International Academic Institute for Science and Technology

International Academic Journal of Science and Engineering
Vol. 5, No. 1, 2018, pp. 241-254.
ISSN 2454-3896

International Academic Journal of Science and Engineering

www.iaiest.com

The Problem of Locating - Allocation of Facilities and Central Warehouse in the Supply Chain with Bernoulli Demand

Mohsen Sojoudi[a], Hamidreza Saeedi[b]

[a]*Phd Student of Operation Research, Ferdowsi university , Mashhad, IRAN.*

[b]*Master Student of Engineering Management, University of Politecnico di Milano, Italy.*

Abstract

Today, in the existing competitive market, proper supply chain management has attracted a lot of attention to increase profitability and customer satisfaction (Khorasani, 2014; Torabzadeh and Memarian 2012). Managers and decision-makers may use policies to survive in this paradigm (Khorasani and Almasifard, 2017), however, the optimal result will only be achieved when a precise and comprehensive program is used. In this research, discrete a multi-facilities location and a central warehouse with Bernoulli demand were investigated. The goal of this problem is the optimization of facilities locations, and allocating all customers to deployed facilities as well as locating a warehouse from among the candidate places of the warehouse as the central warehouse and allocating facilities to the warehouse. Therefore, the total fixed cost of locating facility and central warehouse as well as the cost of service and the cost of outsourcing resources can be minimized, the computational results of this study show that the problem with the Lingo software does not achieve the optimal solution in large sizes in a reasonable time. All in all, Efficient supply chain management increases the financial development (Çiftçioğlu and Almasifard, 2015; Almasifard and Khorasani, 2017).

Keywords: locating, distribution warehouse, mathematical planning, Bernoulli demand.

Introduction:

Locating the facilities and routing of the vehicles are interrelated; Marazana (1964) showed that the locating of factories, product caches, and supply of products are often influenced by transportation costs. In General, In addition, according to Rand (1976), many activists (traders) are aware of the risks of sub-optimization by locating separate warehouse and vehicle routing, both groups of scientists and traders,

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

usually they refuse this connection. Locating device, usually without regard to infrastructure routing, we will give you three possible reasons for this (Elyasi M. et al, 2012a, 2012b).

(1) When there is no routing problem locating problem, many practical situations are created, in which case clearly the routing-route is not a suitable case for solving.

(2) Some research objectives for locating- routing are based on the inadequacy of this. Meanwhile, locating is considered as a general strategy, while it regards routing as a tactical problem (simple and brief). The routes can be calculated frequently (even daily) but locating warehouse are usually for a very long period. Therefore, their idea is that the combination of locating and routing in the context of the same planning for different programs is inappropriate and they criticize writers for considering that: using routing- locating in paths that are allowed to change, they can reduce the additional costs of a project (Salhi and Naji, 1999; Moradinasab N. et al, 2018).

(3) Conceptually, the problem of locating-routing is much more complicated than the classic positioning problem. Berman (1995) showed that in the locating-routing problem of the centrality of the relationship between the executive groups of demand points, the means are thus unknown, the movement of which is still unknown, different facilities, etc in classical locating problem should be located at the desired distance from the unique demand points, which makes it possible, our problem is more controllable, which helps with the advancement of the core of the routing- locating problem (Hasani, et al, 2013; Jafarzadeh H.et al, 2014; Jafarzadeh H.et al, 2017).

The problem of locating-routing is modeled from the mathematical point of view as a composite optimization problem. From the training point of view, it forms part of dispersion management (distribution). We note that this is a NP-hard problem, which also includes another NP-hard problem (1-facility locating and 2-routing of the vehicle). In this research, we present a mathematical model for locating facilities and allocating customers to deployed facilities and locating and allocating a central warehouse to the facility with the aim of minimizing the expected cost, taking into account the probability of customer demand.

Review of previous research

In Rooney et al., (2014) provide a sustainable alternative energy management model for remote communities in the Amazon region suitable for the isolation of the community, due to the high cost of exploitation and maintenance for supply to specific consumers; they are out of reach in small places using biomass.

