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Research Article

Optimization of Urban Waste Transportation Route Based on Genetic Algorithm

Yanling Zhang, Xu Luo, Xiaoxuan Han, Yongxing Lu, Jiacheng Wei, and Chunyu Yu

School of Mechanics and Construction Engineering, Jinan University, Guangzhou, China

Correspondence should be addressed to Xu Luo; tluoxu@jnu.edu.cn

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Under the normal conditions of the new economy, people's living standards have improved; the amount of urban domestic waste has increased suddenly; and the differentiation of waste has become more and more complicated. However, the garbage transportation method at this stage has been difficult to meet the needs of reality. Therefore, it is particularly urgent to reform the original and simple treatment methods and adopt the latest and more reasonable garbage transportation. The urban waste transportation route optimization described in this article is quite complicated in the specific problems faced in the optimization of the urban domestic waste transportation route. This paper proposes to combine computer science to study the system optimization model and combine information management and other disciplines to develop and apply research on the dynamic management software of urban waste logistics systems. In the modern service industry, logistics occupies an important position. The optimization of urban waste transportation routes based on genetic algorithms also promotes the development of high-end modern service industries and is an important task to promote urban development and maintained hygiene and improve the healthcare of the citizens. The optimization of urban waste transportation routes is conducive to creating a clean and tidy urban environment.

1. Introduction

Urban domestic waste mainly includes kitchen cabinet waste, waste paper, fabrics, household utensils, glass and ceramic fragments, waste electrical appliances, waste plastic products, coal ash, and waste vehicles. With the acceleration of the pace of life and the improvement of living standards, the output of domestic garbage has increased rapidly, and the proportion of inorganic substances such as coal ash and slag in the garbage has gradually decreased. The proportion of organic matter, combustibles, and recyclables such as products in the garbage is gradually increasing. The classification and treatment of garbage at the source determines whether the process of resource utilization and reduction of garbage can be carried out effectively, and it is the most critical part of garbage classification and transportation. In recent years, the continuous improvement of domestic waste removal has reached 261.04 million tons, and the national urban waste is increasing at an annual rate of 8%~10%. The domestic garbage that has not been effectively collected and processed not only pollutes the air and water sources but also poses a threat to the lives and health of urban residents. The use of "Internet" technology to establish a coordinated transportation mechanism for the government, private enterprises, social organizations, and the public is an important way to achieve the reduction, harmlessness, and resource disposal of domestic waste. The problem of urban domestic garbage has become an increasingly prominent problem [1, 2]. The amount of garbage generated is greater than the amount of clearing and transportation, and the amount of harmless treatment is smaller. The transport link of municipal solid waste is an important part of the waste treatment system. In the cost of waste treatment, the cost of the collection and transportation accounts for a considerable proportion. For example, the total annual waste treatment cost in the United States is about 20 billion US dollars. Collection and transportation costs have exceeded 10 billion US dollars. Therefore, it is necessary to optimize the collection and transportation route of garbage trucks to reduce the cost of collection and transportation system and reduce environmental pollution and social impact.

At present, in the transportation of urban domestic waste, due to the lack of information disclosure mechanism and information communication mechanism, it is difficult for different transportation entities to achieve interconnected information communication and information sharing, which has led to the existence of information between various government departments, government departments and enterprises, and the public. The municipal urban management committee and the district urban management bureaus are responsible for the treatment, and the trade committees are responsible for the garbage recycling [3]. The garbage infrastructure construction and related transfer work are responsible for the relevant enterprises. Since the information exchange platform among various departments has not been established. Among different departments, it is difficult for relevant functional departments, enterprises, and the public to understand the progress of their respective work, and it is difficult to achieve collaborative operations, which makes it difficult to improve the effect of waste classification. In addition, due to the lack of information-sharing platforms, residents also lack an expression and feedback mechanism for the actual needs of urban domestic waste transportation, which makes it difficult to stimulate the public's enthusiasm for waste classification. According to the forecast of the growth for waste generated in the past 10 years, it will be 409 million tons by 2030 and 528 million tons by 2050. At present, China has accumulated nearly 7 billion tons of municipal solid waste, covering an area of more than 500 million square meters. About two-thirds of large and medium-sized cities are surrounded by garbage, and about one-fourth have developed to no suitable place for stacking. Municipalities and provincial capitals account for an important proportion of waste generation [4]. Sixty percent of the domestic waste output is concentrated in 52 key cities with a population of more than 500,000. Such a current situation makes the collection and transportation system of domestic wastes more and more important in the management of domestic waste. China's municipal solid waste has the following characteristics. (1) The generation source is scattered, and the generation amount is large. Domestic waste is mainly produced in households, so the sources of production are spread across all residential areas. In the past 20 years, the process of urbanization in our country has been accelerating year by year, and the amount of municipal solid waste produced has gradually increased. (2) The composition is complex, and the nature is unstable. Due to the diversity of residents' lives, there are many types of domestic waste generated, resulting in a complex composition of domestic waste. Especially new materials and new products emerge in an endless stream, making the composition of domestic waste more and more complicated. (3) The amount, composition, and nature of domestic waste are related to many factors, for example, residents' living standards, living habits, climate, geographic location, and so on. (4) Municipal solid waste has potential economic value. Many components in urban domestic waste are useful resources that can be recycled and reused, such as waste paper, waste batteries, waste plastics, and so on, and thus exhibit great economic value.

