the success or failure of a chain, supplier selection is known as a strategic task(Talebi and Malatayefeh, 2014). Supply chain integration represents the extent based on which a producer strategically cooperates with its supply chain partners and collaboratively manages inter-organizational and intra-organizational processes .that Stevens (1989) found that companies that manage their supply chain from a strategic perspective as an independent entity (integrated), and use tools and techniques that respond to market needs will survive(Iranban, 2019). Suppliers Are vendors that provide raw materials, components, and services that an organization cannot provide itself. In the current production environment for the supply chain, the supplier is an essential part of an organization, and a suitable supplier can offer the company products with the high quality and quantity and at a reasonable price and at the right time (Shang, 2010; Lee et al., 2009; Eltayeb et al., 2010).Rao believes that companies should form teams to review and select suppliers. Such action ensures Compatibility of the company's products or services with the environment, Prevention of contamination at the source, Reuse of materials, Increasing the volume of recycled in production, Optimizing processes in such a way that the generation of both harmful and non-harmful waste is minimized, Redesign products so that their adverse environmental effects are minimized (Roa, 2004, 300). One of the problems that today affect supply chains is the variety in demand and its changes from the end customer, which has a huge impact on the supply chain (ponte, et al, 2017).Small changes in demand at the bottom of the flow (customer), which results in a strong demand and a huge increase in inventory levels and inventory changes at the high levels of the supply chain, whipping effect is called. This means that small changes in real customer demand are the same as upstream suppliers for more production (Metters, 1997, 89-100). Forster believed that the main cause of the bullwhip effect in the supply chain is the problems of information sharing. According to conducted studies, Lead Time, market sensitivity, resource allocation, and poor flow of materials in the supply chain are sources of the source of the bullwhip effect. Removing it can increase the profit from 15% to 30% (Farajpur, 2012, 8). The results of Lee and Zabinsky's (2011) study, entitled Uncertainty in a supplier selection issue, focused on the issue of a reliable supplier selection with a possible planning approach, indicated that supplier selection was an important strategic decision in the field Supply chain design. The purpose of this is to determine the minimum set of suppliers and determine the order quantity with consideration of the amount of discounts, and the model was formulated in the form of linear integer programming. Jane et al (2014) in their research, in addition to selecting suppliers and assigning orders to them for several products, also considered the location of facilities. They proposed a possible nonlinear programming model that used the forbidden search algorithm and the all-nothing allocation technique to solve it.Shahroudi, Taleghani and Taheri (2013) Model of selection of the best supplier based on agility criteria (case study: ceramic tile industry of Yazd province) with AHP-TOPSIS combination approach. The combination of these two models, resulted in the weaknesses of each model being covered by the strengths of the other model.Soltani (2018) has presented a model for financing buyer and supplier in the supply chain of distributors of health products, which shows that between all aspects of financing strategy, buyer-supplier financing and sharing of buyer-supplier information with There is a positive and significant relationship between financing performance. Fazli and Eidi (2014) the issue of selecting of suppliers in multiple sourcing mode is under the uncertainty environment: models and approaches to solutions, and according to the research, one of the most basic steps in the management of suppliers is the reduction of suppliers. Sadeghi Moghadam, Afsar and Sohrabi (2005) Modeling to find the flow of materials and the amount of materials transported in the supply chain of agricultural machinery production, with a genetic algorithm approach that provides the objective function with emphasis on minimizing costs, especially transportation costs, Also compared with other pattern search methods, which is evidence of the superiority of the genetic algorithm. The calculated objective function of the genetic algorithm shows a 9.4 percent improvement over the Nelder Mead method and a 2.37 percent improvement over the Latin Hypercube method. Koo and Thompson (1983) developed a mathematical planning model for grain transportation in the United States. The objective of the model is to minimize transport costs due to limitations on production, consumption and carrying capacity .The value aspect of Koo and Thompson's study is that by performing some hypotheses, the transportation cost is estimated by the distance variable. . Bilsel and Ravindran (2011) find a multi-product outsourcing model, that demand, supplier capacity, ordering cost And transportation costs and solved the problem by using programming zero and one multi-objective linear mix, with three objectives functions, maximizing quality, minimizing delivery time and cost minimization. Abbasi Bastami and Ehtesham Rasi (2020) Examine Supplier's Selection Based on Lean-Green Production Indicators by Goal Programming, Fuzzy DEMATEL and Fuzzy Quality Function Development which is an The important aspect of determining how much damage would be bestowed on the best supplier, so that it would be possible to determine the least amount of damage in sum, was reviewed in this section. In other words, the lowest possible losses are based on the suffering of the current losses, the supplier and in which level of losses it has the most optimal status. Therefore, the research questions are as follows:

- Can the raw material supplier's selection materials in the supply chain be formulated using a mathematical model?

- Is it possible to solve the supplier's selection of raw materials in the supply chain using the bee algorithm?
- Can the production unit costs of the supply chain be reduced by the proposed model?
- Can the minimum material required be provided by the proposed model selecting the suitable material supplier?
- Is the bee algorithm better than the genetic algorithm for selecting the Suitable material supplier?

Method

The main approach of this research is the of operational research methods and in particular, mathematical modeling. Therefore, the research method is applied in terms of purpose, and in terms of method is a descriptive mathematical type, that was implemented in the form of a library and field studies. Information gathering tools, such as documentation tools, interviews with experts and production managers were used in relation to production, volume of work and the amount of suppliers. The statistical population is production units of the dairy industry in the city of Maku. Due to the nature of the research, which is modeling and solving by the meta-heuristic algorithm, to determine the sample size, the two companies were selected by cluster sampling method and random sampling. The two companies are the Nizar factory produces Lighvan cheese and the Dairy and Pasteurized Milk factory of the Cooperative Company.The selective model was designed by considering the purchase cost and transportation cost and then using the approach of bee meta-heuristic algorithm using MATLAB software to analyze and implement the algorithm. Genetic algorithm was used to compare the proposed algorithm. Also, for validating mathematical modeling to select supply supplier in the supply chain, two Lingo software and WINQSB software have been used.

Findings

The proposed model is only to supply a type of material. All suppliers have the same requirements in terms of quality and timely delivery. All suppliers are committed to their obligations and comply with environmental requirements. The manufacturing company needs to produce n units, and the supply of this amount of production is beyond the responsibility of one supplier alone. The planning horizon in model is seasonal. In companies with more than four suppliers, the meta-heuristic algorithm approach is used. The general parameters of the problem model are given in Table (1).

Table 1.

General Parameters of the Problem Model

Xi	The amount of purchase of the product or piece by the supplier i
i	Number of suppliers
ci	Cost of production of parts or materials by supplier i or purchase cost from the supplier
C'i	The cost of transporting the piece or material from the supplier i
Z	Total Minimum Cost
bi	Capacity of piece or material production from supplier i
D	Minimum piece or material required

If supplied from supplier i $Xi \geq 0$

i =1, 2, 3… n

If not supplied from supplier i $Xi=0$

The objective function is to minimize the total cost of supplying the parts and materials needed (purchase and transportation costs) in the entire program

$$\text{Minimize } z = \sum_{i}^{N} (ci + c'i)xi$$

he first set of constraints is to provide at least the pieces or materials required by the suppliers. This constraint ensures that the number of pieces or materials required to satisfying the final product requirements for final consumer demand.