Jean-Joo Jay et al (2013) explored how to set up optimization and the intelligent collection industry in supply chain networks. Using mathematical models and genetic algorithms, they have developed a model to minimize losses due to delivery delays. The variables used in this research are: daily operation time, expected ratio of the center manufacturer, industry cycle time, total delay to loss, industry index, total number of industry, cooperative indexes, total number of industry partners, I S index, ISS number, total ISS, integer value of n by deletion, time of practice for industry colleagues, the time of operations for J's

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

industry colleagues at ISK, ISK's industry, delivery time of industry colleagues, the delivery time of the Associates industry at ISK, the entire process time of industry colleagues, the whole process time of the industry colleagues at ISK.

Biswierger Sarkar et al (2013) have been studying locating issues for facilities and in the first step they have provided a two-step model. Then, by adding the type of goods, they upgraded their model to three-dimensional mode and eventually reached the four-dimensional model by entering the mode of transportation. They also address the issues of reducing the cost of the supply chain network.

Atefeh Baghlyan et al (2013) developed a randomized mathematical formula for designing a multi-product supply chain including multi-capacity production facilities, distribution centers and retailers in uncertain markets. In this study, they are looking for a discrete set of potential locations for distribution centers and retail outlets, and examine the impact of strategic location decisions on operational inventory and supply chain decision-making. Also, Javid Jazzani et al (2013) the location of dairy facilities and dynamic supply chain planning by minimizing the cost of facilities, traffic and transportation of raw milk / processed and dairy products under the uncertainty of demand have been studied. They have dynamically proposed the model by changing the transportation network, the investment costs of the facility, the time value of money, and changes in the production process.

In a study by Mahmood Ebadian et al (2013), they used a simulation method to optimize the biotahanol production chain. Khorasani et al (2017) also applied simulation for pharmaceutical supply chain. In their study, they found that the costs of storage and transportation would be additional to those that would undermine the optimal bio-ethanol chain production cycle.

Shabani and Solati (2013) in a study of integrated integer nonlinear planning improve the cost competitiveness of forest biomass to produce electricity against wood biomass. In this research, the authors presented a dynamic optimization model based on the forestry supply chain configuration and the construction of a biomass power plant to maximize the overall value of the supply chain. The model presented by these researchers suggests that investing in a new ash recovery system has economic and environmental benefits for the power plant.

In another study, Fengli-Zhang et al (2012) used the simulation method, relying on the key activities of the production of biotahanol and supply chain. Key activities in this research were harvest / processing, transportation and storage. This model used raw material costs, energy consumption and greenhouse gas emissions as system performance measures. In the end, the researchers showed that a given model is a useful tool for supply chain management, including the selection of optimal biofuel location facilities, logistics design, inventory management, and information exchange.

Gritt Walther et al (2012) in their studies devoted to the design of regional production networks for the second generation of artificial biofuels in Germany.

In this research, they provide concepts for plant benefits, as well as a strategy for installing and building capacity, and ultimately providing advice to policy makers as well as potential investors.

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

In a study by Mashbeh, Ahmadi Javid et al (2010) in the proposed model simultaneously prohibited the optimization of location, allocation, capacity, inventory, and routing decisions in a random supply chain system using the search meta-initiative model. The results of this study indicate that the proposed model has been considerably effective and efficient. The variables examined in this model are as follows: the number of customers in the set, the average annual customer demand, the annual customer demand variance, the annual fixed cost to open and set up the distribution center with the desired capacity level, capacity with the distribution center level, transportation costs, annual transportation capacity of a vehicle, the number of visits per car per year, the cost of inventory per unit of product per year at the distribution center, fixed costs for each order by the distribution center to the supplier, lead time, distribution center per year, fixed fee for the shipment from the supplier to the distribution center, the cost per unit of transportation from the supplier to the distribution center, the percentage approved by the customer, standard left percentiles normal random variable Z, operating weight related to shipping costs, operating weight related to inventory costs.

In the research we examined above, we find that most of the methods used do not match the real-world variables, but in the leading research, we try to provide a model with the highest possible returnability with respect to real-world variables.