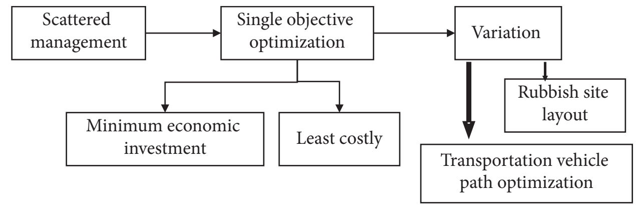

Figure 1: Optimized status of urban waste transportation.

The development of cities and the continuous expansion of the city's scale have made the urban area covered by the waste collection and transportation system larger and larger. The collection and transportation system of municipal solid waste is composed of the three links of collection, transportation, and transfer in the disposal system. Collection and transportation are common to each collection and transportation system. It is determined according to the transportation distance from the source of garbage to the treatment site, the transportation capacity of garbage collection vehicles, and the amount of garbage. The distance between garbage treatment and disposal facilities and the source of municipal solid waste is getting farther and farther. Therefore, the overall optimization of the modern urban domestic waste collection and transportation system is very necessary. How to achieve scientific and effective collection and processing through classification and how to classify are always the focus of domestic waste transportation. Many developed countries in the world have issued corresponding laws, regulations, policy plans, and transportation measures in accordance with their national conditions, for example, Germany's "garbage economy" legislation, two-way recycling system, and other measures; Belgium's garbage classification "family compulsory course"; and so on. In addition, urban household waste has the characteristics of large quantity and wide range, complex composition, rising harmful types, and large regional differences [5], making the classification and treatment of urban domestic waste in our country face tremendous pressure. The main work of this paper is as follows: it introduces the research status of urban waste transportation routes, which needs to optimize. This paper proposes the GA optimization method and develops and applies the dynamic management software of the urban waste logistics system. System software promotes the important tasks of urban development, maintaining hygiene and improving the health of citizens. Based on the standardized transportation of urban domestic waste in some areas in the early stage, it is of great significance to conduct research on the classification and treatment of urban domestic waste from the perspective of a more systematic standardized transportation theory.

2. Related Theoretical Research

2.1. Literature Review. The optimization of transportation routes of municipal solid waste started late. It is in a weak link in the solid waste environmental management system and lacks scientific planning and research. This has caused a lot of labor loss, material resources, and financial resources as well as useful resources. The optimization route of garbage vehicles based on the basic situation of our country is drawing on the results of foreign research [6]. The optimization model from single- to multi-objective is shown in Figure 1, which is from a simple function to an uncertain multi-objective mathematical model.

Initially, due to the small amount of garbage generated, the impact on the environment was not obvious, and the management of urban domestic garbage was in a state of fragmented management, allowing it to dissipate naturally in the environment. The single objective is optimized by only one factor. Multi-objective realization and multi-factor have been optimized by multi-dimensional space realization. With the growth of the population, the development of cities, and the improvement of people's living standards, the output of domestic waste is increasing. People gradually realize that if domestic waste is not managed effectively, it will bring serious environmental and health problems [7]. The waste management model has been researched and tested, and the initial research method is a single-objective optimization method. The single-objective optimization model focuses on economic input and is simple and easy to implement. However, the consideration is one-sided and suitable for the management model of small and medium-sized cities. For large cities, environmental impact and social effects must have been considered. Therefore, for the collection and transportation of domestic waste in large cities, single-objective optimization mode performance is also very limited. Jia [8] took the cold fresh meat logistics distribution path of S enterprise as the research object, constructed a cold chain logistics path optimization decision model with the goal of minimizing the total cost, and used the improved genetic algorithm to optimize the distribution route. The optimized plan is in various distribution costs are significantly reduced. Hadipour [9] established an improved multi-objective, mixed-integer planning model for collecting vehicle routes and solved the problem of collecting vehicle routes and schedules. GIS technology is used to create, store, retrieve, analyze, and display spatial information under complex spatial and geographic relationships and has been widely used in many aspects of the environmental field. For example, use GIS technology to simulate surface water flow and surface water pollution and manage water distribution networks. Isnafitri's research [10] shows that by combining GIS technology, mathematical planning software, and associated database management systems, it is possible to analyze and compare the available garbage collection schemes under the circumstances of changes in the environment and municipal planning. In addition, a large number of scholars continue to experiment and research on this issue.