Subject to: $\sum_{n}^{N} xi \geq D \quad$ i = 1… N (1)

The second set of constraints ensures that each supplier has a production capacity constraint and cannot satisfy all customer needs.

Subject to: $Xi \leq bi$ (2)

Therefore, the general model of this research is presented with the assumptions and the suitable model for choosing the supplier is presented as follows:

Minimize z = $\sum_{i}^{N} (ci + c'i)xi$

Subject to:
$$\begin{cases} \sum_{n}^{N} xi \geq D \quad i = 1\ldots N \quad (١) \\ Xi \leq bi \quad (٢) \\ Xi \geq 0 \qquad i = (1,2,3,\ldots..n) \end{cases}$$

The bee algorithm by Karaboga in 2005 based on exploration behavior is used to find suitable food sources for solving optimization problems, one-objective, multi- objective, and multi-dimensional, bee algorithm is inspired by bees in nature. In Some research has shown that ABC's efficiency is higher than other algorithms such as genetics, ants, and differential evolution. This algorithm has been developed to simulate the behavior of food search for bee groups (karaboga, 2005). The bee colony algorithm consists of three groups of bees: employed (worker) bee, scout bee and unlooker bee. The honey bee that remains in the dance zone to make todecion to choose a food source is called The bee explorer, and the honey bee that goes to the predetermined food supplies is called The bee employed(worker), and the honey bee that dose a random search is called The bee leading or. In the algorithm, for the first time, half the population of bees, employed bees and the other half are explorers (Yang & Dirogo, 2005). Table 2 shows the supply capacity of each supplier, plus the cost of purchasing each liter of milk and the cost of transporting each liter of milk by each supplier. In addition, the cheese producer needs at least 360000 liters of milk in the entire program, and the supply of this liter of milk alone is solely beyond the control of a supplier.

Table 2.

Supply Capacity, Purchase Cost, and Transporting Costs

Supplier Name	The Cost of Purchasing	The Cost of Transporting	Supply or Production Capacity
Ranchers of yekhelghan village	25000	5000	27300
Ranchers of Aghgol village	24000	4500	44600
Ranchers of Qom Gheshlagh village	26000	5500	24800
Ranchers of Deim Gheshlagh village	24000	6000	49600
Ranchers of Sarang Village	24000	5500	23560
Ranchers of Ghareblagh village	25000	4500	26000
Ranchers of Movlik village	25000	4250	22320
Ranchers of Inje village	24000	2750	49600
Ranchers of Isa Khan village	24000	3750	23560
Ranchers of Mirza Khalil village	24000	3250	24800
Ranchers of Hasan Shake Village	23000	2500	27300
Ranchers of Khale Zaghasi Village	23000	3750	22320
Ranchers of Tikme village	23000	4250	23560
Ranchers of Ghourishkak village	24000	4500	49600

Supplier Name	The Cost of Purchasing	The Cost of Transporting	Supply or Production Capacity
Ranchers of Zelake 1 village	24500	6000	49600
Ranchers of Zelake 2 village	24500	5500	44600
Ranchers of Mullah Hasan village	24000	5000	24800
Ranchers of Hesar village	26000	1000	31000
Ranchers of Shouraghol village	25000	4500	18600

If supplied from supplier i Xi>0

i =1, 2, 3,…, 19

If not supplied from supplier i Xi=0

The objective function is to minimize the total cost of supplying the milk needed (purchase and transportation costs) in the entire program

$$\text{Minimize } z = (25000+5000)x_1+(24000+4500)x_2+(26000+5500)x_3+$$
$$(24000+6000)x_4+(24000+5500)x_5+(25000+4500)x_6+(25000+4250)x_7+$$
$$(24000+2750)x_8+(24000+3750)x_9+(24000+3250)x_{10}+(23000+2500)x_{11}+$$
$$(23000+3750)x_{12}+(23000+4250)x_{13}+(24000+4500)x_{14}+(24500+6000)x_{15}+$$
$$(24500+5500)x_{16}+(24000+5000)x_{17}+(26000+1000)x_{18}+(25000+4500)x_{19}$$

Constraints of the mathematical model:

$$x_1+x_2+x_3+x_4+x_{5+.}\ldots\ldots\ldots+x_n \geq 360000 \quad i=1\ldots\ldots, 19 \qquad (1)$$

$$x_1 \leq 27300 \quad x_2 \leq 44600 \quad x_3 \leq 24800 \quad x_4 \leq 49600$$
$$x_5 \leq 23560 \quad x_6 \leq 26000 \quad x_7 \leq 22320 \quad x_8 \leq 49600$$
$$x_9 \leq 23560 \quad x_{10} \leq 24800$$
$$x_{11} \leq 27300 \quad x_{12} \leq 22320 \quad x_{13} \leq 23560 \quad x_{14} \leq 49600$$
$$x_{15} \leq 49600 \quad x_{16} \leq 44600 \quad x_{17} \leq 24800 \quad x_{18} \leq 31000$$
$$x_{19} \leq 18600 \quad Xi \geq 0 \quad)\, i=(1,2,3,\ldots.19$$

Run Bee Algorithm:

Determine the parameters of the algorithm

The number of variables (nvar): the same is the input data of the problem.

The lower limit of variables (lb): that is zero.

The upper limit of the variables (ub): equal to the column amount of the supply or production capacity.

Total number of bees (NB): 50 bees

Number of employer's bee or food sources (SN): 25 bees

Number of unlooker bees (N_unlooker): 25 bees

Max of cycle number (MCN): 200

The trial matrix (Trial): is currently zero

Maximum number of replicates with no improvement (Limit): 60

The number of dimensions to be moved to it (Ndim): 1

The code for it is as follows:

```
 %%parameters setting
Data=load ('data. Mat'); load data
Nvar=data.nvar;
lb=0*ones (1, nvar);     % lower bound
ub=UB.*ones (1,nvar);      % upper bound
NB=50;                   % number of bee
SN=round (NB/2);         % source number
N_unlooker=NB-SN;        % unlooker number
MCN=200;                 % max of cycle number
Trial=zero's (SN, 1);
Limit=60 ;
Ndim=1
```

If CH=0, that is, the limitations are met and the answer is in the justified zone. But if the amount of material supplied (SX) is less than the amount of material required (D), then CH is equal to CH=D-SX and is not equal to zero.

```
Function sol=fitness (sol, data)
Load data
sol.x=CB (sol.x, 0, UB);
x=round (sol.x;(
OBJ=sum ((c+cp).*x');
SX=sum(x);
CH=0;
If SX<D
CH=D-SX;
end
SCH=1000000000*sum (cp)*sum (CH);
sol.fit=OBJ+ (SCH);
sol.SCH=SCH;
sol.info.CH=CH;
sol.info.X=x;'
```

Preparing or Starting a Timeline: Build an empty vector with an x variable and amount of fitness, repeat the empty unit vector with the required number stored in the food matrix, for the unit generate a completely randomized response per unit for each area of X, then Calculate its fitness and identify the best food area and name it global food. The code for it is as follows:

```
 %%initialization
tic
emp.x =[] ;
emp. fit =[] ;
emp. info =  [] ;
emp. SCH =[] ;
```

```
Food=repmat (emp, SN,1);
For i=1: SN
Food (i).x=unifrnd (lb, ub);
Food (i) =fitness (food (i), data);
end
[value, index]=min([food(i).fit]);
gfood=food (index);             % global food
```