Problem Structure

Suppose $I_9 J$ respectively, represents a set of potential places of facilities and a set of customers, which is the demand of each customer $j \in J$ for a random variable of zero and one, which is indicated by γ_j whether it indicates whether the customer j has demand or not. We also assume that γ_j a Bernoulli probability distribution follows the parameterp_j that γ_j and its distribution function can be displayed as follows:

$$\gamma_j = \begin{cases} 1 & p_j \\ 0 & 1-p_j \end{cases} \qquad j \in J$$

$$\mathbb{P}_x(X=x) = p_j^x (1-p_j)^{1-x} \qquad j \in J$$

Before presenting the model, it explains the hypothesis to better understand it.

3.1 Model hypothesis
The items included are:
– For each facility, minimum and maximum capacity is considered.
– All facilities are allocated to a warehouse.
– The capacity of the central warehouse is unlimited.
– If a facility is built, it should serve customers as much as its minimum capacity.
– The number of candidate points for the location of the facility and the designated warehouse.

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

– Although the facility has limited capacity, it is possible to allocate a customer number more than its capacity. In other words, limited capacity does not have an impact on the number of customers that are assigned to an ease.

3.2 Model Subtitles

i : Counter facilitator

j : Customer Counter

w : Warehouse counter

3.3 Model Parameters

f_i : fixed cost of facilitating deployment i if it is deployed.

l_i : minimum number of customers assigned to facilitated deployment.

k_i : maximum number of customers that can be facilitated i when opened.

c_{ij} : cost per service unit of customer i facilitated by j.

g_i : cost of outsourcing to facilitate i if that facility is open.

b_w : Depositary cost of warehouse w

d_{iw} : The cost of allocating warehouse w to facilitate *j*.

3-4. Model decision variables

The decision variables of zero and one are considered in the model:

x_{ij}: If the customer j is assigned to facilitate$i$, then equals one, otherwise it is zero

z_{iw} If the warehouse w is assigned to facilitate$i$, it equals one, otherwise it is zero

y_i : If a facility is located in a location i equal to one, otherwise it equals zero

o_w If a warehouse is located at w, it is equal to one, otherwise it is zero

3-5. Other symptoms of the mathematical model

Some customers may not be in demand due to accidental vectors. $j_i$reveals a set of customers that is allocated to facilitate i. In addition to the subheadings of the model, parameters and decision variables, two hypervelocity definitions only contribute to the mathematical modeling of the model as follows:

t_i the total number of customers assigned to facilitate i

n_i total number of customers assigned to facilitate i

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

They can be shown as below:

$$t_i = \sum_j x_{ij} \qquad \eta_i = \sum_{j \in J} \gamma_j \; x_{ij}$$

3-6- Proposed mathematical model

In this research, the aim is to find a set of facilities that should be induced and allocate customers to deployed facilities so that they meet the total cost of the facility being deployed and the function of the option. According to the hypothesis, the parameters and decision variables defined in the previous sections of the proposed mathematical model are as follows:

min z=$\sum_i f_i y_i + E_\zeta ($ cost of outsourcing+ cost of service (1)

s.t

$$\sum_i x_{ij} = 1 \qquad \forall j \qquad (2)$$

$$x_{ij} \leq y_i \qquad \forall i,j \qquad (3)$$

$$l_i y_i \leq \sum_j x_{ij} \qquad \forall i \qquad (4)$$

$$z_{iw} \leq o_w \qquad \forall i,w \qquad (5)$$

$$\sum_w o_w = 1 \qquad (6)$$

$$\sum_w z_{iw} = \begin{cases} 1 & s - k_i > 0 \\ 0 & o.w \end{cases} \qquad \forall i \qquad (7)$$

$$y_i, x_{ij}, o_w, z_{iw} \in \{0,1\} \qquad \forall i,j,w \qquad (8)$$

Limitation (2) ensures the allocation of each customer to one of the facilities, in other words, for each customer, the total variable of the decision to allocate facilitation to the customer, should be 1 for the various facilitators.

Limitation (3) states that only deployed facilities can estimate demand. In this way, the j-th customer demand can be provided to facilitate deployed location i ($x_{ij} = 1$)) located in facilitate deployed location$i$).

