ISSN: 2414-1895 DOI: 10.6919/ICJE.202009_6(9).0035

Study on Location Selection and Optimization of Logistics Center based on Particle Swarm Optimization

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Abstract

In the entire logistics system, the location of the logistics distribution center is very important. Optimizing the logistics distribution center can achieve the advantages of low operating costs, high transportation quality, and improved management efficiency. Therefore, to solve the problem of logistics distribution center location, particle swarm algorithm is used to select the location of the distribution center, and the solution is compared with the traditional location method. Through case analysis, particle swarm optimization has unique advantages in terms of optimization effects, and can optimize the choice of distribution center location to achieve the optimal objective function.

Keywords

Logistics, Distribution location, Particle swarm optimization.

1. Introduction

With the increasing maturity of the domestic e-commerce industry, the logistics industry also presents an explosive growth.Logistics is the intermediate link between manufacturers and consumers, is the necessary link to carry out time and space transfer of goods.As logistics cost is always an important part of enterprise cost, how to reduce logistics cost and improve distribution efficiency has become an urgent solution for various countries and industries.Research of logistics distribution center location selection can directly affect the quality of goods distribution costs, the effects of service, and distribution as a result, choose a good distribution center location, can minimize logistics cost, increase profit, improve customer trust, more can improve the operation efficiency of logistics system, improve the utilization of social resources.It can be said that the location of logistics center has a very important research value [1].

There are many research methods in academic and logistics field about the location of logistics center.Some scholars consider the influence of a single variable, such as the minimum sum of distance between logistics center and demand point;The other is a reasonable distribution of distribution center distribution scope;Still have to consider the relationship between traffic volume and distance to determine the distribution center.Feng[2] et al. proposed a OPTICS clustering algorithm in a more innovative way. The algorithm has a clustering density that can be adjusted and the parameters required by different data can be flexibly adjusted. However, due to its complexity, the running time and efficiency of the algorithm have drawbacks.Shi Hongyu [3] adopted the two-stage method to select the location of logistics park from the perspective of industrial cluster, and determined the location scheme.Li Shuang and Pan Xiu [4] applied DEA and AHP models to logistics location selection, selected scheme coefficients with DEA and ranked them with AHP method, and simply established the site selection scheme of logistics distribution center.In terms of green logistics, Fang Wenting [5] considered the mathematical model of path selection with the lowest total cost and

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adopted the hybrid ant colony algorithm based on the global convergence of A* algorithm and the positive feedback construction of ant colony algorithm, but the algorithm had premature convergence.Zhao Gang et al. added the comprehensive weight value jointly determined by the distribution time of logistics transportation and the distribution time and demand, and set up different distribution centers in the region, and carried out simulation through MATLAB, further verifying the feasibility of the immune algorithm [6].Of course, there are also many scholars who conduct logistics site selection by integrating with other algorithms, such as the combination of particle swarm optimization algorithm with immune algorithm, genetic algorithm and artificial bee colony algorithm [7].

Based on particle swarm optimization (PSO), this paper analyzes the location behavior of logistics center, and considers the factors of distance, cost and demand in the distribution process to ensure the rationality of the location of logistics center.Based on particle swarm optimization (PSO) and traversal search (ERGOc), a comparative analysis was conducted to verify the effectiveness of the proposed center site selection method, and Java was used for the simulation verification of logistics center site selection.

2. Site selection Method

At present, there are many types of distribution center site selection models, which can be divided into single site selection and multi-objective site selection according to the number of sites.

According to the discrete degree of site selection, it can be divided into continuous and discrete site selection method.

There are also dynamic and static siting methods divided according to time continuity.

With the increase of the dimension of the problem and the model, it is difficult to deal with the traditional mathematical solution, so it is necessary to optimize the modeling to solve the problem.