Main loop: Create a best matrix and an AVR matrix empty

```
 %%main loop
Best=zeros (MCN, 1);
AVR=zeros (MCN, 1);
```

For each repetition in the Employed bee section, and for each Employed bee, choose another bee colony randomly, the neighboring bee position (XK): Each Employed bee randomly selects a neighbor, determines the dimension of movement (J): randomly select one of the variables and move on to that position. Position of the previous bee (x):

```
For cycle=1: MCN
 %    employed bee section
 For i=1: SN
k=randsample ([1: i-1 i+1: SN], 1);
XK=food (k).x; % neighbor
 j=randsample (nvar, ndim');
X=food (i).x;
```

The new bee position is obtained through the following equation (each Employed bee randomly selects a neighbor and moves to it through the equation below)

```
 NEWX(j)=X(j)+unifrnd(-1,1,size(j)).*(X(j)-XK(j));
```

That X (j) is the same as the previous bee position, and unifrnd (-1, 1, size (j)) or Ǿij a random number is between 1 and -1. (X (j)-XK (j)); the same difference is the position of the previous bee with the position of the neighbor bee. Where in k ∈ {1, 2. . . SN}, j ∈ {1, 2, . . . , D} and their index is randomly selected. Xk, j a neighborhood xi, j is in the population that i and k is randomly selected.

The position of the new bee is likely to be outside the justified area. Given the two formulas below, we put it in the justified area.

NEWX=max (NEWX, lb);

NEWX=min (NEWX, ub);

Get fitness amount of new area:

Sol=food (i);

sol.x=NEWX;

Sol=fitness (sol, data);

If the quality is better than the previous one, the bee will go to the new area and it's the trial index is zero. The trial index is the count of the number of consecutive movements of the bee with no improvement. If the hive exceeds certain amount of r trial index, it means that the other food area is no longer native, and the area should be left.

If sol.fit<food (i).fit

Food (i) =sol;

Trial (i) =0;

But if its quality is not better than the previous one, it means no improvement, one unit is added to its trial index.

else

Trial (i) =Trial (i) +1**;**

we want to change the amount of fitness. In fact, we identify all the fitness, that is, those whose fitness are greater than zero, and then identify those whose fitness are smaller than zero.

```
f=calculated_Pfit ([food. Fit]);
PF=find (f>0);
NF=find (f<0);
```

Then the fitness of each solution is calculated by the following formula.

$$\text{Fitness}(i) = \begin{cases} 1 + \text{Fit}(i) & \text{Fit}(i) \geq = \\ 1 + \text{abs}(\text{Fit})(i) & \text{Fit}(i) < 0 \end{cases}$$

Formula2 Formula3

We then normalize them according to the following formula, that is, we divide it into its total, so the probability of each solution is calculated according to the formula below.

$$P(i) = \frac{\text{Fitness}(i)}{\Sigma \ \text{Fitness}(i)}$$

Formula3

Therefore, The movement of unlooker bees to food sources with the probability of calculating through the roulette wheel using the above equations and determining the new neighborhoods. , Then, through the roulette wheel, we bring them together in a cumulative manner.

F = cumsum (f);

Select a bee or an area through the roulette wheel. The roulette wheel means that you select a random number and choose a smaller number from which p to choose the first one from the beginning.

```
Function k=Roulette Wheel (P);
P=P. /sum (P);
P=cumsum (P);
  k=find (rand<=P, 1,'first');
  end
```

Select a neighbor randomly: repeat the above section

```
  K = ran sample ([1: i-1 i+1: SN], 1);
```

Find the sources or areas of food that are more than Limited, that is, identify areas that are unfavorable to the nectar, and for each unfavorable area, a random move is made and random answers are created and fit them to the trial index Equal to zero.

```
Q=find (Trial>Limit);
  For j=1: length (Q)
        i=Q (j);
        Food (i).x=unifrnd (lb, ub);
        Food (i) =fitness (food (i), data);
        Trial (i) =0;
```

Identify the best source or food area for this repeat

```
  [value, index]=min([food. Fit] );
```

Therefore, scouting bees those areas identified as undesirable nectar, cracks and randomly select other areas. If a better food source is not found to reach the prescribed limit after the trial index arrives, a new food supply by the Scout bees will be randomly determined using the following equation:

$$x_{ij} = x_j^{\min} + rand(0,1)(x_j^{\max} - x_j^{\min})$$

If the best source or food zone of this repeat is better than the best source or food zone, then the best food area is the update and final algorithm, save the best source or food area of this repeat and save the average food performance of this repeat.

```
If value<gfood. Fit
gfood=food (index);
  end
  Best (cycle) =gfood. Fit;
  AVR (cycle) =mean ([food. Fit] );
```

The final result of the bee algorithm is shown in Table 3.

Table 3.

The Results of Purchasing Per Liter of Each Supplier with the Bee Algorithm

Supplier name	Variable	Purchase Rate	Supplier name	Variable	Purchase Rate
Ranchers of yekhelghan village	X1	11603	Ranchers of Hasan Shake Village	X11	21754
Ranchers of Aghgol village	X2	32806	Ranchers of Khale Zaghasi Village	X12	5765
Ranchers of Qom Gheshlagh village	X3	6412	Ranchers of Tikme village	X13	8252
Ranchers of Deim Gheshlagh village	X4	19585	Ranchers of Ghourishkak village	X14	36672
Ranchers of Sarang Village	X5	23560	Ranchers of Zelake 1 village	X15	3663
Ranchers of Ghareblagh village	X6	15557	Ranchers of Zelake 2 village	X16	21335
Ranchers of Movlik village	X7	21499	Ranchers of Mullah Hasan village	X17	10638
Ranchers of Inje village	X8	49600	Ranchers of Hesar village	X18	18713
Ranchers of Isa Khan village	X9	22729	Ranchers of Shouraghol village	X19	6585
Ranchers of Mirza Khalil village	X10	23828			
Total					360000

Therefore, the objective function is to minimize the total cost of supplying the milk needed (purchase and transportation costs) in the entire program

Minimize z = 10200970750

Figure 1 shows the results of purchasing and supply costs by each supplier with the honey bee algorithm.

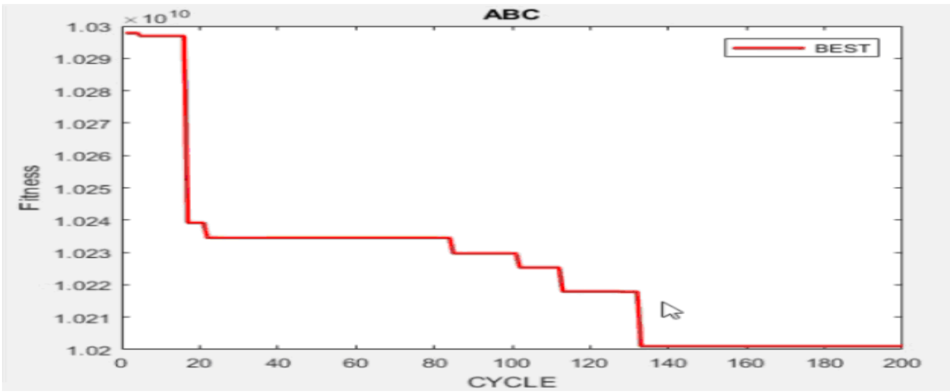

Figure 1.