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

Relation (4) for each facility, limitation of the lower limits the number of customers of each facility, thus only the answers that this minimum will be presented. In other words, the amount the decision maker enters into the model will be the criterion of the minimum number of customers. Generally, the input number will be greater than or equal to 1.

Limitation (5) states that if the warehouse w is deployed, the facility i can be allocated to it.

Relationship (6) states that from among several candidate warehouses only one warehouse is selected as the central warehouse.

Limitation (7) actually ensures that, if facility i is more than capacity of customer has demanded, can be outsourced, and that is to say received from the central warehouse of the service.

Relationship (8) also points out that the decision variables are zero and one variables. Now, we want to explain the remedy proposed in this research. As we said before, the probability distribution η_i is dependent on vector x_{ij} for $j \in J$. So we will have:

$$\mathbb{P}_x[\eta_i = s] = \mathbb{P}_x\left[\sum_{j \in J_i} x_{ij}\gamma_j = s\right] \tag{9}$$

In other word:

$$\mathbb{P}_x[\eta_i = s] = \sum_{x \subset J_i} \prod_{j \in x} p_j \prod_{j \in J_i \setminus x} (1 - p_j) \tag{10}$$

Outsourcing: When the requested services facilitate i is more than its capacity, it facilitates more and the intended facility cannot estimate the demand of its customers. Facilitating a central warehouse (external source) to provide the demand is allocated. Of course, it should be noted that the capacity of this warehouse, as stated in the hypothesis of the problem, is unlimited. The cost of applications fulfilled is dependent on outsourcing $g_i$and service cost c_{ij}. In addition, the cost of deployment and the cost of allocating warehouse to facilitate should also be considered in the objective function of the model. This strategy is common in supply chain management and internal logistics. So we write the function of the choice as follows:

$$E_\zeta \text{ (service cost+demand outsourcing cost+warehouse location-allocation cost)}$$
$$= E_\zeta \text{ (service cost)} + E_\zeta \text{ (demand outsourcing cost)} + E_\zeta \text{ (warehouse location-allocation cost)}$$
$$E_\zeta \text{ (service cos)} = \sum_i \sum_j c_{ij}\, x_{ij}\, p \tag{11}$$

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

$$E_\zeta(\text{demand outsourcing cost}) \tag{12}$$
$$= \sum_{i\epsilon I}\left[\sum_{s=0}^{t_i} \mathbb{P}_x[\eta_i = s] \times E_\zeta[Outsourcing\ cost|\eta_i = s]\right]$$
$$= \sum_i y_i g_i \sum_w z_{iw} \sum_{s=k_i+1}^{t} p[\eta_i = s]\,(s - k_i)$$
$$E_\zeta\ (\text{warehouse location} - \text{allocation cost}) = \sum_w c_w o_w + \sum_i \sum_w z_{iw} d_{iw} \tag{13}$$

Due to the complexity of the proposed model, it is very difficult to solve problems due to different probabilities for customers. Here we consider the homogeneous state, that is, we assume that all customers have the same probability $p_j = p \ \ \forall\ j \in J$ Therefore, η_i has a binomial probability distribution with parameters t and p that is, here $t = t_i$, distribution of η_i depending on the number of customers assigned to facilitate i these customers' demand, since the Bernoulli random variable is independent, the probability distribution can be represented as follows.

$\eta_i \sim$ Binomial (t, p) $\Longrightarrow b_{ts} = \mathbb{P}_x[\eta_i = s] = \binom{t}{s} p^s (1-p)^{t-s} \ \ \forall\ 0 \le s \le t$