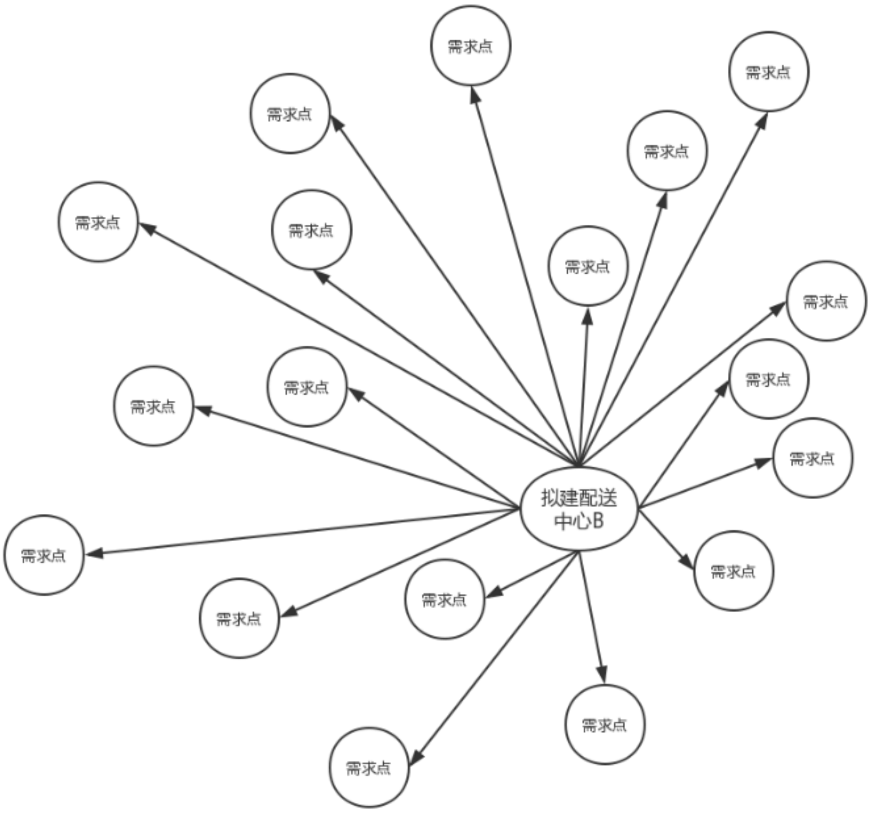

Fig. 1 Relationship between distribution center and demand point

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3. Logistics distribution center location selection model

3.1 Distribution center cost analysis

The location of distribution center plays a key role in logistics distribution. A logistics center not only needs to consider the delivery cost, but also needs to consider the delivery distance and customer satisfaction, so as to meet the actual needs of modern logistics distribution center.

The cost of logistics distribution center can be divided into construction cost, storage cost, transportation cost, etc.

Reasonable assumptions should be made for this model:

1). You need to know the annual demand for each demand point.

2). Transportation costs in the process of transportation.

3). The distribution speed of each distribution center is relatively constant and there is no difference.

4). There is no long-term inflow than outflow in the distribution center.

3.2 Logistics center location problem model

As can be seen from the above figure, the location of logistics distribution center is selected according to the known location coordinates of the customers and the distribution demand of the required goods, so as to optimize the objective function needed by the logistics distribution center.

The objective function is

$$\min \sum_{i=1}^{n} \sum_{j=1}^{q} t_{ij} q_j d_{ij} \tag{1}$$

Where, t_{ij} is the transportation cost between two points, q_j is the annual demand at Demand point J, and d_{ij} is the distance between the proposed location and demand point J.

4. particle swarm optimization

Particle swarm optimization (PSO) is an iterative optimization tool created by Dr. Eberhart and Dr. Kennedy based on the study of bird flock predation behavior. By initializing a set of random solutions and searching for the optimal value through iteration, PSO has been successfully applied in functional optimization, scientific planning, artificial intelligence and other fields so far [8].

