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Research on solid waste disposal site selection model based on Genetic algorithm

Eryin Zhang

University College Dublin

eryin210815@163.com

Abstract: In the development of social and economic construction, the excessive shortage of resources and the serious pollution of ecological environment and other problems directly affect the basic goal of sustainable development. Especially after entering the development trend of economic globalization, although a variety of high-quality resources have been stored and developed, there is a serious waste of resources in the practice development, which cannot give full play to the application value of various resources. Therefore, scholars in various fields have strengthened their research on related topics. Urban solid waste not only affects the stability of the ecological environment, but also limits the application efficiency of various resources. Therefore, how to deal with urban solid waste scientifically and give full play to the application value of various resources in the recycling is the main problem of scientific research and discussion at present. In this paper, on the basis of understanding the research status of solid waste disposal, the use of genetic algorithm to build a solid waste disposal location model. The final experimental results show that the design model is feasible and the genetic algorithm can improve the accuracy and effectiveness of data calculation.

Keywords: Genetic algorithm; Solid waste; Mathematical model; Deal with site selection; Sustainable development

1. Introducion

Solid waste refers to the final products of human life, mainly including beverage containers, glass, old newspapers and books, packaging, sludge, household appliances and other contents. According to the actual investigation and research, the world every year more than 10 billion tons of solid waste, of which urban solid waste accounts for a large proportion. Especially with the acceleration of urbanization and the increasing number of residents, the production and emission of municipal solid waste will also increase. For example, in 2003, the amount of urban solid waste removal reached 146 million tons, and in 2010 it increased to 5.5 tons. It is expected that the annual increase of solid waste will reach 150 percent by 2030. Now, when processing municipal solid waste, the main channels such as resource reclamation, pollution control and ecological environment protection are selected. At the same time, the United States, Germany, Japan and other countries study and manufacture advanced technology equipment, put forward relevant laws and regulations on solid waste disposal industrialization development, and formulate preferential policies to encourage and support the industrialization development. We will gradually improve the efficiency of the utilization of solid waste resources, and scientifically ease various pressures on the ecological environment. As a country with the most successful solid waste industry development, Japan divides solid waste into seven types and hands the practical management work to the environmental protection department. Almost no waste will be discharged into the natural environment, basically achieving the development goal of zero emission.[1-3]

In the era of big data, the development level of social economy and science and technology is getting higher and higher. In the face of the contradiction and conflict between man and nature, reasonable recycling and use of waste materials has become the basic way to control production costs and market reform and development, while reverse logistics is an effective measure to solve the shortage of resources. Nowadays, when studying reverse logistics network, scholars in various countries pay more attention to the recycling of items with useful value, and few people pay attention to the solid waste which has no useful value. At the same time, facility location, as the

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core content of reverse logistics network operation, directly affects whether the logistics network can run continuously and stably. Therefore, when considering solid waste disposal in the new era, intelligent algorithm and software technology should be used to build a solid waste disposal location model, so as to provide an effective basis for practical development. For example, some scholars proposed to use linear programming model to determine the construction location of transfer station. After collecting route information of a certain region, some scholars regard the minimization of transportation cost as the objective function, and then use mixed integer programming to calculate and analyze the optimal parameter information such as the number and location of transfer stations. When studying the status and role of refuse transfer station, some scholars used practical cases to comprehensively explore the practical significance of building and developing refuse transfer station under the condition of a certain transport distance. After putting forward the theory of artificial intelligence technology, intelligent algorithms represented by neural network and genetic algorithm play an important role in the design of location selection model. Among them, genetic algorithm, as a computational model simulating Darwin's biological evolution, was first proposed in the early 1960s. After entering the 1990s, it has been widely used in the research fields of robotics, image processing, production planning, automatic control and so on. This kind of algorithm can be encoded to form an initial population, operate individuals in the population according to the environmental fitness, and finally achieve the processing goal of survival of the fittest. From the point of view of optimization search, genetic manipulation can optimize the solution of the problem generation after generation and approximate the optimal solution. Therefore, on the basis of understanding the research status of solid waste disposal site selection at home and abroad in recent years, this paper uses genetic algorithm to build the corresponding mathematical model, combined with practical cases, to explore the effectiveness of the application algorithm.[4]