In accordance with homogeneous hypothesis, equations (11) and (12) are summarized as follows:

$$\sum_i \sum_j c_{ij}\, x_{ij}\, p \tag{14}$$

$$\sum_i g_i y_i \sum_w z_{iw} \sum_{s=k_i+1}^{t_i} b_{ts}\,(s - k_i) \tag{15}$$

Since the upper limit of the decision variable t_i , which is the sum of customers (s), is not clear. To avoid problems in solving a variable y_i, we redefine the decision as follows: if a facility is located in a location i equal to one, otherwise it is zero. Now, by defining new variables, it can be a new constraint for the problem $\sum_{t=l_i}^{|J|} y_i^t \le 1$, $y_i^t = 1$ that defines if and only if $t_i = t$. Hence, relation (15) was rewritten as follows:

$$\sum_i \sum_{t=l_i}^{|J|} y_i^t\, g_i \sum_w z_{iw} \sum_{s=k_i+1}^{t} b_{ts}\,(s - k_i) \tag{16}$$

The objective function (1) is considered as follows:

$$F(y,x) = \sum_i \sum_t y_i^t f_i + \sum_i \sum_j c_{ij}\, x_{ij}\, p + \sum_i \sum_{t=l_i}^{|J|} y_i^t\, g_i \sum_w z_{iw} \sum_{s=k_i+1}^{t} b_{ts}\,(s - k_i) + \sum_w c_w o_w + \sum_i \sum_w z_{iw} d_{iw}$$

The model's mathematical formula for a homogeneous sample is assumed:

$$\min F(y,x) \tag{17}$$

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

$$s.t.$$

$$\sum_{i} x_{ij} = 1 \qquad j \in J \qquad (18)$$

$$\sum_{j} x_{ij} y_j = \sum_{t=l_i}^{|J|} t y_i^t \qquad i \in I \qquad (19)$$

$$\sum_{t=l_i}^{|J|} y_i^t \leq 1 \qquad i \in I \qquad (20)$$

$$z_{iw} \leq o_w \qquad \forall i, w \qquad (21)$$

$$\sum_{w} o_w = 1 \qquad (22)$$

$$\sum_{w} z_{iw} = \begin{cases} 1 & s - k_i > 0 \\ 0 & o.w \end{cases} \qquad \forall i \qquad (23)$$

$$y_i^t \in \{1,0\} \qquad i \in I, l_i \leq t \leq |J| \qquad (24)$$

$$x_{ij}, o_w, z_{iw} \in \{1,0\} \qquad i \in I, j \in J, w \in W \qquad (25)$$

Limitation (18) is the allocation limitation, and indicates that each customer is assigned only one facility and Equation (19) show the relationship between assignment variables and new location variables, or, in other words, ensures that any facility that is deployed can serve a specific customer number.
Unequal (20) shows the minimum number of customers serving each facility deployed and the Limitation (19) and (20) simultaneously ensure that, if an facility is deployed, the number of customers assigned to it is facilitated at least l_i.

3-7- Linearization of the proposed model

What is clear is that the relations (23) and (16) presented in the model are not linear relationships, which increases the time of problem solving and are linear in terms of the nature of zero and the existence of decision variables.

Introducing the variable $\mathrm{yz}_{\mathrm{iw}}^{t} = \mathrm{y}_{\mathrm{i}}^{\mathrm{t}} \times \mathrm{z}_{\mathrm{iw}}$ and paying attention to the fact that:

1. If one of the variables z_{iw} or $\mathrm{y}_{\mathrm{i}}^{\mathrm{t}}$ to be zero, $\mathrm{yz}_{\mathrm{iw}}^{t}$ will also be zero.

2. If both variables z_{iw} and $\mathrm{y}_{\mathrm{i}}^{\mathrm{t}}$ to be one, $\mathrm{yz}_{\mathrm{iw}}^{t}$ are also the same.

3. The new variable $\mathrm{yz}_{\mathrm{iw}}^{t}$ also is zero and one.

Therefore, by adding two following limitation, the relation (16) will be linear:

$$yz_{\mathrm{iw}}^{\mathrm{t}} - \mathrm{y}_{\mathrm{i}}^{\mathrm{t}} - \mathrm{z}_{\mathrm{iw}} + 1.5 \geq 0 \qquad \forall\, i, t, w \qquad (26)$$

$$1.5 yz_{\mathrm{iw}}^{\mathrm{t}} - \mathrm{y}_{\mathrm{i}}^{\mathrm{t}} - \mathrm{z}_{\mathrm{iw}} \leq 0 \qquad \forall\, i, t, w \qquad (27)$$

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

And the following limitation is inserted into the conditional limitation (23):

$$(s - k_i) \geq 1 - (M \times (1 - \sum_w z_{iw})) \qquad \forall\ i \qquad (28)$$

$$(s - k_i) \leq M \times \sum_w z_{iw} \qquad \forall\ i \qquad (29)$$

M is a very large number in the upper limit.

