



Application of Queuing Theory for Locating Service Centers by Considering Provides Several Service in That

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Abstract

One of the factors contributing to the success of the service centers to provide high quality services to customers can be short waiting time for customers to receive service and quick access to a service center for the service is licensed under. In this paper, a model for locating service centers stated that its goal is to minimize travel time and waiting for customers to receive service. The main purpose served by assuming diversity is followed. Serving a variety of different means of providing some kind of service each type of service in each service center is a different and independent. Since most service centers will provide some kind of service, diversity is supposed to serve many applications and makes precise location of choice for service centers and service providers to choose the number of each type in each center. The proper selection of these two cases, it is very effective in enhancing the quality of service to customers. The problem with this objective and key assumptions, modeling and meta-heuristic algorithms and solving community dispersed particles is investigated.

Keywords: Location, queuing theory, service diversity, quality of service, distributed particle swarm algorithm

1. INTRODUCTION

Locating service centers of the most important management decisions to improve customer service quality is considered. For determining the appropriate location for service centers improve the quality of service to customers. In other words, shorter time to reach the source of the customer service center and a shorter time to get the service they spend, these factors increase the service quality of these centers will attract more customers. In the past, these things were modeled assuming constant demand and service times and one of these models can be modeled as P- middle of Hakimi [1] cited. However, this assumption makes the most out of the service in the face of demand, queuing and congestion. Resulting in more accurate modeling of these problems, demand and customer service can be considered random queuing systems follow the rules. These applications can be used to locate the bank and ATM locations, health centers and stores mentioned. There is an extensive literature on this subject. Berman et al [2] algorithm for optimal positioning of a service provider network congestion queuing system M/G/ 1 provide. Then Berman et al. [3] the algorithm to find the optimal location of servers in the network P swarm develops. Wang et al [4] examined the issues of locating a service center server queuing system M/M/1 pay. The model aims at reducing the total travel time and average waiting time of customers to the service center.

Bremen and Zvi Drezner [5] and Aboolian et al [6] developed the model and the problem of locating multiple servers to service centers in stochastic modeling and solving them. Thus the model with queuing system M/M/m queuing system is instead of M/M/1 model. Customer service center nearest you elect to receive service. In this paper an innovative problem solving and meta-heuristic algorithms are used. Baffi et al. [7] the full overview article on locating service centers in random environment with service providers offering fixed. Tammy Drezner

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and Zvi Drezner [8] to locate service centers deal with multiple servers. The allocation of customers to the center of gravity location-based service centers, service and customer interests are all customer demand node allocation cannot find the service center nearest you.

Pasandideh and Niaki [9] model, the objective is to reduce the total time to get the service that customers spend and the unemployment rate is presented providers. The problem with queuing system M/M/1 model and using the utility function and the genetic algorithm solve the problem. Seif Barghi et al [10] model for locating service centers from a client perspective queuing system M/M/m expressed each sensor measures the distance from the center where customers and service providers of the service centers are allocated. The objective is to minimize the average queue length. Their meta-heuristic algorithms solve their model of genetics and their gradual freezing.

In all of the above it is assumed that at each service center is only one type of service provided. If you have more service centers in several different types of service provided and some of the waiting queue. For example, a gasoline service stations may be different types of conventional gasoline fuel, supercharged gasoline and diesel offer, or a specialist clinics that exist in each specific patient is waiting for her. Service of the waiting time, service rate, the demand for the service, the coefficient of efficiency, cost and the total number of servers are different and the differences in management decisions in selecting appropriate locations for service centers and determine the number of servers are very effective and need to be considered. These two are the right choice, quality service to customer's increases. In this paper, a new model for improving the quality of service to customers in the selection of a suitable location for service centers expressed and given the diversity of the service has been modeled. This is done by assuming some kind of service in each center, the goal is to minimize the total travel time and waiting customers that the most important factor in customer satisfaction with the quality of the service is paid. Customer service centers are allocated based on the distance from the center, the center of gravity location and service providers as possible have been done. The problem with taking this model and particle swarm algorithm with sparse (PSO) has been solved. The results of the review are the continuation of this paper is the following: In Section 2, a description that includes modeling and problem-solving method with PSO algorithm is expressed. In Section 3, an example of the results of the model is presented in Section 4. Finally, conclusions and recommendations for future research are suggested.

