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*Research Article*

# Bus Route Design Problem for Rural Tourism Objectives: A Multiobjective Approach

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Rural tourism bus routes are an essential component of rural public transport systems, intending to serve tourist trips with passengers moving between critical regional transport nodes and tourist attractions. This paper presents a methodology for the optimal design of rural tourism bus routes by minimizing total travel costs for tourists and maximizing the total quality of tourism bus services. Road scenery, road design attributes, and route popularity elements are integrated into the evaluation of tourism bus service quality. The constraints for the bus route planning and tourism demand are taken into account to guarantee the rational design of rural tourism bus routes. A solution approach is put forward based on the initial solution set generation procedure and strengthens the elitist genetic algorithm. Finally, the bus network in a rural tourism destination of Nanjing is taken as the case study to validate the feasibility and efficiency of the proposed model.

## 1. Introduction

As the gathering regions for the touring of natural resources and landscapes, many rural areas have cultivated tourism as a local specialty industry, which has drastically stimulated the economic development of these areas. Visits to rural tourism destinations can provide authentic experiences and locally produced offerings, connect tourists with nature, and offer an escape for urban residents [1]. Especially, since the outbreak of the Covid-19 pandemic, some studies have proved a rising preference for suburban and rural destinations by domestic tourists instead of long-distance travel and urban tourism, implying that these areas are considered safer with a lower possibility of coronavirus transmission [2]. While the increased interest in rural tourism has provided opportunities for rural development and revitalization, it is also accompanied by certain issues. One of the major challenges recognized by practitioners and scholars is the social and environmental sustainability issues associated with the massive number of visitors to rural destinations [3]. With rapid infrastructure expansion, population growth, and environmental pollution, increased rural tourism may bring irreversible damage and disturb the ecological equilibrium [4]. In this way, rural tourism destinations that hope to overcome competition while attracting more tourists must take deliberate measures to strike a balance between regional development and sustainability outcomes.

Transportation has been confirmed to be a fundamental element of sustainable tourism development [5], and the provision of public transport systems in tourism destinations is essential for attaining desirable social and environmental sustainability. Although bus services in rural destinations offer an economical and environmental-friendly way for tourists to move between attractions, they generally have limited appeal for tourists in practice. In most cases, tourists tend to pay more attention to the safety, comfort, accessibility, and convenience of their travel process than regular bus riders, and the travel experience directly affects their overall tourism experience [6]. Bus services may become less competitive for rural tourists compared to the flexibility and comfort of self-driving car trips, weakening the motive for the development of sustainable rural tourism transport systems. The insufficient development of bus services for tourists also makes it hard to guarantee the equity of tourism resource availability for nondriving visitors. Moreover, if most tourists choose the self-driving mode, it will have a detrimental effect on the peak hour traffic congestion and may give rise to a parking problem around tourist attractions. Nonetheless, most rural tourism destinations rely on existing rural bus networks that are primarily designed to fulfil the regular travel demands of rural residents to serve tourists at the early stage of tourism industry development, ignoring tourist flow, which leads to negative effects from detours and lack of comfort on the quality of bus services.

As an essential procedure in the systematic planning of bus services [7, 8], bus route design from the tourist perspective can improve sustainable mobility for rural tourism development. These additional routes on rural bus networks are of great significance for serving the tourism industry and enhancing the attractiveness of public transport to tourists. The design outcomes are also expected to help achieve the diversion of some self-driving tours to public transit mode, alleviating the adverse environmental impact of private car travel modes on rural tourism and transport systems, especially during peak periods. Compared to bus network design for residents in urban areas where the majority of bus trips are clustered, there is less research on bus routes for rural tourism objectives. Because tourist travel demand fluctuates over time and these routes mainly provide an additional service that connects tourism demand-concentrated places (including attractions, transit hubs, and stations), it is not needed to establish a new and dense tourism bus network in a rural destination. The integration of an existing bus network in a city's outskirts with additional routes for tourism objectives can be more cost-effective. Another different feature of rural tourism bus route design is that the optimization objectives give priority to passenger needs because the role of these routes is to offer high-quality bus services delivering tourists to their final tourism destinations. Thus, this highlights the importance to find a feasible approach for the optimal design of rural tourism bus routes to meet visitors' expectations of public transport quality of service.