2. Method

2.1 Analysis of solid waste logistics

According to the laws and regulations of solid waste prevention and control of environmental pollution, solid waste refers to the solid and semi-solid waste materials produced in production, construction, daily life and other activities that pollute the environment, such as spoiled food, human feces, glass waste, plastic waste, construction waste, mining waste, animal carcass and so on. According to the analysis of the logistics term put forward in our country, solid waste logistics refers to the goods that will lose their original value in economic activities, according to the actual demand for collection, processing, packaging, storage and other basic treatment, respectively transported to the special treatment plant. The specific operation process is shown in Figure 1 below:[5-7]

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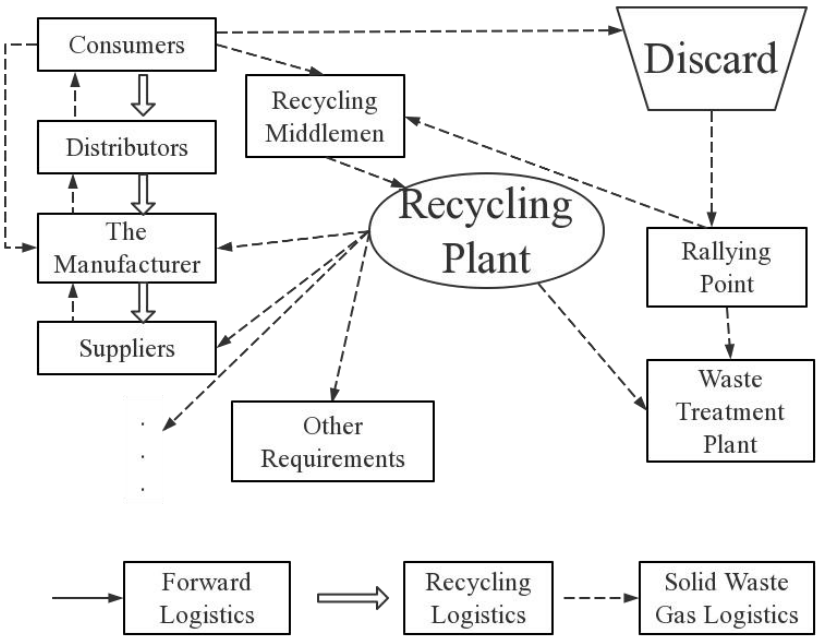

Figure 1 Flow chart of solid waste logistics

2.2 Facility Location

This problem was first put forward by Torrice scholars in order to minimize the Euclidean distance between customers and service facilities. In this paper, the location, quantity, capacity and other information of solid waste treatment stations will be determined from the candidate addresses, which can not only effectively control the expenditure of fixed investment and operating costs, but also improve the ecological environment of the city. According to the analysis of solid waste disposal site selection in recent years, there are many factors affecting equipment site selection, which can be divided into two aspects: on the one hand, external. From the economic point of view, we should focus on transportation costs, labor costs, energy supply costs, land use costs and other content; From the political point of view, we should focus on the analysis of urban planning, preferential measures, legal provisions and other content; From the perspective of natural environment, it is necessary to integrate the research of water supply and drainage conditions, geographical location, climate change, terrain conditions and so on. On the other hand, the interior. From the perspective of social environment, we should study people's living habits, living standards and other contents; From the logistics scale and distribution of logistics nodes, it is necessary to ensure that the distribution of all kinds of logistics facilities meet the transportation needs. From the point of view of logistics facility cost expenditure, we should give full consideration to transport costs, construction costs, processing costs and other contents.[8-11]

2.3 Site Selection Model

Combined with the analysis of solid waste reverse logistics network structure shown in Figure 2 below, it can be seen that the following assumptions should be determined when building the corresponding mathematical model:

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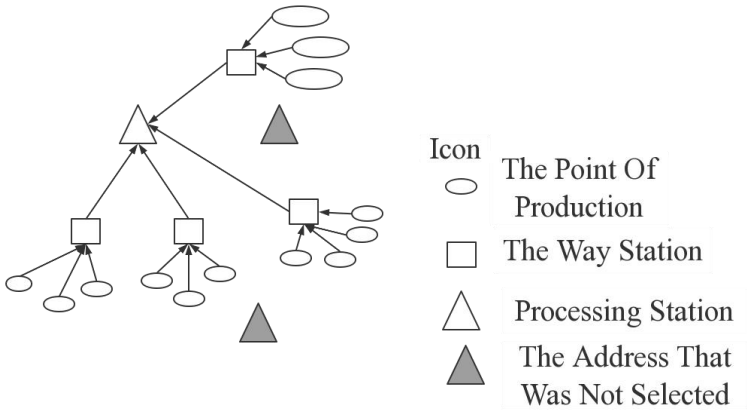

FIG. 2 Structure diagram of solid waste reverse logistics network

First, a two-layer waste reverse logistics network structure consisting only of treatment stations and production points is constructed, in which the capacity of treatment stations is limited.

Second, all alternative processing stations have been demonstrated and evaluated by relevant laws and regulations, and truly meet local policy requirements and technical specifications;

Third, there is a simple ground line relationship between the waste transportation cost and the transportation distance, without considering the management expenses.

Fourth, the unit distance transportation cost of waste has been determined, including labor cost and operation cost, which does not change in a certain period of time.

Fifth, the amount of waste obtained from all waste generation points has been determined and does not change within the specified time range;

Sixth, the road conditions of waste vehicles are basically determined, without considering road congestion, congestion and other problems.

The mathematical model for dealing with site selection is as follows:

$$\min R = \sum_{k=1}^{K}\sum_{m=1}^{M} F_{km}X_{km} + \sum_{k=1}^{K}\sum_{i=1}^{I} \beta L_{ik} q_i Y_{ik} + \sum_{i=1}^{I}\sum_{k=1}^{K}\sum_{m=1}^{M} B q_i X_{km}$$

$$\min Z = \sum_{i=1}^{l} (q_i)^{\theta} \sum_{k=1}^{K} \frac{(X_{km}Q_m)^{\omega}}{(L_{ik})^{\phi}}$$

And meet the following constraints:

$$\sum_{k=1}^{K} Y_{ik} = 1 \quad \forall i \in I$$

$$Y_{ik} \le X_{km} \quad \forall i \in I, j \in J, m \in M$$

$$\sum_{i=1}^{l} q_i Y_{ik} \le \sum_{m=1}^{M} Q_m X_{km} \quad \forall j \in J$$

$$\sum_{m=1}^{M} X_{km} \le 1 \quad \forall k \in K$$

$$q_i \ge 0 \quad \forall i \in I$$

$$X_{km} \in (0,1) \quad \forall k \in K, m \in M$$

$$Y_{ik} \in (0,1) \quad \forall i \in I, k \in K$$

This mathematical model belongs to multi-objective integer programming model, and the final results can fully show the model research problems.

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2.4 Genetic Algorithm

Combined with the genetic algorithm flow chart shown in Figure 3 below, it can be seen that the following steps should be followed in the application of solid waste disposal site selection model:[10-13]