The Results of Purchasing and Supply Costs by Each Supplier with the Bee Algorithm

For the bee, we set the motor radius that is, move between a minimum and a maximum. Figure 2 shows the improved chart of the bee algorithm.

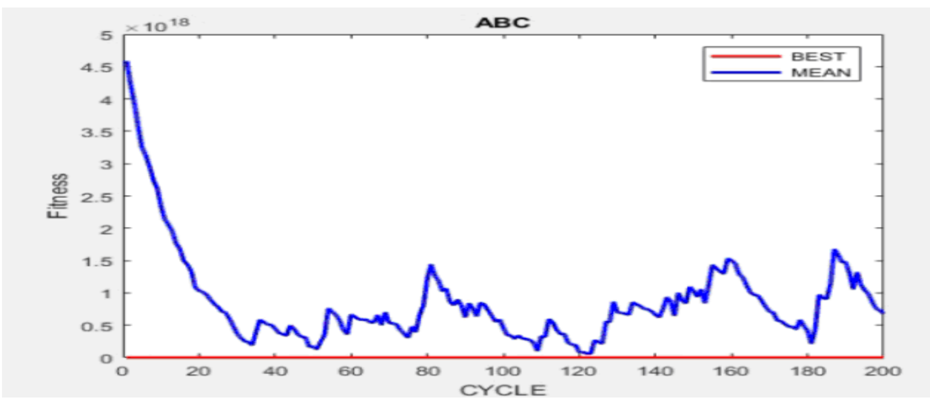

Figure 2.

Improved Results of Purchase and Supply Costs by Each Supplier with the Bee Algorithm

The genetic algorithm was first invented by John Holland in 1975 at the University of Michigan as a lesson to the theory of comparative systems (Holland, 1975). It is used to optimize the direction of defined functions on the limited range (Croce et al., 2002). Past information is extracted due to the inheritance of the algorithm and is used in the search process. Algorithm concepts were developed in 1989 by Goldberg (Kazarlis et al., 1992). GA searches a problem space with a population of chromosomes (Farsad and Hosseinpour, 2015). The basis of genetic algorithms is the conversion of any solution to a coding. This is called a chromosome (Sinriech & Samakh, 1999). A set of chromosomes is called a population, and the number of chromosomes in each population is called the population size (N), (Ghasemi Yaghin et al., 2013).In optimization problems, the objective function is used as a fitness function (Vanlarhoven & Aarts, 1987). After evaluation, more suitable chromosomes are selected for childbearing, including parent selection methods, roulette cycle, whole population selection, and probable selection. (Ghasemi Yaghin et al., 2013). The creation of new chromosomes called offspring is done by genetic operators (Nizamuddin and Honarvar, 2004). The main operator for generating new chromosomes in a genetic algorithm is the intersection operator. The second operator in the genetic algorithm is the mutation operator, which prevents the algorithm from falling into the local optimal (Ghasemi Yaghin et al., 2013). The role of mutation is often as a guarantee that the probability of searching in the string will never be zero (Vanlarhoven & Aarts, 1987). The final stage of the genetic algorithm is the stop criterion. In this regard, there are several criteria (Ghasemi Yaghin et al., 2013). Any repetition of the algorithm that leads to the creation of a new population is called a generation (Sadeghi Mohamad et al., 2009).

Run genetic Algorithm:

Determine the parameters of the algorithm

The number of variables (nvar): the same is the input data of the problem.
The lower limit of variables (lb): that is zero.
The upper limit of the variables (ub): equal to the column amount of the supply or production capacity.
Chromosome number or population number (npop). 50 chromosomes
Percentage of crossover or intersection (pc): 70%
Number of crossovers (ncross): (70% npop) ÷ 2 = 18
Mutation percentage (pm): 30%
Number of jumps (nmut): (30% p npop) = 15
Max of cycle number (maxiter): 70
The code for it is as follows:

```
 %%parameters setting
Data=load ('data.mat'); load data
Nvar=data.nvar;
lb=0*ones (1,nvar);     % lower bound
ub=UB.*ones (1,nvar);      % upper bound
npop=50;     % number of population
pc=0.7;       % percent of crossover
ncross=2*round(npop*pc/2);  % number of crossover offspring
pm=1-pc;        %  percent of mutation
nmut=round(npop*pm);  % number of mutation offspring
maxiter=70;
data.npop=npop;
data.ncross=ncross;
data.nmut=nmut;
data.maxiter=maxiter;
data.lb=lb;
data.ub=ub;
```

Objective function: The related code is similar to the code of the bee algorithm.

We are at the random production stage of the initial population, and how long the program takes, the construction of an empty vector with the x -variable and the fitness fit

```
 %%initialization
tic
emp.x =[] ;
emp. fit =[] ;
emp. info =  [] ;
emp. SCH =[] ;
```

Repeat the empty unit vector with the required number of 50 rows and one column stored in the pop matrix. Generate a completely random answer for each chromosome unit for each area of x, then calculate its fitness fit, identify the best food area and name Put it global food

```
pop=repmat(emp,npop,1);
for i=1: npop
      Pop (i).x=unifrnd(lb,ub);
      pop (i)=fitness(pop (i),data);
end
[value,index]=min([food(i).fit]);
gfood=food(index);              % global food
```

Main loop: Generate a best matrix and an mean matrix of AVR

```
 %%main loop
BEST=zeros(maxiter,1);
MEAN=zeros(maxiter,1);
```

Crossover operation: For each iteration, perform the main loop of the crossover operation. Repeat the empty unit vector for the number of children of the crossover operation, then apply it to perform the crossover operation and subtract the number of children of the crossover operation from the data. Get out

```
 %  crossover
    crosspop=repmat(emp,ncross,1);
    crosspop=crossover(crosspop,pop,data);
function  crosspop=crossover(crosspop,pop,data);
ncross=data.ncross;
```

According to the roulette wheel, the one that fits better has a better chance of being selected. If the objective function is minimal, it is enough to invert it and then we normalize them according to the formula, that is, we divide it by its sum, then we bring them cumulatively through the roulette wheel.

```
f=[pop.fit];
f=1./f;
f=f./sum(f);
f=cumsum(f);
```

For each pair of crossovers: Using the roulette wheel means that a random number is selected and this number is smaller than which of the f's. Select the first one from the beginning. Because two parents must be selected, this must be done twice.

```
for n=1:2:ncross
      i1=find(rand<=f,1,'first');
   i2=find(rand<=f,1,'first');
```

After the parents are selected, the chromosomes of the two parents enter the single-point crossover and the children leave. First count the number of devices in that parent and generate a random number, that is, generate a random number from one to the last remaining device, then cut it and divide it into two parts.of course , the parent with x and children with y show that the first child takes its first part from the first and second part of the second parent.