The PSO algorithm first initializes a group of random ions, and then the particles follow the current optimal ions to search for solutions.

Assume that the velocity position of the ith particle in the D-dimensional space is $Xi = (xi1, xi2, xi3, \cdots xi4)$ and $Vi = (vi1, vi2, vi3, \cdots vid)$, in each iteration, the particle updates itself by tracking two optimal solutions, of which Pbest is its own optimal solution $Pi = (pi1, pi2, pi3 \cdots pid)$ and the other is the population optimal solution Gbest, and its velocity and position are updated according to the following formula.

$$V_{ij}(t+1) = WV_{ij}(t) + c_1 r_1 [p_{ij} - x_{ij}(t)] + c_2 r_2 [p_{gj} - x_{ij}(t)] \tag{2}$$

$$X_{ij}(t+1) = X_{ij}(t) + V_{ij}(t+1), j = 1,2,\cdots,d \tag{3}$$

Where, W is the inertia weight factor, c_1、c_2 is the positive learning factor, and r_1、r_2 is the random number uniformly distributed between 0 and 1.The number of particles is generally determined by the complexity of the problem. In general, very good results can be obtained within 20~50 for the general problem. For simple problems, about 10 particles can be used, while for

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complex problems, more than 100 particles can be used for solving. Dimensions are generally based on the dimensions of the solution to the problem. The maximum particle velocity is generally set not to exceed the range width.

The learning factors C_1 and C_2 are usually 2, usually equal and within the range of 0~4.

5. Case Application

Suppose there are 50 demand points B0~B49 to be distributed in the logistics network of a certain region, and it is necessary to select a location near these 50 points or among them for the construction of logistics center.

Due to the lack of information between logistics points, the software was used to directly generate 50 random data points as demand points, and randomly generate coordinates and demand.

The annual demand and distribution locations of the 50 demand points are known, and the solving parameters are shown in the following table.

Table 1 Coordinate of demand point, transportation cost and quantity demanded

Number	X coordinate	Y coordinate	Cost	Demand	Number	X coordinate	Y coordinate	Cost	Demand
0	57.32028408	38.062483	0.204878104	0.796032509	25	86.38534043	85.47510205	7.942346784	54.96445124
1	96.31471297	84.24528942	3.197318977	96.90967382	26	72.46018764	94.74544417	0.689484727	65.76526251
2	29.57841491	59.75011276	5.940225603	83.52030001	27	1.34960567	52.23982847	6.755011245	28.18795506
3	50.02882139	4.877948269	2.617112926	90.52666663	28	88.17269564	16.86838428	6.146731371	97.40708513
4	27.00764587	81.39921538	3.198451872	47.62375397	29	58.50098217	2.771377644	3.16364911	78.08192389
5	92.78875571	79.68354531	8.731212905	14.40101312	30	66.95314507	56.27932256	9.830161441	73.83278461
6	26.26491909	46.71123173	8.483033167	66.45450278	31	94.8332584	15.8510419	7.26772498	43.47424434
7	36.84276384	44.08821522	9.405501993	11.31868233	32	29.25114536	44.29370428	8.708708409	7.562276337
8	63.45594157	67.1269043	3.719754185	76.74262062	33	7.058037723	72.47080016	7.735295473	62.48076082
9	44.45815844	5.611571626	0.300346963	25.53906013	34	72.74974733	46.98888545	7.720692521	34.708785
10	81.08585457	82.70957195	2.065561631	26.71944244	35	55.48828136	23.41929962	7.576525726	74.38284856
11	15.02558182	48.70546147	2.565040285	25.90509762	36	21.72044254	53.96913181	7.819839099	90.98948608
12	74.90704346	82.83961852	1.302793347	0.1026833	37	66.61766339	32.25275769	3.324840263	53.75174896
13	28.0964423	60.28968936	1.43989967	98.89277477	38	34.85530912	26.39144939	7.008375927	0.111101288
14	15.19756614	79.04433793	8.69746724	76.57992579	39	13.72860591	48.91654549	8.976197115	54.33642422
15	90.5151496	43.4642405	5.885680449	2.398934626	40	39.57754033	9.571462109	0.896453384	10.53832282
16	35.33092638	15.82329988	9.12694639	51.88819378	41	47.1126687	18.33637802	4.996084145	65.39722541
17	64.14163804	91.01552656	8.843510446	49.99342441	42	80.55072506	36.59464969	3.854320666	23.92890836
18	15.77959086	27.46303425	7.790500504	8.200706479	43	0.487125128	10.0525535	4.460350003	44.64768685
19	25.44629988	79.37795895	1.118190438	9.94879917	44	5.879487243	75.36573103	8.26586154	39.08223408
20	85.52363908	9.877439593	1.264549502	6.471343171	45	79.41289015	73.2966786	5.86315067	20.96924042
21	81.94338622	66.21463852	9.163405023	98.54203318	46	41.25821311	68.71660615	9.259858868	72.34321142
22	13.77174019	34.61094663	9.858380265	53.14325706	47	49.85250658	23.26994147	8.277169645	54.80262454
23	70.28800568	11.96603238	3.125168346	28.88708846	48	85.57804771	56.08059937	9.610666166	15.58201563
24	49.16018495	33.43769076	4.581133817	49.62751746	49	7.914134359	79.48752034	5.87810163	21.97664357