2.2. Genetic Algorithm. Genetic algorithm is generated by simulating the concept of biological survival in nature. Generally speaking, the genetic algorithm includes three operators, namely selection, crossover, and mutation. The function of the selection operator is to increase the average moderate value of the entire population. In the entire population, individuals with high evaluation values are selected to form the main group of the mating pool: The main function of the crossover operator is to select the good genes in the mating pool to be inherited to the next. In the first generation, individuals in the mating pool are paired, and then some genes are exchanged purposefully to generate individuals with more complex genetic traits. The mutation operator is to invert one or several individual binary characters according to a certain small probability, so as to realize the simulation of gene mutation phenomenon in nature. In this algorithm, every problem that needs to solve has been coded and designed as a "chromosome" as much as possible. Multiple chromosomes can then form a population. In this process, genetic operations such as selection, mutation, crossover, and duplication will occur. When the genetic algorithm is initially set, an initial value, namely a population, is first randomly generated, then the individuals in the population are processed and evaluated according to the function of the algorithm, and the corresponding value of the environmental fitness is generated [11–13]. Then the algorithm will select excellent individuals for next-generation derivation based on these fitness values, and then mutate and cross-process the selected excellent individuals. As shown in Figure 2, genetic algorithms are widely used in the path design of robots; the scope of application is not only in the travel of a single robot but also in the cooperation of multiple robots; and they have achieved good results.

The genetic algorithm is a robust query algorithm applied to the optimization of complex systems. Compared with other optimization algorithms, optimization genetic algorithm has the following characteristics:

(1) Decisive variables are encoded, and a code is used as the object of algorithm processing
(2) In the algorithm, the calculated fitness value is used to query other data information
(3) The query process of the genetic algorithm starts from a population, not from an individual
(4) The query of a genetic algorithm is a query based on probability, not a query based on a certain value

3. Optimization of Urban Waste Transportation Route

3.1. Existing Problems and Optimization Ideas. The municipal solid waste collection and transportation system is a large-scale logistics system, and its problems are very complex and involve a wide range of areas. However, it is mainly applied to the specific situation of foreign municipal solid waste management. Due to different national conditions, the current situation of municipal solid waste management in China is quite different from that of foreign

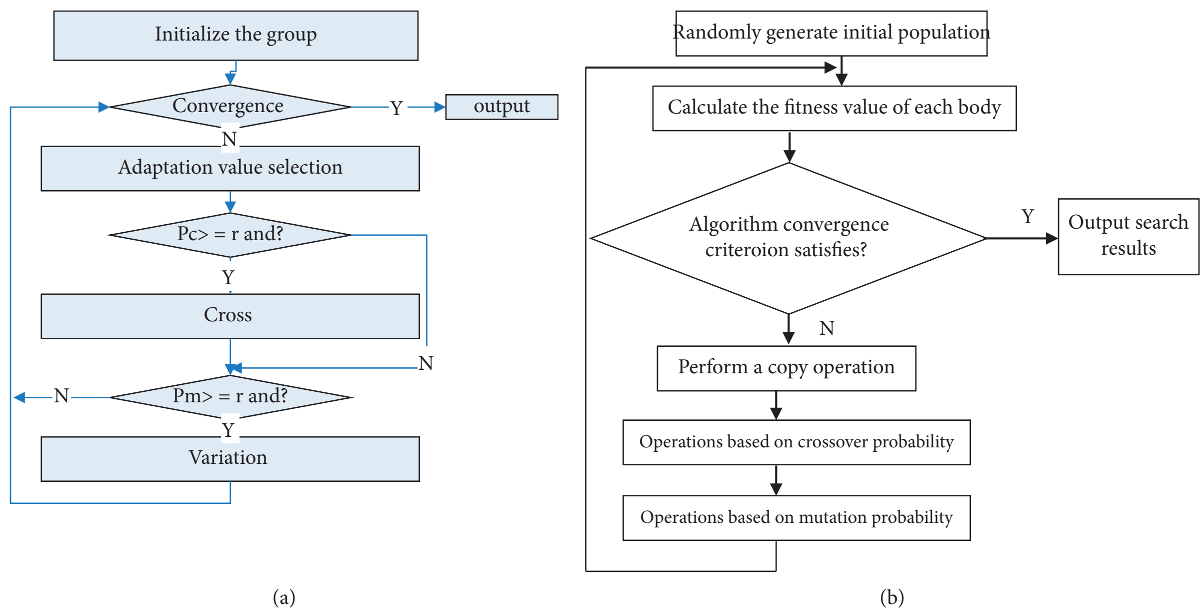

Figure 2: Workflow of two methods: (a) standard genetic algorithm and (b) optimization genetic algorithm.

countries. In terms of optimization methods, some optimization methods (such as fuzzy comprehensive evaluation and analytic hierarchy process) have strong subjectivity and cannot express the economics of optimization results [14]. The calculation results of some optimization methods cannot be better. The actual situation and complex calculations such as nonlinear programming, dynamic programming, and fuzzy programming restrict its application in practical problems.