the second child takes part from the first parent and second part from the second parent .

```
function [y1,y2]=Uniform Cross Over (x1,x2);
R1=rand(size(x1));
R2=1-R1;
y1=(R1.*x1)+(R2.*x2);
y2=(R2.*x1)+(R1.*x2);
end
```

note : in this case , the single - point cross - over of the repeating elements may arise, then the correction must be modified using a correction function. Discriminant function: the elements that are derived from the parent are invariant. Remove the elements that are repetitive and replace those that do not exist. Then compute the fitness of the children:

```
crosspop(n)=fitness(crosspop(n),data);
crosspop(n+1)=fitness(crosspop(n+1),data);
```

mutation operation: Repeat the empty unit vector with the required number, then put it in the mutation function to perform the mutation operation

```
 %    mutation
   mutpop=repmat(emp,nmut,1);
   mutpop=mutation(mutpop,pop,data);
```

First we extract the ova data, ie how many mutant offspring we produce and also what our previous chromosome population was:

```
function  mutpop=mutation(mutpop,pop,data)
nmut=data.nmut;
npop=data.npop;
```

For each jumping child: The method of choosing a parent is based on a random process, choose a number from one to 50

```
for n=1:nmut
   i1=randi([1 npop]);
```

Then generate a leap child through swap or unicorn

mutpop(n).x=Uniform Mutation(pop(i1).x,0.01,data.lb,data.ub);

How to unify the method: Count the number of data on that vector and select a data amount then specify the maximum and minimum available data, which is the maximum percentage of available data. Then calculate the fitness fitness of leap children:

```
function y=UniformMutation(x,R,lb,ub);
n=numel(x;(
I=randsample(n,ceil(R*n));
d=unifrnd(-0.1,0.1,size(lb)).*(ub-lb);
x(I)=x(I)+d(I);
y=x;
end
Mutpop (n) =fitness (mutpop (n), data);
```

Merged phase: This phase includes the number of initial population (npop) 50, the number of crossovers 18 and the number of mutations 15, the total population is 83 total

```
 %  Merged
[pop]=[pop;crosspop;mutpop];
```

Sorting phase: First sort from good to bad, i.e. from small to large. According to the maximum and minimum, the objective function is performed. Of course, the amounts in the value and the numbers in the index store, and sort the population according to the index numbers, and the best answer is the first pop

```
 %Sorting
[value,index]=sort([pop.fit]);
   pop=pop(index);
   gpop=pop(1);
```

Selection phase: In the selection step, select the initial 50

```
%Select
  pop=pop(1:npop);
```
The best answer to this repetition is fitness
```
  BEST(iter)=gpop.fit;
```
The mean of this repetition and the mean fitness of all the answers
```
  MEAN(iter)=mean([pop.fit]);
```

When we reach the end of the main loop, we return to the beginning of the loop, ie the first 50 that we have selected, on which the crossover, mutation, merge, sort and select operations are performed. To reach the stop condition, here the stop condition is the number of repetitions, which is equal to 70 repetitions. Therefore, the final result of the genetic algorithm with 70 replications and 50 chromosomes in Table (4) is as follows

Table 4.
The Results of Purchasing Per Liter of Each Supplier with the Genetic Algorithm

Supplier Name	Variable	Purchase Rate	Supplier Name	Variable	Purchase Rate
Ranchers of yekhelghan village	X1	12981	Ranchers of Hasan Shake Village	X11	22848
Ranchers of Aghgol village	X2	29705	Ranchers of Khale Zaghasi Village	X12	15901
Ranchers of Qom Gheshlagh village	X3	10807	Ranchers of Tikme village	X13	14770
Ranchers of Deim	X4	21936	Ranchers of Ghourishkak village	X14	34778

Supplier Name	Variable	Purchase Rate	Supplier Name	Variable	Purchase Rate
Gheshlagh village					
Ranchers of Sarang Village	X5	754	Ranchers of Zelake 1 village	X15	28682
Ranchers of Ghareblagh village	X6	15483	Ranchers of Zelake 2 village	X16	29482
Ranchers of Movlik village	X7	16233	Ranchers of Mullah Hasan village	X17	20591
Ranchers of Inje village	X8	31313	Ranchers of Hesar village	X18	20031
Ranchers of Isa Khan village	X9	10966	Ranchers of Shouraghol village	X19	6396
Ranchers of Mirza Khalil village	X10	16358			
Total					360015

Therefore, the objective function is to minimize the total cost of supplying the milk needed (purchase and transportation costs) in the entire program Minimize z = 10263564750

Figure 3 shows the results of purchasing and supply costs by each supplier with the genetic algorithm.

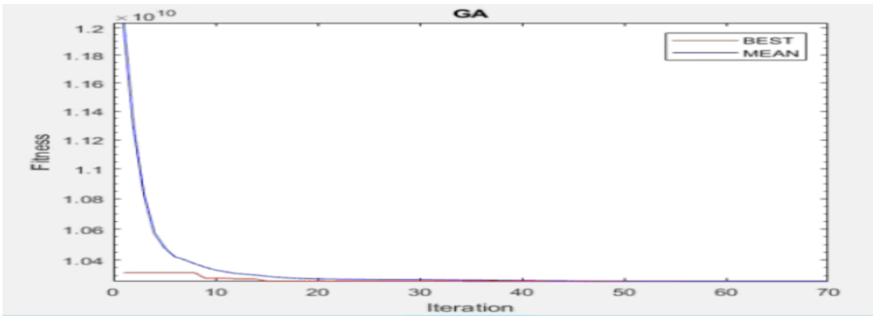

Figure 3.
The Results of Purchasing and Supply Costs by Each Supplier with the Genetic Algorithm

Information on the Dairy and Pasteurized Milk factory of the Cooperative Company, as presented in Table 5. In addition, the cheese producer needs at least 450000 liters of milk in the entire program, and the supply of this liter of milk alone is solely beyond the control of a supplier

Table 5.
Supply Capacity, Purchase Cost, and Transporting Costs

Supplier Name	The Cost of Purchasing	The Cost of Transporting	Supply or Production Capacity
Ranchers of Sadal village	15000	3000	55800
Ranchers of Abbas kandi village	14000	1500	48600
Ranchers of Masjed lou village	14500	2500	52200
Ranchers of Haj musa	13500	3000	54000
Ranchers of Hussein valizadeh	14000	2500	54900
Ranchers of Ghrkh bulakh	15000	3500	48600
Ranchers of mazraae	13000	2500	50400
Ranchers of tazeh kand	14000	2750	52200

Supplier Name	The Cost of Purchasing	The Cost of Transporting	Supply or Production Capacity
Ranchers of chokhur	13000	2750	46800
Ranchers of zaviyeh	15000	3000	48600
Ranchers of haram Lou	14500	3500	46800
other Ranchers	13500	3000	63000

Therefore, the objective function is to minimize the total cost of supplying the milk needed needed (purchase and transportation costs) in the entire program

$$\text{Minimize z} = (15000+3000)x_1+(14000+1500)x_2+(14500+2500)x_3+ (13500+3000)x_4+(14000+2500)x_5+(15000+3500)x_6+(13000+2500)x_7+ (14000+2750)x_8+(13000+2750)x_9+(15000+3000)x_{10}+(14500+3500)x_{11}+ (13500+3000)x_{12}$$

Model constraints:

$$x_1+x_2+x_3+x_4+x_{5+.}.........+x_n \geq 450000 \quad \text{i = 1… 12}$$

$$x_1 \leq 55800 \quad x_2 \leq 48600 \quad x_3 \leq 52200 \quad x_4 \leq 54000 \quad x_5 \leq 54900$$

$$x_6 \leq 48600 \quad x_7 \leq 50400 \quad x_8 \leq 52200 \quad x_9 \leq 46800 \quad x_{10} \leq 48600$$

$$x_{11} \leq 46800 \quad x_{12} \leq 63000 \quad Xi \geq 0 \quad i=(1,2,3,....12)$$

Considering the details and the steps to solve the bee algorithm approach and genetic algorithm in Case Study 1, in this Case Study is ignored and only the results are given in Table 6 below.