2. DESCRIPTION OF THE METHOD

In this section we describe the notations and modeling problem and then solving method will be explained in detail.

Modeling a network with N nodes ($N = \{1, \dots, N\}$) is studied and network nodes are nodes that represent both the demand and represent potential sites for locating centers are being served. Edge of network paths between nodes in the network may be expressed. The $M = \{1, \dots, M\}$ denotes the set of various service is done at each service center.

The following assumptions were used in the modeling problem:

- Any customer service requests, the Poisson process with independent random variables.
- Each service center at least one service provider to service time is exponential.
- The service center may offer more than one type of service that is independent of each other.
- Each service center for queuing system M/M/acts (k indicates the type of service and service location j.).
- Location servers is fixed.

2.1 notations and modeling problem

Symbols and the following variables have been used in the modeling problem:

The mathematical model is defined by the above symbols are placed as follows:

$$\text{Min } Z = \sum_{k \in M} \sum_{j \in N} \sum_{i \in N} \lambda_j^k t_{ij} + \sum_{j \in N} \sum_{k \in M} \lambda_j^k w_j^k(1) \quad \text{s.t.}$$

$$\lambda_j^k = \sum_{i \in N} h_i^k x_{ij}^k ; \forall j \in N , \forall k \in M(2) \quad \sum_{j \in N} m_j^k = P^k ; \forall k \in M(3)$$

$$x_{ij}^k = \frac{m_j^k A_j e^{-\gamma t_{ij}}}{\sum_{j \in N} m_j^k A_j e^{-\gamma t_{ij}}} ; \forall i, j \in N , \forall k \in M \quad (4)$$

$$w_j^k = \left(\frac{1}{\mu^k} \right) + \left(\frac{\mu^k \left(\frac{\lambda_j^k}{\mu^k} \right)^{m_j^k}}{(\mu^k - \lambda_j^k)^2 (m_j^k - 1)!} \right) \left(\frac{1}{m_j^k!} \right) \left(\frac{\lambda_j^k}{\mu^k} \right)^{m_j^k} \left(\frac{\mu^k m_j^k}{m_j^k \mu^k - \lambda_j^k} \right) + \sum_{r=0}^{m_j^k-1} \left(\frac{1}{r!} \right) \left(\frac{\lambda_j^k}{\mu^k} \right)^r)^{-1} ; \forall j \in N$$

, $\forall k \in M(5)$

$$t_{ij} = \frac{d_{ij}}{v} ; \forall i, j \in N(6)$$

$$\frac{\lambda_j^k}{\mu^k m_j^k} \leq R ; \forall j \in N , \forall k \in M(7)$$

$$m_j^k \leq P^k y_j ; \forall j \in N , \forall k \in M(8)$$

$$\sum_{k \in M} m_j^k \geq y_j ; \forall j \in N(9)$$

$$m_j^k \geq 0 \text{ and integer} ; \forall j \in N , \forall k \in M(10)$$

$$y_j \in \{0,1\} ; \forall j \in N(11)$$

2.2 dispersed particle swarm algorithm (PSO)

The problem of integer linear programming model and exact methods for solving it, especially it is large enough, it will be very time consuming. Bremen and Drezner [5] Aboolian et al [6] to solve the problem of locating service centers with multi-service provider of innovative and meta-heuristic algorithm is used. In this paper, the meta-heuristic algorithm is used to solve community dispersed particles or PSO. PSO algorithm by Kennedy and Eberhart [12] was introduced. The algorithm is inspired by the natural social life, such as social housing batch of fish and birds that have been useful in solving many problems.

The population of the location and direction of the particles are randomly generated. In successive iterations of the algorithm, each particle location and direction based on the inertia of the motor, the best personal experience or the experience of those categories and other bits of information are regulated. In this paper, the objective function is the fitness function that specifies the location of each particle size to what is good.