In terms of optimization algorithms, heuristic methods can simultaneously meet the needs of the detailed description of the problem and solution, and more accurate optimization methods are more practical. The disadvantage is that it is difficult to know when a good heuristic solution has been obtained. Although the saving method lists between each point and construct the path from large to small according to the savings, it has the advantage of fast calculation speed, but it has the problem of messy uncombined points and difficulty in combining edge points. If the genetic algorithm wants to obtain a more satisfactory solution set, it is at the cost of prolonging the calculation time.

After referring to a large number of domestic and foreign documents, the author of this paper proposes research routes and methods for the optimization of urban domestic waste collection and transportation routes, which is shown in Figure 3.

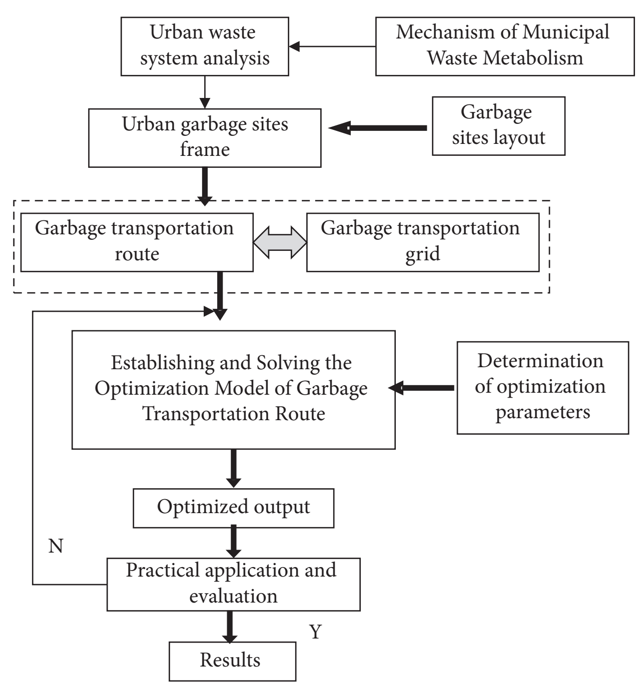

Figure 3: The optimization of urban domestic waste collection and transportation routes.

This method integrates model research, optimization methods, evaluation, and diagnosis technologies. The theory application of pollution loss and uncertainty factors used to optimize the collection and transportation routes of municipal solid waste based on the economic quantification of environmental impacts, explore the optimal mode and method for collection and transportation of municipal solid waste, and establish a set of measures for municipal solid waste [15]. A comprehensive, multi-level comprehensive evaluation, diagnosis, and management system provides decision support for municipal solid waste management and promotes a benign interaction between solid waste, social, and economic development. In addition, comprehensively consider various factors in the optimization process from both vertical and horizontal aspects. On the one hand, the systematic analysis of municipal solid waste, the setting of garbage points, the selection of collection routes, and the selection of transportation routes need to study in detail to determine the best optimization plan. On the other hand, the formulation of urban domestic waste collection and transportation routes has closely related to factors such as economy, population, consumption, and society. Any change in one of them will affect the entire optimization model. Various factors are intricately intertwined and mutually restrict each other. The related works are in Table 1.

Table 1: The related works.

NO.	Contents
1	Existing problems
2	Construction of the mathematical model
3	GA path optimization
4	Case analysis

3.2. Mathematical Model of Urban Garbage Transportation Vehicle Scheduling Problem. The scheduling problem of urban garbage transportation vehicles can be described as follows: from a logistics center with multiple garbage transportation vehicles to multiple customers, each customer's location and demand for goods are certain, and the load capacity of each garbage transportation vehicle is certain. The maximum driving distance of the distribution is fixed; it is required to arrange the vehicle distribution route reasonably.

Suppose that the logistics center has K garbage transport vehicles, a car goes to n garbage sites to pull goods, all the routes are repeated and then back to the starting point, so that the distance traveled is the shortest. The path optimization problem is expressed as a directed graph of M garbage sites $G = (m, b)$.

$$\begin{aligned} M &= \{1, 2, \ldots, m\}; \\ B &= \{(i, j) | i, j \in M\}. \end{aligned} \tag{1}$$

The distance between junk sites is as follows:

$$\left(e_{ij}\right)_{m\times m}. \tag{2}$$

The objective function is as follows:

$$f(uv) = \sum_{l=1}^{m} e_{i_l i_{l+1}}, \tag{3}$$

where

$$uv = (i_1, i_2, \ldots, i_m). \tag{4}$$

It is an arrangement of garbage sites 1, 2, $\ldots m$. When $i_{m+1} = i_1$, $f(uv)$ is the garbage compression transfer facility. The construction of garbage compression facilities improves the efficiency of garbage transportation, garbage transportation generally uses large vehicles, and the starting point of garbage transportation cannot be too scattered [16]. Moreover, garbage should have compressed before transportation to reduce the volume of garbage and save transportation costs. All cities should make reasonable planning and construction of garbage compression stations as an indispensable supporting infrastructure for urban construction.