Thus, the limitations (24) to (27) are added to the model and the target function is changed as follows:

$$F(y,x) = \sum_i \sum_t y_i^t f_i + \sum_i \sum_j c_{ij}\, x_{ij} + \sum_w \sum_i \sum_{t=l_i}^{|J|} yz_{iw}^t\, g_i \sum_{s=k_i+1}^{t} b_{ts}(s - k_i) + \sum_w c_w o_w + \sum_i \sum_w z_{iw} d_{iw}$$

With the linearization of the proposed model, it can be obtained in a short and reasonable time to the optimal answer for small-size issues by LINGO optimization software. While, if the same problem is solved in a nonlinear model, it may be possible to reach the optimal solution at a later time or lack of access to the optimal solution by the LINGO software, and we will be limited to the optimal topical answer that is not logical in terms of the answer.

Designed Example

Here's an example consider to better understand the problem behavior. In this example, there are six locations for facility deployment and three locations for the deployment of the center with 15 customers, 12 of which are in demand, for the allocation of facilities. The minimum capacity for facilities (l_i) is equal to one and the maximum capacity of each facility (k_i) is 3. The probability for all customers is equal to 0.7. Other information is given in Table 1 to 3.

Table 1: Parameter values c_{ij}

C_{ij}	Customer j														
Facility i	8	5	3	3	9	8	7	10	5	2	5	4	4	7	4
	8	3	9	7	3	2	2	4	6	4	7	8	8	1	5
	2	9	4	9	5	5	8	4	6	2	6	8	7	5	7
	4	3	5	2	5	2	6	9	9	3	4	8	3	9	4
	3	9	8	9	8	8	7	4	5	7	6	2	7	4	8
	9	1	1	5	8	2	9	3	7	5	9	8	5	7	3
r_j	1	1	1	0	1	1	1	1	1	0	1	1	1	0	1

Table 2: Parameter values for facilities i

	Facility *i*					
g	7	5	7	4	5	2
f	10	12	10	15	15	14

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

Table 3: Parameters of the warehouse

d	Warehouse w		
Facility i	2	4	5
	2	3	4
	3	1	2
	5	4	5
	4	4	2
	2	4	1
b	4	6	7

The code of the proposed model is written using the Lingo software, one of the mathematical programming software then it is solved by the Lingo 14 software and the optimal answer is obtained when the values of the objective function are given in both linear and nonlinear states in Table 4. The results obtained from solving this model are shown in Table 5.

Table 4: Value of the target function

target function	target function value
cost of locating of facility	24
Assignment costs of facility	4/36
Warehouse locating cost	4
cost for warehouse allocation	4
cost of outsourcing	609/6

Table 5: The optimal answer to the problem

Facility	**1**	**2**	**3**	**4**	**5**	**6**
t_i	0	0	6	0	0	9
η_i	0	0	4	0	0	9
Outsourcing	0	0	0	0	0	6
z_{iw}	0	0	0	0	0	1

According to Table (5), out of the 6 existing facilities, facility 2 (3 and 6) has been deployed, which facilitates 3.6 customers and facilitates 6, 9 customer allocated; there are only 3 customer who have 3 requirements for demand, which means 3 customers are not in demand and as we see in row 3, 6 requests are made to facilitate 6 surpluses on its capacity, and the facility should estimate this demand from one of the warehouses. This demand is allocated to warehouse 1 with regard to costs.