The overall direction and location of each particle can be determined by the relation (12) and (13) in the following terms:

$$\vec{v}_{k+1} = \vec{w}_k \cdot \vec{v}_k + c_1 \cdot \vec{r}_1 \cdot (\vec{p}_1 - \vec{x}_k) + c_2 \cdot \vec{r}_2 \cdot (\vec{p}_2 - \vec{x}_k)(12)$$

$$\vec{x}_{k+1} = \vec{x}_k + \vec{v}_{k+1} (13)$$

It should be noted that the inertia coefficient at iteration of equation (14) comes to hand:

$$\vec{w}_{k+1} = \vec{w}_k \times \text{wdamp}(14)$$

In equation (14), wdamp inertia coefficient is reduced. Since the inertia coefficient (w) for large global search and local search is used for small inertia coefficient, it is better to gradually reduce the ratio of inertial to start a global search is done and gradually goes to the local search. Therefore, the overall design of meta-heuristic PSO algorithm to solve the model used in this article, as follows:

- Step 1. Initialization: Generate random population of particles with location and direction.
- Step 2. Assessment: The fitness functions for each particle count.
- Step 3. Comparison: The fitness function of each particle with the best fitness function value compared to its previous iteration.

If the new location of the fitness function better chooses the best personal experience otherwise the same point in the previous iteration is selected as the best personal experience. As well as the fitness function of each particle with the best experience of those in the previous iteration compare. If you have a little bit more elegance, class and choose the best experience, otherwise the experience category remains unchanged.

Step 4. Convergence: The algorithm stops if the condition is not improving fitness function in several successive iterations of the algorithm, established, stopping. Otherwise, go to step 5.

Step 5. When the values of inertia, the movement and position of each particle by the relations (14), (12) and (13) into account and go to step 2.

PSO algorithm in this paper is a response to $M \times N$ matrix shown where the rows of the matrix, the number of different types of service and columns of the matrix, the number of potential sites for placement service center in it. Matrix elements are corresponding to the number of service providers and service locations. If all entries in a column are zero, ie, the node service center has been established. Figure 1 shows a typical four-node solution with three types of service and location shown where, in all nodes except the second node, the service is constructed.

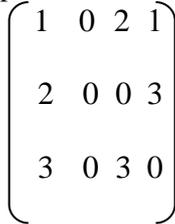


Figure 1. An example of a solution

In the proposed PSO algorithm, due to the limitations of the model may be infeasible solutions generated. The penalty function method is used in the treatment of intractable answers. Functions outside one of the most popular methods deal with the problem with constraints. For example, a limitation on the penalty function $g(x) \leq b$ in equation (15) is added to the objective function.

$$P(x) = U \times \text{Max} \left\{ \left(\frac{g(x)}{b} - 1 \right), 0 \right\} \quad (15)$$

Where U is a large positive value. If the answer satisfies the constraints generated the amount of the fine or P (x) is zero, otherwise the penalty is equal to a positive number. In fact, using a penalty function approach to issues of limitations issues become unrestricted this strategy is particularly useful in solving problems of optimization with constraints. In the next section some numerical examples of the model with the proposed PSO algorithm are given.

3. COMPUTATIONAL RESULTS

For example, the numerical evaluation of the proposed solution is evaluated. For example, computational results for 10 different sizes with the proposed PSO algorithm are given in Table 1. Values of nodes (N), types of service (M) and the total number of service providers of any kind are assumed equal ($P = P_k, k \in M$), for each example are given in Table 1. The values of other parameters of the problem are as follows:

- The rate of demand for the service of any kind, following a uniform distribution function, namely $[15, 1]$ uniform $\sim h_i^k$
- Rate of service of any of the following uniform distribution function, ie, $[80 \text{ and } 50]$ Uniform $\sim \mu^k$
- Travel distance between two nodes of a uniform distribution function obeys the $[100, 50]$ Uniform $\sim d_{ij}$
- Ten times the speed between two nodes is assumed, ie $10 = v$
- The attractiveness of each node to reference customers following a uniform distribution function, ie $[1, 0]$ uniform $\sim A_j$
- The maximum productivity rate was assumed to be equal to 0.9, the $R = 0.9$
- Distance equal to a constant parameter of the exponential function is assumed, ie $1 = \gamma$

PSO algorithm parameter values, for example, in the example of three tables 1 to 10 knots and 3 types of service, the performance of the sequential algorithm to values of $0.9 = w$, $0.99 = wdamp$, $4 = C1, 2 = C2$, and the maximum number of particles = 10 reps without continuous improvement in the objective function value = 10 is set. In Table 1, the value of the objective function (Z) and the second time the issue has been resolved.