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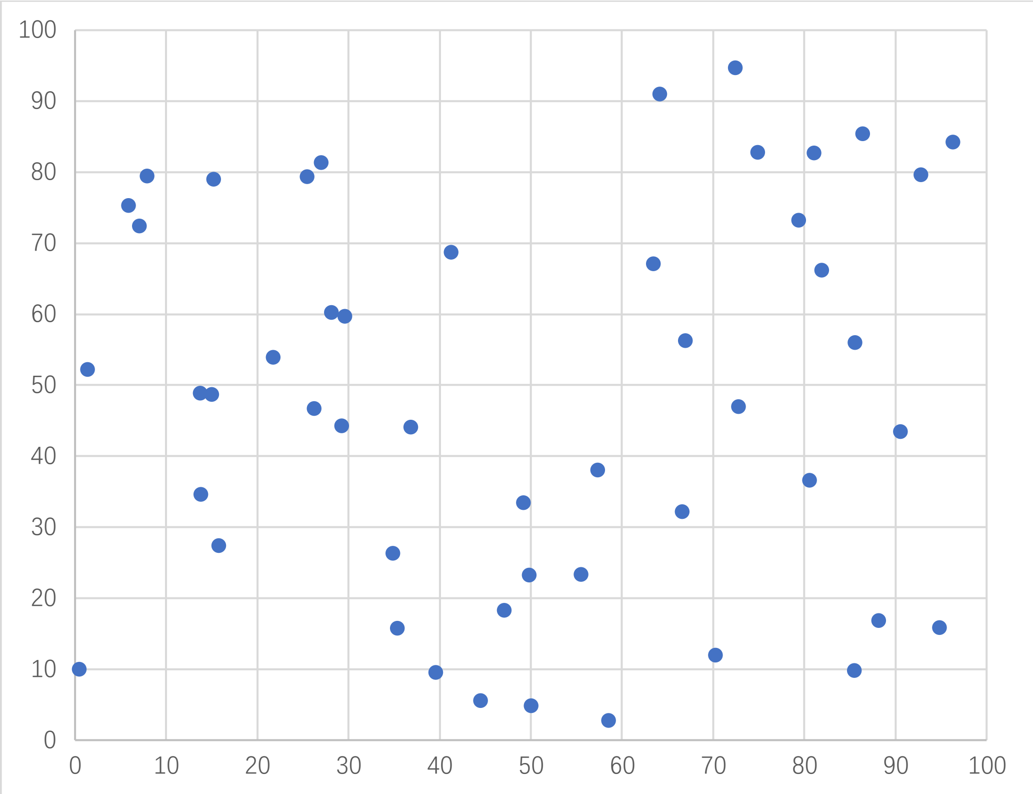