The probability that s garbage trucks are randomly placed at m garbage sites and the k-th garbage truck at site i chooses the next site j is as follows:

$$P^s(i, j) = \begin{cases} \dfrac{[\tau(i, j)]^{\alpha} \cdot [\eta(i, j)]^{\beta}}{\sum_{s\notin \text{tabu}_s} [\tau(i, k)]^{\alpha} \cdot [\eta(i, k)]^{\beta}}, & \text{if } j \notin \text{tabu}_s, \\ 0, & \text{otherwise}, \end{cases} \tag{5}$$

where

$\tau(i, j)$ indicates the pheromone concentration on edge (i, j)

$\eta(i, j) = 1/d(i, j)$ is heuristic information, where d is the distance between cities i and j

α and β reflect the relative importance of pheromone and heuristic information

tabu_s indicates the list of cities that ant K has visited

$$\begin{aligned} \tau_{ij}(t + n) &= \rho \cdot \tau_{ij}(t) + \Delta\tau_{ij}, \\ \Delta\tau_{ij} &= \sum_{k=1}^{m} \Delta\tau_{ij}^{k}. \end{aligned} \tag{6}$$

ρ is a constant less than 1, indicating the persistence of information.

$$\Delta\tau_{ij}^{k} = \begin{cases} \dfrac{Q}{L_k}, & ij \in l_k, \\ 0, & \text{otherwise}, \end{cases} \tag{7}$$

where Q is a constant, l_k represents the path taken by the k-th garbage truck in this iteration, and L_k is the path length.

3.3. Path Optimization Design. The standard genetic algorithm includes group initialization, selection, crossover, and mutation operations. The main steps can be described in Figure 4. The transportation of urban garbage vehicles has neighborhood characteristics, and the candidate window is set, and the window size should be a reasonable value [17]. Garbage vehicles always prioritize the cities in the candidate window. After the search is over, the path is optimized according to the candidate window. If the node in the candidate window is switched to the vicinity of the current node and the distance is shorter, then the mutation is performed.

Explanation:

(1) The judgment end criterion of this algorithm is to fix the number of iterations. When the algorithm reaches the number of iterations, the algorithm ends, and the current optimal solution is output.

(2) When calculating and selecting according to the adaptation value, the recorded current optimal value is added to the new group after the mutation to ensure that the TSP solution is getting better and better (will not get worse) in the new iterative cycle.

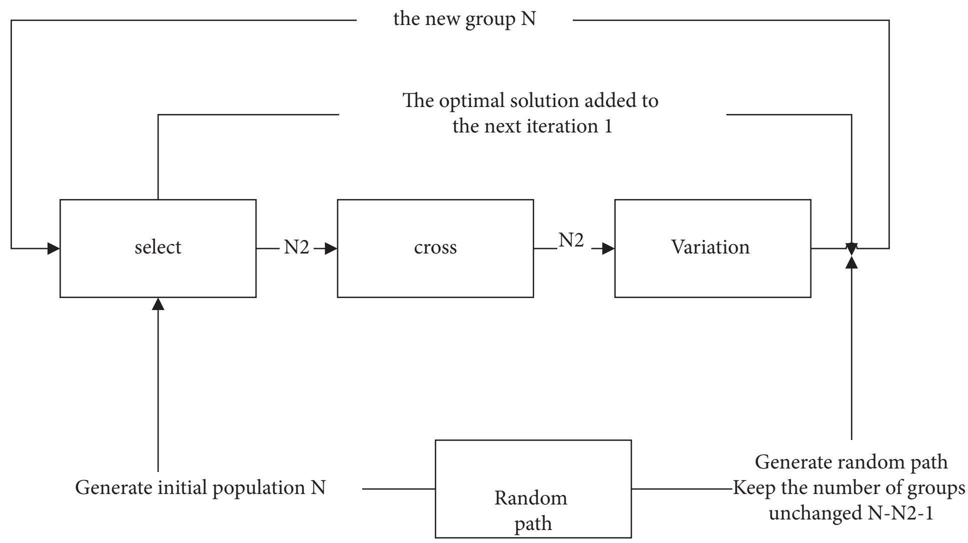

Figure 4: Route optimization ideas for garbage transportation vehicles.

(3) An operation in the selection is to replace the worst K individuals with the best K individuals. In this example, the selection is based on the fit value, and the number of groups is reduced. After each mutation operation, a random path is generated to supplement the population; the number of the population remains unchanged; and the cycle is repeated. To a certain extent, prevent falling into the local optimum due to the selection problem of the initial group.