Table 6.

The Results of Purchasing Per Liter of Each Supplier with the Bee Algorithm and genetic Algorithm

Supplier Name	Variable	Purchase Rate Per Supplier	
		Bee Algorithm	Genetic Algorithm
Ranchers of Sadal village	X1	31389	52438
Ranchers of Abbas kandi village	X2	45992	31106
Ranchers of Masjed lou village	X3	26403	41191
Ranchers of Haj musa	X4	50197	24607
Ranchers of Hussein valizadeh	X5	31861	27910
Ranchers of Ghrkh bulakh	X6	36960	38940
Ranchers of mazraae	X7	38210	34792
Ranchers of tazeh kand	X8	43676	46690
Ranchers of chokhur	X9	39660	34803
Ranchers of zaviyeh	X10	42799	25103
Ranchers of haram Lou	X11	1562	35904
other Ranchers	X12	61475	56516
Total		450184	450000
The Objective Function		7525754500	7613315250

To solve the problem of choosing a suitable supplier of production, two Companies were examined for the Nizar factory produces Lighvan cheese the Dairy and Pasteurized Milk factory of the Cooperative Company. At the Nizar factory, 19 suppliers in the model presented with the Bee's algorithm approach, considering the cost of purchasing and the cost of transportation per liter of milk and the capacity constraints of each supplier was implemented, so that the 19 suppliers would supply a quantity of 360000 liters of the milk of the Nizar factory, as well As seen in Table 3, Ranchers of the villages of

Injeh, Ghourishakak and Aghgol, respectively With the amount of 49600,36672 and 32,806 liters of milk, the highest amount of milk supply, and on the other hand, suppliers such as Ranchers of Zelakeh 1, Khale Zaghasi, Qom Gheshlagh and Shouraghol villages respectively with the amount of 3663, 5765, 6412 and 6585 liters of milk lowest amount of milk supply has been allocated. Therefore, the objective function is to minimize the total cost of supplying the parts and materials needed (purchase and transportation costs) in the entire program to supply 360000 liters of milk to 10200970750 rials. But at the Dairy and Pasteurized Milk factory, 12 suppliers with the bee algorithm approach were implemented, so that will supply the amount of 450000 liters of the milk, As shown in Table 6, other Ranchers, Ranchers of the villages of Haj musa, Abbas Kandi, tazeh kand and zaviye, respectively, with the amount of 61475,50197,45992,43676,42799 liters of milk, the highest amount of milk supply, and on the other hand suppliers such as ranchers of the villages of haram Lou, Masjed lou, Sadal and Hussein valizadeh respectively, with the amount of 1562, 26403, 31389 and 31861 liters of milk have the lowest amount of milk supply. Therefore, the objective function is to minimize the total cost of supplying the parts and materials needed (purchase and transportation costs) in the entire program to supply 450000 liters of milk to 7525754500rials. The result of the fact that the Nizar factory to select a suitable supplier for production with a bee algorithm approach with the goal of minimizing the total supply cost of milk should pay more attention to suppliers such as Ranchers of the villages of Injeh, Ghourishakak and Aghgol of their capacity and focus on them and at the Dairy and Pasteurized Milk factory to selected, other Ranchers, Ranchers of the villages of Haj musa, Abbas Kandi, tazeh kand and zaviye. Another result of this research is the use of genetic algorithm approach for the proposed model to select a suitable supplier of production in the two factories. Observed in Nizar factory according to table number (4), Ranchers of the villages of

Ghourishakak, Injeh, Zelakeh 2 and Aghgol, respectively With the amount of 34778,31313, 29705 and 29482 liters of milk, the highest amount of milk supply, and on the other hand, suppliers such as Ranchers of Saranj, Shouraghol, Qom Gheshlagh and Isa Khan villages respectively with the amount of 754, 6396, 10807 and 10966 liters of milk lowest amount of milk supply has been allocated. Therefore, the objective function is to minimize the total cost of supplying the parts and materials needed (purchase and transportation costs) in the entire program to supply 360015 liters of milk to 10263564750 rials.But at the Dairy and Pasteurized Milk factory, with the genetic algorithm approach Observed according to Table (6),other Ranchers, Ranchers of the villages of sadal, tazeh kand and Masjed lou , respectively, with the amount of 56516,52438,46690 and 41191,42799 liters of milk, the highest amount of milk supply, and on the other hand suppliers such as ranchers of the villages of Haj musa, zaviye, Hussein valizadeh and Abbas Kandi, respectively, with the amount of 24607, 25103, 27910 and 31106 liters of milk have the lowest amount of milk supply. Therefore, the objective function is to minimize the total cost of supplying the parts and materials needed (purchase and transportation costs) in the entire program to supply 450000 liters of milk to 7613315250 rials. The result of the fact that the Nizar factory to select a suitable supplier for production with a genetic algorithm approach with the goal of minimizing the total supply cost of milk should pay more attention to suppliers such as Ranchers of the villages of Ghourishakak, Injeh, Zelakeh 2 and Aghgol, of their capacity and focus on them and at the Dairy and Pasteurized Milk factory to selected, other Ranchers, Ranchers of the villages of sadal, tazeh kand and Masjed lou. From the results obtained of the results of the bee algorithm and the genetic algorithm, it is inferred that in order to select the appropriate supplier of production, Nizar factory should pay more attention to the Ranchers of the villages of, Injeh, Ghourishakak, and Aghgol, according to their supply capacity and select them but in the pasteurized milk factory of the cooperative company, other Ranchers, Ranchers of the villages of tazeh kand and Abas abad should pay The most attention and selected them. Therefore, in order to evaluate the efficiency of algorithms by combining different parameters from two scales of efficiency, the quality of the answer or the objective function and the calculation time of use, the results of which are described in Table (7).

Table 7.