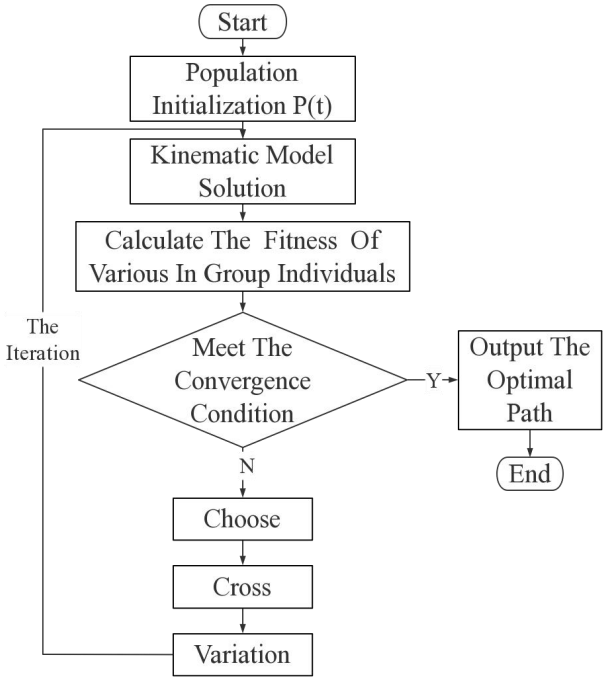

Figure 3. Flow chart of genetic algorithm

Firstly, an initial population composed of characteristic strings of certain length is generated randomly.

Secondly, the fitness values of all individuals in the population should be calculated accurately.

Thirdly, the new population individuals are selected according to the fitness value. The individuals with higher fitness value are more likely to be replicated, but the individuals with lower fitness are likely to be eliminated.

Fourth, according to the corresponding genetic probability operation, can form a new population;

Fifth, accurately judge whether it meets the optimization standards. If the criteria are met, the optimal individual and the optimal solution represented by it will be output and the algorithm will be terminated. Otherwise, the second step should be returned for iterative calculation until the termination condition is met and the optimal solution is output.[14-15]

3. Result analysis

According to the mathematical model and genetic algorithm flow chart proposed above, 10 alternative treatment stations and 20 waste generation points were selected, and the hierarchical cost as shown in Table 1 was planned and designed. Matlab7.0 software was used for simulation analysis, which mainly studied and solved the site selection problem of solid waste treatment stations.

Table 1 Level cost of planning and design

Level	Capacity (ton/day)	Construction cost (ten thousand yuan)
1	150	300
2	200	400
3	250	500

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Among them, the population size of the genetic algorithm is set as 40, the crossover probability is 0.8, the mutation probability is 0.03, and the evolutionary algebra is 200. The final calculation results are shown in Table 2 below:

Table 2 Calculation results

Results of calculation	001001
Construction location of processing station (capacity)	3（200），1,2,3,8,9,10,11,13,14,19
The location of a production point served by a processing station	6（200），4,5,6,7,8,9,10,11,12，15,16,17,18,20
Total cost	815.5
Negative effect	2687

Combined with the analysis of the above table, it is found that the use of genetic algorithm to build a solid waste disposal site selection model, the use of binary coding, single point crossover, basic bit variation and other genetic operations to determine the location of the disposal station, capacity and location of the generation point, can better meet the requirements of solid waste disposal management, genetic algorithm is effective in the mathematical model. Therefore, while strengthening the research on the location of solid waste disposal, we should integrate multiple intelligent algorithms for practice and innovation, and pay attention to the construction of corresponding mathematical models for specific problems, so as to continuously optimize the treatment level of municipal solid waste and contribute to the construction and development of high-quality social environment. At the same time, we should attach importance to the education and training of professional and technical personnel, learn from the research results proposed by foreign researchers, organize and carry out diversified practical exploration activities, apply advanced theories and technologies to specific work, and select the appropriate location and quantity of solid waste disposal as soon as possible.

4. Conclusion

To sum up, after understanding the basic principles of solid waste production and treatment, this paper focuses on the study of the two-layer solid waste reverse logistics network including treatment stations and production points, proposes a two-objective mathematical model with minimum total cost and minimum environmental disutility, and uses genetic algorithm to quickly determine the optimal solution. The experimental results show that genetic algorithm plays an important role in location selection model. Therefore, while we attach importance to solid waste treatment, we should actively introduce the research results of domestic and foreign scientific research scholars, optimize and innovate the theory and technology, strengthen scientific and technological reform and professional personnel training, and create a more high-quality research model based on artificial intelligence, big data and cloud architecture to speed up the solid waste treatment. Ensure the quality of practical work, control the excessive loss of resource costs, reduce the impact of solid waste on the ecological environment, and contribute to the construction and development of a harmonious society.

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