Conclusion:

In this research, a nonlinear mathematical model was investigated for locating and allocating facilities and storage in a discrete space with limited capacity and Bernoulli demand. The objectives are to find the optimal location for facility deployment and the allocation of customers to this facility, as well as locating a warehouse from among the candidate locations of central warehouse and allocating facilities to it. So

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

that we can minimize the total fixed costs of the facility and central warehouse, plus the expected cost of service and the cost of outsourcing resources. The proposed problem was solved by Lingo software. Since the software is time-consuming to solve problems of great size, we linearize the proposed model. To evaluate the proposed small dimensional model, we compare the solutions to the Lingo solution and for the large dimensions of the average target function obtained in 10 repetitions. In order to develop the model presented above, the following suggestions can be made in future research:

– Other possible distributions may be considered, such as normal distribution and exponential distribution

– In this study, due to the complexity of the probability distribution of non-homogeneous mode, we considered the homogeneous state of this distribution

Therefore, the problem can be considered in a non-homogeneous state.

– Solve the problem continuously

References:

Almasifard, M., & Khorasani, S. T. (2017). Relationship Between Domestic Production in Agricultural and Industrial Sectors and Purchasing Power by Controlling for International Trade Variables (Iran). *International Journal of Economics and Financial Issues*, *7*(4), 244-253.

Baghalian, A., Rezapour, S., & Farahani, R. Z. (2013). Robust supply chain network design with service level against disruptions and demand uncertainties: A real-life case. *European Journal of Operational Research*, *227*(1), 199-215.

Berman, O., Jaillet, P., Simchi-Levi, D., 1995. Location-routing problems with uncertainty. In: Drezner, Z. (Ed.), Facility Location: A Survey of Applications and Methods. Springer, New York, pp. 427–452.

Çiftçioğlu, S., & Almasifard, M. (2015). The Response of Consumption to Alternative Measures of Financial Development and Real Interest Rate in a Sample of Central and East European Countries. *Journal of Economics*, *3*(2), 1-6.

Ebadian, M., Sowlati, T., Sokhansanj, S., Townley-Smith, L., & Stumborg, M. (2013). Modeling and analysing storage systems in agricultural biomass supply chain for cellulosic ethanol production. *Applied energy*, *102*, 840-849.

Elyasi M., Jafarzadeh H., Khoshalhan F. (2012a) “An economical order quantity model for items with imperfect quality: A non-cooperative dynamic game theoretical model”, LOGISTICS AND SUPPLY CHAIN CONFERENCE, IRAN

Elyasi M., Jafarzadeh H., Khoshalhan F. (2012b) “Hybrid Ant Colony Optimization (ACO) algorithm for no-wait flow-shop makespan” Proc. of the 5th Int. Conference of the Iranian Society of Operations Research, Tabriz, IRAN, pp. 16-17

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

G., Schatka, A., & Spengler, T. S. (2012). Design of regional production networks for second generation synthetic bio-fuel–A case study in Northern Germany. *European Journal of Operational Research*, *218*(1), 280-292.

Hasani, R., Jafarzadeh, H., Khoshalhan, F. (2013) "A new method for supply chain coordination with credit option contract and customers' backordered demand", Uncertain Supply Chain, 1, 207-218, doi: 10.5267/j.uscm.2013.09.002

Hajipour, V., Fattahi, P., Tavana, M., & Di Caprio, D. (2016). Multi-objective multi-layer congested facility location-allocation problem optimization with Pareto-based meta-heuristics. *Applied Mathematical Modelling*, *40*(7), 4948-4969.

Jafarzadeh H., Moradinasab N., Eskandari H., Gholami S. (2017) "Genetic Algorithm for A Generic Model of Reverse Logistics Network", International Journal of Engineering Innovation & Research, 6, 174-178

Jafarzadeh, H., Gholami, S., Bashirzadeh R.(2014) "A new effective algorithm for on-line robot motion planning", Decision Science Letters, 3, 121-130, doi: 10.5267/j.dsl.2013.07.004

Jouzdani, J., Sadjadi, S. J., & Fathian, M. (2013). Dynamic dairy facility location and supply chain planning under traffic congestion and demand uncertainty: A case study of Tehran. *Applied Mathematical Modelling*, *37*(18), 8467-8483.

Khorasani, S. T. (2014, August). Design-Driven Integrated-Comprehensive Model CDFS Strategic Relationships. In *ASME 2014 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference* (pp. V004T06A020-V004T06A020). American Society of Mechanical Engineers.