Comparison Between the Results of Bee Algorithm and Genetics

The Calculation Time			The Value of the Objective Function			Number of Variables	Factory Name
Percentage of Improvement	Genetic Algorithm	Bee Algorithm	Percentage of Improvement	Genetic Algorithm	Bee Algorithm		
-2/07	7/1836	22/0757	%٠/61	10263564750	10200970750	19	Nizar
0/94	3/0625	0/18038	% 1/2	7613315250	7522902500	12	cooperative company

According to table number (7) The cost of the objective function in the Nizar factory is equal to the bee algorithm 10200970750 and with genetic algorithm is equal to 10263564750.As a result, the cost of the objective function of the bee algorithm is less and this reduction is equal to 62594000, which indicates that the performance of the bee algorithm is better than the genetic algorithm, ie the amount of the objective function calculated by the bee algorithm is 0.61% better than the genetic algorithm. The cost of the objective function in the cooperative company is equal to the bee algorithm 7522902500 and with genetic algorithm is equal to 7613315250.As a result, the cost of the objective function of the bee algorithm is less and this reduction is equal to 90412750, ie the amount of the objective function calculated by the bee algorithm is 1.2% better than the genetic algorithm. According to Table (7), in Neyzar factory, the time required to reach the answer in the bee algorithm is equal to 22.0757 and in the genetic algorithm is equal to 7.1836.

As a result, the amount of time calculated by the bee algorithm is higher than the genetic algorithm and does not show a percentage of improvement. But in cooperative company, the time required to reach the answer in the bee algorithm is equal to 0.18038 and in the genetic algorithm is equal to 3.0625 As a result, the amount of time calculated by the bee algorithm is less than the genetic algorithm and shows an improvement of 0.94%.In summary, as seen, it can be concluded that the bee algorithm has the best performance in terms of response quality or objective function and computational time compared to the genetic algorithm for selecting the best production supplier. In order to review the sensitivity of the bee algorithm to parameters, the following changes were made to the parameters:

Total number of bees (NB): 10 bees

Number of employer's bee or food sources (SN): 5 bees

Number of unlooker bees (N_unlooker): 5 bees

Table 8.

Results of Bee Algorithm Sensitivity to Parameters in Factories

Factory Name	Number of Modes	Total Number of Bees	Number of Employer's Bee	Number of Unlooker Bees	The Number of Repetitions	Minimum Milk Supply	The Objective Function	Computational Time
Nizar factory	The first mode	50	25	25	200	360000	10200970750	22/0757
Nizar factory	Second mode	10	5	5	200	360009	10281865500	4/8353

As shown in Table 8, when the total number of bees from 10 bees to 50 bee's increases, the objective function is improved from 10281865500 to 10200970750 and the quality of the answer is improved. Increasing the size of the community improves significantly the quality of the time and the dispersion of the unlucky responses. At the same time, this increase also increases the computational time, which increases the computing time from 4.835.34 to 2.257. Thus, the more the number of bees and the number of repetitions, the better the quality will be, that is, from the same repetitions , The justifiable answer and the final answer will improve. To validate mathematical modeling to select the supply supplier in the supply chain, use all available ways as much as possible. first, by studying the content of mathematical modeling based on operational research methods from different sources, by referring to numerous examples of mathematical modeling and the rules and principles governing modeling, then valid mathematical models, that are presented in the supply chain mathematical modeling provided by prominent individuals has been based on the design of the model, also, the views of professors, advisers, referees, Experts and modeling technicians have been used to study the model, and ultimately to validate The mathematical modeling of the Lingo software and WINQSB software has been used, the results of which are presented in Tables 9 and 10.

Tables 9.
The Results of Lingo and WINQSB Software

Supplier Name	Variable	Optimal Purchase Rate with lingo	Optimal Purchase Rate with	Supplier Name	Variable	Optimal Purchase Rate with Lingo	Optimal Purchase Rate with
Ranchers of yekhelghan village	X1	0	0	Ranchers of Hasan Shake Village	X11	27300	27300
Ranchers of Aghgol village	X2	44600	44600	Ranchers of Khale Zaghasi Village	X12	22320	22320

Supplier Name	Variable	Optimal Purchase Rate with lingo	Optimal Purchase Rate with	Supplier Name	Variable	Optimal Purchase Rate with Lingo	Optimal Purchase Rate with
Ranchers of Qom Gheshlagh village	X3	0	0	Ranchers of Tikme village	X13	23560	23560
Ranchers of Deim Gheshlagh village	X4	0	0	Ranchers of Ghourishkak village	X14	49600	49600
Ranchers of Sarang Village	X5	0	16540	Ranchers of Zelake 1 village	X15	0	0
Ranchers of Ghareblagh village	X6	0	0	Ranchers of Zelake 2 village	X16	0	0
Ranchers of Movlik village	X7	22320	22320	Ranchers of Mullah Hasan village	X17	24800	24800
Ranchers of Inje village	X8	49600	49600	Ranchers of Hesar village	X18	31000	31000
Ranchers of Isa Khan village	X9	23560	23560	Ranchers of Shouraghol village	X19	16540	0
Ranchers of Mirza Khalil village	X10	24800	24800	total		360000	360000
Optimal object function						9973300000	9973300000

Tables No. 10: The Results of Lingo Software with WINQSB Software

Supplier Name	Variable	Optimal Purchase Rate with Lingo	Optimal Purchase Rate with WINQSB	Supplier Name	Variable	Optimal Purchase Rate with Lingo	Optimal Purchase Rate with WINQSB
Ranchers of Sadal village	X1	0	27900	Ranchers of mazraae	X7	50400	50400
Ranchers of Abbas kandi village	X2	48600	48600	Ranchers of tazeh kand	X8	52200	52200
Ranchers of Masjed lou village	X3	52200	52200	Ranchers of chokhur	X9	46800	46800
Ranchers of Haj musa	X4	54000	54000	Ranchers of zaviyeh	X10	0	0
Ranchers of Hussein valizadeh	X5	54900	54900	Ranchers of haram Lou	X11	27900	0
Ranchers of Ghrkh bulakh	X6	0	0	other Ranchers	X12	63000	63000
Total						450000	450000
Optimal Object Function						7371900000	7371900000

as shown in Table 9and 10,using Lingo and WINQSB software at the Nizar factory, the minimum material required, 360000 liters of milk supplied by its suppliers, also the capacity constraints provided by each supplier are satisfied, and there is no difference between the two software's answers. And ultimately the solution obtained by both software, which is the optimal final solution and have an optimal objective function, representing the validity of the mathematical model. That is, the optimal objective function to minimize the total cost of material supply (purchase and transportation costs) by both software is equal to 9973300000. At the Dairy and Pasteurized Milk factory also 450,000 liters of milk has been supplied by Its suppliers also the capacity constraints provided by each supplier are satisfied And ultimately the solution obtained by both software, which is the optimal final solution and have an optimal objective function, representing the validity of the mathematical model. That is, the optimal objective function to minimize the total cost of material supply (purchase and transportation costs) by both software is equal to 7371900000. Therefore, in order to evaluate the efficiency of the software, three efficiency scales, the quality of the answer or objective function, the number of repetitions and the time of calculation are used as follows, the results are presented in tables 11.