Table 1 Examples of calculation results with PSO algorithm

No	N	M	P	Z	The solution (s)
1	2	1	1	121.8807	1.9670
2	5	2	3	1728.7009	2.9934
3	10	3	5	16664.4746	4.1425
4	20	4	10	83267.6776	5.3738
5	30	5	15	250734.7776	10.5915
6	50	6	25	810134.7916	19.8663
7	70	7	35	1882121.9692	26.9244
8	80	8	40	2887831.2624	40.7274
9	100	9	50	5240233.3339	68.4662
10	200	10	100	23063446.5193	314.1700

The proposed PSO algorithm convergence diagram is shown in Figure 2. Example # 6.

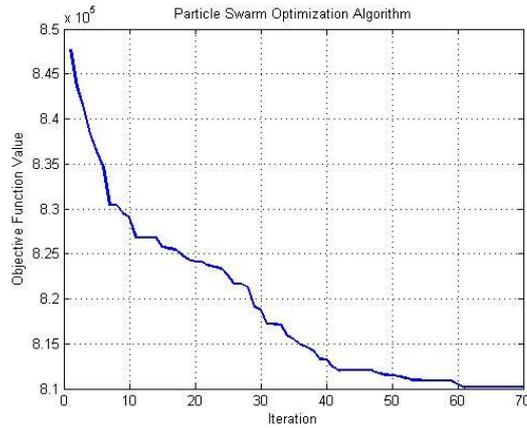


Fig. 2. Convergence history

The results of numerical examples of different sizes in Table 1 show PSO algorithm for solving nonlinear model is fit and able to respond in the desired time is achieved. All of the examples in Table 1, the duration of less than six minutes have been resolved. For example, the values of variables, for example 2 to 5 potential locations (nodes) and 2 types of service is given in Table 2.

Table 2. The values of the instance variables (2)

Variable values	Variable ame
[0 1 0 1 0]	<i>y</i>
0 1 0 2 0	<i>m</i>
0 1 0 2 0	

Variable values are expressed in Table 2 show that management decisions to improve the quality of service to customers in order to establish service centers in locations 2 and 4 is shorter travel time to reach the customer service center to spend. Management decisions related to the number of service providers is located in the center at locations 2 and 4 for improving the quality of customer service that reduces the waiting time for the service includes:

- Position 2: 1 and 1 service provider of a service provider
- Position 4: 2 and 2 servers of one of the two servers.

With this decision, the total travel time and waiting for customers to get the service to a minimum, or even to be close. It improves the quality of customer service and customer satisfaction is considered one of the most important factors. PSO algorithm programming with MATLAB [13] edition 2010 on a notebook with 4GB of memory and processor 2.30 GHz is done. In the next section, the conclusions derived from the location of the service diversity expressed.

4. CONCLUSIONS AND SUGGESTIONS FOR FUTURE:

In this paper, a new model for improving the quality of service to customers in locating appropriate service centers stated that serves a variety of modeling assumptions have been means that each service center may be a different type of service provided. Serve a variety of important issues in service centers is very high. Since most service centers in more than one type of service provided and some of the waiting queue. Different criteria are different for the different service given the diversity of the service, the goal is to minimize the total travel time customers expect that the most important factor in customer satisfaction and service quality is the center, deals with the allocation of customer service centers based on the distance from the center, the center of gravity location and service-providers of the service is done. This makes the ratio of the population in each demand node assigned to a service center.

Application of Queuing Theory for Locating Service Centers

The result is an integer linear model and meta-heuristic PSO algorithm was used to solve the problem.

Computational examples show the results of different sizes this algorithm can solve the model at the right time and in sizes small to be a good answer.

Travel time and waiting for customers to receive service from the most important factors is the quality of customer service, improved.

For future research, the following are recommended:

- Budget constraints are added to the problem.
- Providers of different rates at different times have different service.
- Instead of queuing system M/M/m, other queuing systems can be used.
- Some parameters it can be assumed that phase.

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