Khorasani, S. T., & Almasifard, M. (2017). Evolution of Management Theory within 20 Century: A Systemic Overview of Paradigm Shifts in Management. *International Review of Management and Marketing*, *7*(3), 134-137.

Khorasani, S. T., Cross, J., Feizi, R., & Islam, M. S. (2017, May). Application of Lean Tools in Medication Ordering Systems for Hospital. In *Proceedings of the 2017 Industrial and Systems Engineering Conference K. Coperich, E. Cudney, H. Nembhard, eds.*.

Khorasani, S. T., Maghazei, O., & Cross, J. A. (2015, January). A STRUCTURED REVIEW OF LEAN SUPPLY CHAIN MANAGEMENT IN HEALTH CARE. In *Proceedings of the International Annual Conference of the American Society for Engineering Management.* (p. 1). American Society for Engineering Management (ASEM).

Kim, J., Realff, M. J., & Lee, J. H. (2011). Optimal design and global sensitivity analysis of biomass supply chain networks for biofuels under uncertainty. *Computers & Chemical Engineering*, *35*(9), 1738-1751.

Received:15 February 2018/Accepted:18 May/Published:1 June 2018

Maranzana, F.E., 1964. On the location of supply points to minimize transport costs. Operational Research Quarterly 15, 261–270.

Moradinasab N., Amin-Naseri M.R., Behbahani T. J., Jafarzadeh H. (2018) "Competition and cooperation between supply chains in multi-objective petroleum green supply chain: A game theoretic approach", Journal of Cleaner Production, 170, 818-841, doi: 10.1016/j.jclepro.2017.08.114

Mousavi, S. M., & Tavakkoli-Moghaddam, R. (2013). A hybrid simulated annealing algorithm for location and routing scheduling problems with cross-docking in the supply chain. *Journal of Manufacturing Systems*, *32*(2), 335-347.

Rabbani, M., & Yousefnejad, H. (2013). A novel approach for solving a capacitated location allocation problem. *International Journal of Industrial Engineering Computations*, *4*(2), 203-214.

Ramezani, M., Bashiri, M., & Tavakkoli-Moghaddam, R. (2013). A new multi-objective stochastic model for a forward/reverse logistic network design with responsiveness and quality level. *Applied Mathematical Modelling*, *37*(1), 328-344.

Rand, G.K., 1976. Methodological choices in depot location studies. Operational Research Quarterly 27, 241–249.

Roni, M. D. S., Eksioglu, S. D., Searcy, E. & Jha, K. (2014). "A supply chain network design model for biomass co-firing in coal-fired power plants". Transportation Research Part E: Logistics and Transportation Review, 61, 115-134.

Salhi S, Rand GK. The e9ect of ignoring routes when locating depots. European Journal of Operational Research 1989; 39:150–6

Sarkar, B., & Majumder, A. (2013). A study on three different dimensional facility location problems. *Economic Modelling*, *30*, 879-887.

Shabani, N., & Sowlati, T. (2013). A mixed integer non-linear programming model for tactical value chain optimization of a wood biomass power plant. *Applied Energy*, *104*, 353-361.

Silke van Dyken, Bjorn H. Bakken, Hans I. Skjelbred, (2010). "Linear mixed integer models for biomass supply chains with transport, storage and processing". Energy 35, 1338–1350.

TORABZADEH KHORASANI, S. A. S. A. N., & MEMARIAN, M. (2012). Integrated and comprehensive study of design driven innovation added value.

Zhang, F., Johnson, D. M., & Johnson, M. A. (2012). Development of a simulation model of biomass supply chain for biofuel production. *Renewable Energy*, *44*, 380-391.

Zhang, W., Ma, Y., Wang, C., Li, S., Zhang, M., & Chu, F. (2013). Preparation and properties of lignin–phenol–formaldehyde resins based on different biorefinery residues of agricultural biomass. *Industrial Crops and Products*, *43*, 326-333.

Received:15 February 2018/Accepted:18 May/Published:1 June 2018