Fig. 2 Coordinate diagram of the location of requirement points

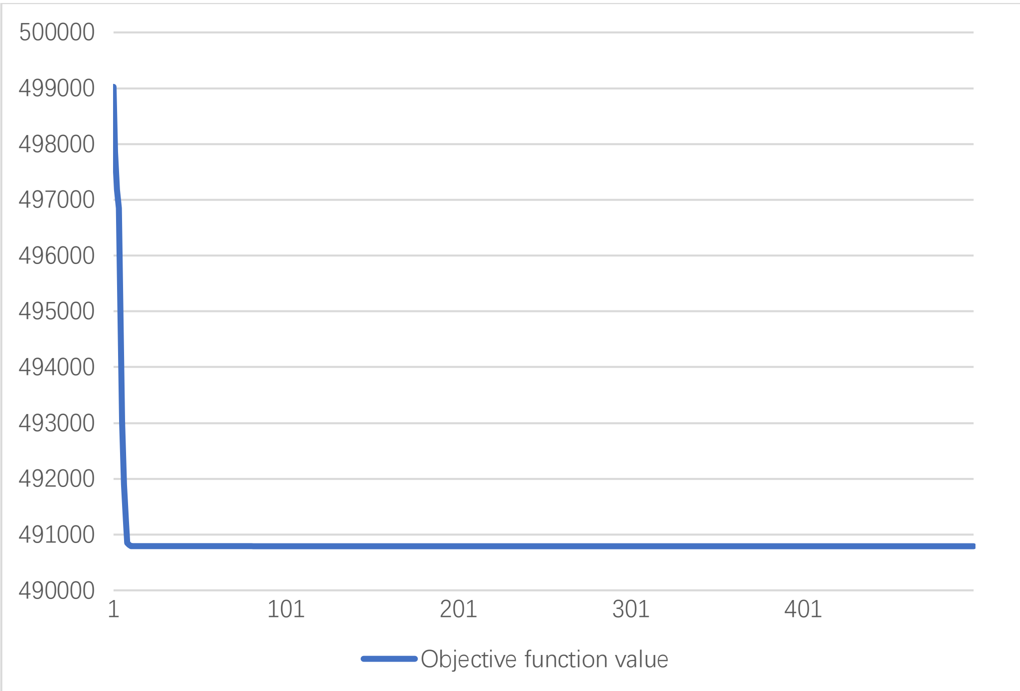

Fig. 3 Changes of the objective function after iteration

Put the data into the algorithm, adjust each parameter in the algorithm, set the number of particles 20, iterate for 500 times, C_1 = C_2 =2, W =1.4.

The following results are obtained: At the point position (43.43021233, 50.89621711), the value of the objective function is 490790.5151. When using traversal search, the following results can be obtained: The minimum target value is 2, and then the minimum target value is 506428.73625039245.

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It can be seen that PSO algorithm has better calculation results in solving logistics site selection, and the value of objective function obtained by solution is also better than that obtained by direct solution.

6. Conclusion

In the thorough analysis on the basis of research on logistics distribution center location planning problem, established the mathematical model of logistics distribution center location, introduces the particle swarm optimization (PSO to solve the problem of the optimal solution, the empirical results show that PSO algorithm can reduce the iteration times and time, and can improve the optimization precision of location selection problem, reduce the total cost of logistics distribution center.Article in the Java language software set up calculation model easy to understand, can get ideal result, and has set up the model has generality and similar engineering problems can be through the change of part of the statement can solve, especially for large complex network, it can play a greater advantage, is well worth wide application in the logistics field.

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