4. Case Analysis

The transportation of urban domestic garbage requires professional vehicles and so on. Individuals and small collectives do not have the conditions for garbage transportation, mainly relying on the unified completion of the urban management (environmental sanitation) department. Large-scale garbage disposal sites are generally far away from cities. The larger the city, the greater the amount of garbage, the more transportation vehicles, and the more transportation routes there will be. The transportation routes should have been planned reasonably to avoid empty running of vehicles or insufficient capacity, which may cause labor and material resources. Garbage transportation vehicles should maintain a neat appearance, and it is strictly forbidden to expose garbage, abide by traffic rules, and pay attention to safety precautions during night transportation [18]. This paper takes Guangzhou as an example to optimize the route of garbage transportation vehicles by using an ant colony algorithm.

4.1. Establish a Garbage Transportation Network. This paper uses GIS to establish a Guangzhou garbage transportation network. The process is as follows: (1) import the map of Guangzhou New Area into GIS and select the appropriate geographic coordinate system and projected coordinate system. (2) A new Shapefile file will enter and exit the main line of Guangzhou. The route map is identified in the GIS, including national highways, provincial highways, and expressways, and the same geographic coordinate system and projected coordinate system as above have been selected to establish a garbage transportation network in Guangzhou Port. The shortest GIS path of n sites or searches for a subset of natural numbers $X = \{1, 2, \ldots, n\}$ (the elements x represent the number of n cities). The subset of the sites is $\pi(X) = \{V1, V2, \ldots, Vn\}$. $\text{len} = \sum d(Vi, Vi+1) + d(V1, Vn)$ is set to take the minimum value, where $d(Vi, Vi+1)$ means the distance from city Vi to city $Vi+1$.

This paper uses spatial registration vectorization to operate the Guangzhou garbage transportation network, design the corresponding electronic map for follow-up research, and import it into the personal geographic information database. Establish a topological layer for the map; set topological rules, that is, no hanging points, no overlapping; and check the correctness of the connections between paths according to the rules. It is assumed that the working space of the garbage truck is a two-dimensional structured space, the location and size of the obstacles are known, and the location and size of the obstacles do not change during the movement of the garbage truck. If there are no obstacles in a certain road size range, the road is called a free road. Otherwise, it is called an obstacle road. Both free space and obstacles can be expressed as a collection of roadblocks. Number the divided roads. The working space of the garbage truck after the division is shown in Figure 5. The shaded areas in the figure are obstacles.

4.2. Road Data Collection. After modeling the garbage transportation network in Guangzhou, it is necessary to collect road-related data. The road-related data in this article is taken from a traffic analysis research report on the starting and ending points of motor vehicles on the Guangzhou highway network. The results of the study pointed out that the number of vehicles within 24 hours of a day has a certain

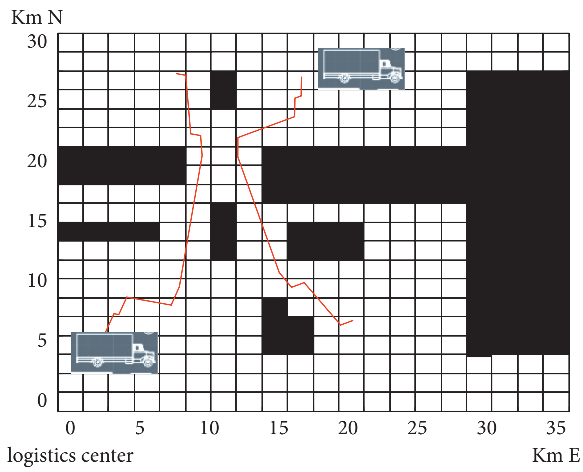

Figure 5: Working space of garbage truck after division.

pattern in the distribution of the city and analyzed the traffic adaptability of different road sections. It also listed the number of vehicles in each hour of the 24 hours during the survey process. Converting the traffic volume, through comprehensive analysis, the corresponding time-space matrix can be established based on the data of each road section. This article assumes that the ratio of the number of vehicles in different time periods of each road section is the same, and the ratio is only related to the time period. Based on the data, the vehicle number ratio of each period is sorted out as shown in Table 2. These data are substituted into the ant colony algorithm to optimize the transportation route.

4.3. Path Optimization. In this paper, a map of a certain area in the center of Guangzhou is collected as an example, as shown in Figure 6 for delivery. C language program is used to simulate the driving path of the supply trolley, and the optimized driving path of the supply trolley is obtained. This map contains one shipping point, ten shipping points, and fourteen intersections. These points are regarded as the vertices of the mixed graph $G = (V, E, W)$, where 1 is the shipping point. The ten points from 2 to 11 are delivery points, and the others are intersections. The path that the delivery car travels meets the requirements: each delivery point is required to have a car for delivery, and only one delivery is required. Make each driving route as short as possible that is as optimal as possible. The solutions are based on the above-mentioned ideas to solve the problem of the optimal travel path of the supply car.