Table 11.
Comparison Between the Results of the Lingo and WINQSB Software

Factory Name	Variable Number	Number of Constrictions	Amount of Objective Function			The Number of Repetitions			Average Computing Time		
			Lingo	WINQSB	Percentage Improvement	Lingo	WINQSB	Percentage improvement	Lingo	WINQSB	Percentage Improvement
Nizar	19	20	9973300000	9973300000	٠	1	13	%0/92	0/01	0/031	0/68
Cooperative	12	13	7371900000	7371900000	٠	1	10	%0/9	0/01	0/016	0/37

The optimum objective function in the Nizar factory with Lingo software and WINQSB software is equal to 9973300000 Rials; in the Dairy and Pasteurized Milk of the cooperative company, the optimum objective function in both software is equal to 7371900000 Rials, and there is no difference between the two software's solutions**,** Which indicates that the Lingo software performance is the same as the WINQSB software in terms of the objective function, and does not show an improvement percentage. As shown in Table 11, in the Nizar factory, the time required to reach the answer in Lingo software is 0/01 and WINQSB software is 0/031. As a result, the amount of time calculated by Lingo software is better than WINQSB software, which indicates that the Lingo software performance is better than WINQSB software and shows a 68% improvement. But in the cooperative, the time needed to reach the initial answer in Lingo software is 0/01 and WINQSB software is 0/016. . As a result, Lingo's time calculated by WINQSB software is low and shows a 37.0% improvement.As shown in Table 11, in the Nizar factory, the number of repetitions in Lingo software is equal to 1 and in the WINQSB software is equal 13. As a result, the number of Lingo software repetitions is low, which indicates that the performance The Lingo software is better than WINQSB software and has a 0/92 percent improvement. But in the cooperative, the number of repetitions in Lingo software is 1 and WINQSB is 10 in the software. As a result, the number of Lingo software repetitions is low and has a 0/90 percent improvement. In summary, as we have seen, it can concluded that Lingo software has the best performance compared to the WINQSB software in terms of the repetition for the final solutions and computational time to choose the suitable supplier. But it does not difference in terms of the quality of the answer or the optimal objective function.

Conclusions

This research was conducted with the aim of providing a mathematical model for choosing the supplier of supply in the supply chain with the approach of the bee algorithm and comparison with genetic telegram in dairy production units of the city of Maku. At first, the math model of the supplier's selection of production was designed considering the cost of transportation and the cost of purchasing with operational research methods. Then, by the method The results of this research based on the proposed model showed that the bee algorithm approach can be selected the suitable supplier of production in the supply chain, so that the cost of the supply, that is, the cost of transportation and the cost of purchasing are minimized, and, on the other hand, the minimum materials required (milk), by the suppliers are provided. The results also showed that the performance of the bee algorithm is more efficient than genetic algorithm in terms of objective function. And also according to the field research findings, we conclude that, The result of the fact that the Nizar factory to select a suitable supplier for production with a bee algorithm approach with the goal of minimizing the total supply cost of milk should pay more attention to suppliers such as Ranchers of the villages of Injeh, Ghourishakak and Aghgol of their capacity and focus on them and at the Dairy and Pasteurized Milk factory to selected, other Ranchers, Ranchers of the villages of Haj musa, Abbas Kandi, tazeh kand and zaviye. Another thing is that Nizar factory with the approach of genetic algorithm should pay more attention to suppliers such as Ranchers of the villages of Ghourishakak, Injeh, Aghgol and Zalke 2 according to their supply capacity and select them, and pasteurized milk factory of cooperative company and other Ranchers, The ranchers of the villages of Sedel, tazeh kand and Masjedloo select them. the results of this study are consistent with the with the findings of Hejazi (2011) with the guidance of ghandahari. Under the title of providing a framework for analysis and selection of raw material suppliers in Isfahan Steel Company, which in a case study to supply 1,200,000 tons of iron ore, five suppliers of central iron ore in Iran - Bafgh, Amir Sangan Parsian, Negin Ahya, East Iran and Kimia Sepahan The combination of GP with AHP has been used to determine and determine the optimal values of suppliers. And it turned out that the buyer, according to the capacity of suppliers, buys the central iron ore of Iran Bafgh and Negin Ahya iron ore and buys the rest of his demand from the iron ore supplier Amir Sangan Parsian. The results of this research are an appropriate approach to use limited financial resources in order to grow and strengthen industrial production to achieve comparative and strategic advantages. Chandra and Fisher (1994) proposed a model called Coordinated Production and Distribution Planning, In this model, the demand for each product in a period for each retailer is determined that The objective function of this model is to minimize the total cost, which includes the costs of operating, production, transportation of manufactured products to retailers and inventory costs. And ultimately the results of this research are alignment with the findings of Rabieh, Azar, Modares Yazdi and Fard Haghighi (2014), the results of the research showed that the supply and allocation of orders to suitable suppliers would significantly reduced the cost of supply and Increase the competitiveness of the organization. Comparing the performance of bee algorithm with genetic algorithm in terms of response quality or objective function in Nizar factory and cooperative company, the amount of objective function, In terms of calculated time, in Nizar factory, the amount of time calculated by the bee algorithm is higher than the genetic algorithm and does not show the percentage of improvement. But in the cooperative company, the amount of time calculated by the bee algorithm is less than the genetic algorithm and shows an improvement of 0.94%.Therefore, it can be concluded that the bee algorithm has the best performance in terms of response quality or objective function and calculated time compared to the genetic algorithm for selecting the best production supplier. And the results are parallel with the results of research by Van and May, (2013),which suggest that in some studies the performance of the ABC is more reported than the evolutionary algorithms such as GA, PSO and differential evolution (DE)and other evolutionary algorithms. Or the results of the studies of Aazami Qhareh-Tapeh, Ranjbar and Moradi with providing a fuzzy clustering method using the honey colony optimization algorithm shows that for evaluating the efficiency, the new fuzzy bee algorithm is compared with the best available algorithms including SA،GA ،FCM ،K-Means ،TS ،ACO and K-NM-PSO, which the honey bee colony optimization algorithm is best suited to existing algorithms, the most effective honey bee colony optimization algorithm, it can be considered as a good alternative to find the best or near to the best solution. Results of another parallelism with the research Rahimi and Ramazani Khansari (2014), entitled Development of the bee hive feeding algorithm for solving the automobile)(vehicle) routing problem, can be pointed out that the results indicate the ability of the proposed honey colony algorithm to solve the car routing problem in comparison with other methods. In order to license and prove the efficiency of the bee algorithm, the proposed solution to several well-known problems is known and the results are compared with the bee algorithm with the best results obtained by other common methods (genetic algorithm, ant algorithm, etc.). Shows honey. In the sensitivity of the bee algorithm to change the parameters, when the total number of bees from 10 bees to 50 bee's increases, the objective function is improved from 10281865500 to 10200970750 and the quality of the answer is improved. Therefore, the more the number of bees and the number of repetitions, the better the quality will be, that is, from the same repetitions, The justifiable answer and the final answer will improve, and to validate The mathematical modeling of the Lingo software and WINQSB software has been used, ultimately the solution obtained by both software, which is the optimal final solution and have an optimal objective function, representing the validity of the mathematical model. Compared to the Lingo and WINQSB software in terms of the quality of the answer or The objective function, the optimal objective function in both software is equal and there is no difference between the two software solutions, but Lingo software has the best performance compared to the WINQSB software in terms of the repetition for the final solutions and computational time to choose the suitable supplier. Therefore, the ability of meta-heuristic algorithms to solve complex problems led researchers to not worry about modeling mathematical models .The meta-heuristic algorithms achieve approximate solutions in neighborhoods of optimal points, although, one cannot claim that the answer is optimal, however, it will be optimal in the neighborhood.

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