4.4. Result and Analysis

4.4.1. Optimization Results. When optimizing garbage transportation routes, there must be clear goals and basic principles. The choice of the garbage transportation route plan can be considered from the following aspects: (1) the garbage transportation has the highest benefit or the garbage transportation cost is the lowest. The benefit is the main goal pursued by an enterprise, and it can be simplified to express it in terms of profit or take profit maximization as the goal.

Table 2: The situation of road vehicles in various periods in Guangzhou.

Period	Vehicle ratio (%)	Period	Vehicle ratio (%)
0~2	1.92	12~14	6.34
2~4	2.01	14~16	6.76
4~6	1.84	16~18	8.23
6~8	7.12	18~20	7.15
8~10	7.62	20~22	3.7
10~12	6.42	22~24 (0)	2.64

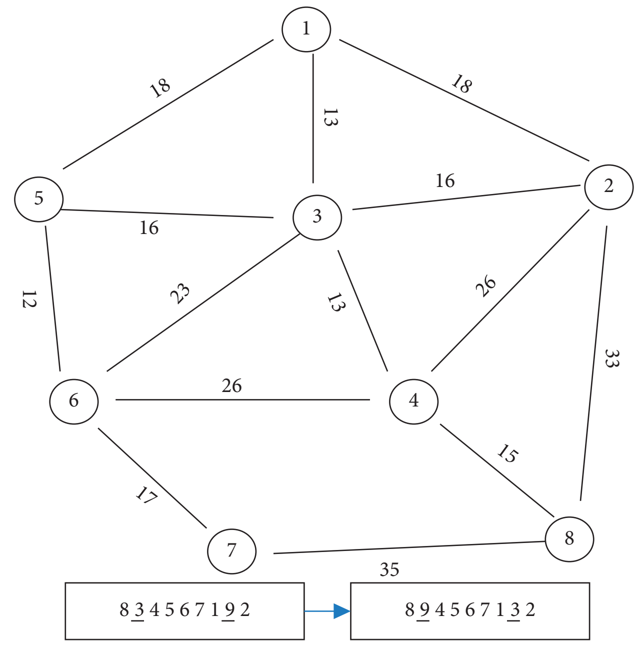

Figure 6: Road map of garbage transport vehicles.

The cost has a direct impact on enterprise benefits, and choosing cost minimization as the target value is directly related to the former. (2) The garbage transportation mileage is the shortest. If the garbage transportation cost has a strong correlation with the garbage transportation mileage, but the correlation with other factors is weak, the shortest garbage transportation mileage is essentially the lowest garbage transportation cost. The shortest garbage transportation mileage can be considered as the target value, which can greatly simplify route selection and vehicle scheduling methods. (3) The level of garbage transportation service is the best. If the requirement for punctual garbage transportation becomes the first priority or when the cost is needed to ensure the service level, the service level should be the first choice within the maximum tolerance of the cost. The loss of this cost may have been compensated by other aspects, such as high-quality services that can adopt a higher price strategy. (4) The consumption of garbage transportation is minimal. That is, the goal is to minimize the consumption of materialized labor and living labor. In many cases, such as labor shortages, fuel shortages, and vehicles and equipment are tight, the scope of selection of garbage transportation operations is limited, and the garbage transportation needs can have considered. Labor, vehicles, or other related resources are used as the target value. Path simulation of garbage transportation vehicles is shown in Figure 7.

For practical problems, due to the increase of restrictions on the garbage transportation path, many related problems can be derived. The main optimization purpose of this article is the (2) mentioned above, that is, the shortest garbage transportation mileage. In this example, a partial matching crossover strategy is adopted for crossover, and the basic steps are as follows:

Step 1: Randomly select two intersections

Step 2: Exchange the gene segments between the two intersections

Step 3: Replace the parts other than the exchanged gene segment that conflict with the elements in the exchanged gene segment with the corresponding position of another parent until there is no conflict

In this example, the path instance as shown in the figure, the intersection points are 2, 7, and after the matching segment is exchanged, there are 7, 6, and 5 conflicts in A. In the matching segment of B, find the value 7–3 at the corresponding position in the matching segment of A. The point 6–0 and the point 5–4 continue to detect conflicts until there are no conflicts. Do the same for B to get the result.

4.4.2. Analysis and Discussion. The author separately compiled the traditional transportation method program for logistics distribution vehicle scheduling problem and the genetic algorithm program for transportation route optimization in C language, which addressed the problem of a distribution center by 2 vehicles to transport garbage to 8 demand points in the literature [9]. Experimental calculations are performed (in addition to the original problem, the constraint condition that the maximum driving distance of the vehicle at one time is 20 km $*$ 30 km is added in the calculation). The following parameters are used in the experiment: the population size is 5; the evolutionary algebra is 50; the crossover probability and mutation probability of the traditional transportation method are 0.92 and 0.1, respectively; and the maximum number of gene transpositions of the genetic algorithm for transport path optimization is 4. The computer programs are run 20 times randomly, and the calculated results are shown in Figure 6.

It can be seen from Figure 8 that the 10 calculation results of the traditional transportation method and the genetic algorithm of transportation route optimization are better than the result of the saving method by 78.3 km, and the genetic algorithm of transportation route optimization obtains better results. In 10 calculations, the genetic algorithm for transport path optimization got the optimal solution of 57.5 km for the problem 3 times and got the suboptimal solution of 69 km 3 times. Before optimization, the total distribution cost was 3,301.25 yuan. After multi-objective optimization, the number of garbage trucks will be reduced by 1, and the number of transportation mileage will be reduced by 0.6 km, saving distribution cost 550.37 yuan, which has a good optimization effect. The transmission efficiency has increased by 23%. However, the traditional

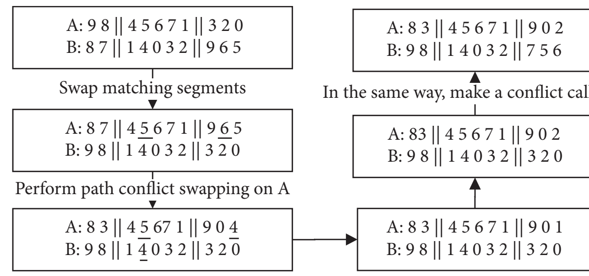

Figure 7: Path simulation of garbage transportation vehicles.

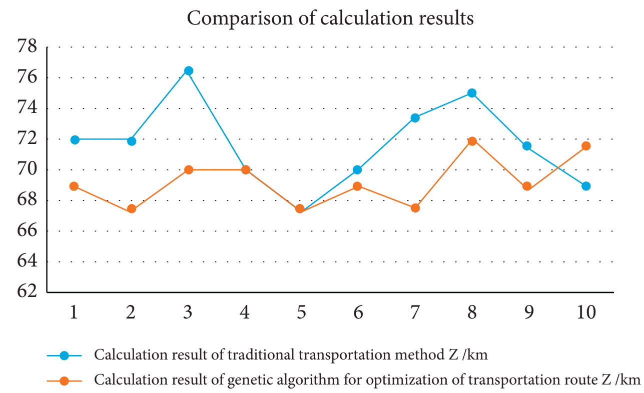

Figure 8: Comparison of calculation results of garbage transportation vehicle scheduling problem.

transportation method only got the optimal solution once, and the genetic algorithm for transport route optimization can overcome the “premature convergence” problem of traditional transportation methods, which avoids falling into local optima. This algorithm adds mutation operation so that the whole process can jump out of the local optimum and reach the global optimum.

In addition, the author also performed experimental calculations on an example of a certain distribution center using three vehicles to transport garbage to ten demand points in the literature [18]. The calculations show the same effect. The genetic algorithm for the optimization of transportation routes can be easily used. Find two optimal solutions to the problem. The total length of the distribution path is 80 km, and one of the solutions is the same as the calculation result of the economy method. Due to the relatively strong constraint conditions of this problem, the traditional transportation method is used to solve it, and sometimes, even a feasible solution cannot be obtained.

5. Conclusions

Unreasonable stacking of urban garbage is one of the main environmental problems facing humans today. Due to its serious harm, it has received widespread attention from all over the world. This article describes the current situation of urban garbage transportation, analyzes its impact on the environment and society and optimizes garbage transportation routes through computers so that garbage can be cleared and transported in time, and the city is clean and hygienic. While enjoying the urban civilization, people are also suffering from the troubles caused by urban waste, of which construction waste accounts for a considerable proportion, accounting for about 30% to 40% of the total waste. Therefore, how to deal with and utilize more and more construction waste has become an important issue faced by government departments at all levels and construction waste treatment units. This paper simulates the accident rate and accident consequences of urban waste transportation; establishes a comprehensive, dynamic, multi-objective urban waste transportation route optimization model based on the transportation cost; and uses the GA model to obtain travel time of different road sections. Then, the coding method in the GA algorithm module and the method of solving the objective function in the custom problem module were designed and improved to make it more suitable in this paper. Finally, an empirical study was carried out with the main line entering and leaving Guangzhou as the research area. By collecting corresponding road data and combining it with the accident threat area obtained by modeling the urban garbage accident scenario, the model and algorithm established in this paper were used to select optimal urban garbage. The transportation route proved the feasibility of the study. This work will apply the optimization models of municipal solid waste collection and transportation routes in other cities. It can also optimize the collection and transportation routes of municipal solid waste in the future. The work of this paper also has certain limitations. It only focuses on the optimization of garbage transportation within individual cities, and cooperative transportation between cities is indeed considered, as well as the consideration of the occurrence of emergencies [19].

Data Availability

All data included in tables are available upon request by contact with the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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