## 2. Literature Review

Due to the environmental degradation caused by tourism-related transport [9–11], the construction of sustainable transport systems in tourism destinations has drawn abundant attention worldwide [12–14]. As the preference for personalized and short-distance tours has been on the rise, scholars have pointed out the importance of rural tourism bus networks, and their positive effects on social inclusion, traffic congestion reduction, and local economics should not be ignored [5]. An attractive bus network for rural tourism development can facilitate access opportunities for visitors without cars, attracting new market segments and visitor spending. To promote sustainable transport development in rural destinations, many studies have been implemented from different view-angles, such as understanding sustainable transport in rural tourism [15], modeling the sustainable accessibility of rural tourist attractions [16], organizing a public transport route network for tourists, optimizing touring bus schedules [17, 18], and regulating the tourist buses [19]. The design and optimization of a rural tourism bus route network are some of the basic and most effective ways to strengthen sustainable transport services at the early stage of rural tourism destination development and tourist source cultivation.

As a specific type of transit route network design problem (TRNDP) [20, 21], the essence of the rural tourism bus routes design problem is a combinatorial optimization problem with a nondeterministic polynomial property [22]. The target is to identify the optimal routes of a rural tourism bus network with relevant objectives and constraints. The objective functions are usually set based on the perspectives of passengers, operators, and the government. To be specific, in terms of passengers, they aim to minimize the cost of travel, including travel time costs that can be divided into walking time to access bus stops, waiting time, and in-vehicle time. For operators, the top priority is to minimize operating costs and maximize transport efficiency. Regarding governments, system optimization should have priority [23, 24]. Feng et al. set up a new bus network optimization model that reduced passenger transit time and transfer times by optimizing route design [25]. Similarly, in the two-level optimization model established by Guo et al., the researchers regarded maximizing the serviceable demand as the upper objective and minimizing the length of the receiving bus line as the lower objective, and they finally generated the route scheme under the actual road network conditions [26]. To solve these transit route design models, a common solution includes the generation of an initial set of routes, the selection of feasible routes based on objectives and constraints, and the evaluation of efficiency. In terms of solving algorithms, metaheuristic algorithms are widely applied concerning that the transit network design problems are considered to be NP-hard given the nonconvex solution space [21]. Commonly used algorithms are genetic algorithms, artificial bee colony algorithms, particle swarm optimization algorithms, and hybrid methods [27–29]. Metaheuristic algorithms combine the advantages of random search and neighborhood search and are characterized by fast convergence and wide application. They can quickly obtain the suboptimal solution when solving practical problems.

With specific regard to tourism bus route design, many studies focused on optimizing tourist routes via existing bus networks by applying the traveling salesman problem (TSP). These studies usually take into consideration the minimal route length criterion, which significantly affects the total cost of tourist transport [30, 31]. Hudzaifah et al. developed a multi-period TSP model to minimize travel distance and fuel consumption [32] using a modified version of a metaheuristic approach proposed in previous research [33]. Deitch and Ladany presented a model for the bus touring problem with a view to maximizing the total attractiveness of the tour with constraints on touring time [34]. To determine the optimal subset of tourist attractions to be visited and scenic routes to be traversed, this research applied a heuristic improvement process algorithm. In addition, Hu et al. presented the bus sightseeing problem and attempted to clarify the bus tour from the perspective of sightseeing or travel companies by maximizing tourist preferences [35]. It is noteworthy that while the design and optimization of conventional bus routes and their solutions are relatively well established, the rural tourism bus route design problem is less researched. Most studies have focused on the generation of tour routes by considering travel distance and tourism attraction scores but ignore the rural tourism travel demand characteristics. Hence, it is necessary to take into account the relationship between the existing rural bus network and tourism bus routes when designing the rural tourism bus routes, as well as the attractiveness of different road segments regarding tourism elements, thereby obtaining a higher level of tourist satisfaction.

## 3. Problem Statement

*3.1. Rural Tourism Bus Network Composition.* Understanding the travel pattern of target passengers is a prerequisite for bus network organization and construction. Potential local tourists with lower auto availability and long-stay foreign tourists usually enter the regular public transport network through stations near their home or accommodation and then transfer to the dedicated tourism bus routes. One-day foreign tourists first access transport hubs near target rural destinations including airport and rail stations via long-distance transport and then reach target attractions via tourism bus services. As shown in Figure 1, the mobility patterns of rural tourists consist of different types based on travel chains, and the appropriate layout of rural tourism bus routes should match tourist travel and activity patterns, reducing the number of transfers and facilitating movement between attractions. The single-destination tours represent those with only one target tourist attraction, and tourists are transported from origins outside the destination area to the attraction through a principal tourist distribution center. In terms of multiple single-ended round trips, tourists need to return to the distribution center every time they finish activities at an attraction, where different tourist attractions are weakly connected. On the contrary, multidestination tandem tours contain several attractions that tourists can visit in order without returning to the distribution center, making the visit more convenient. Another type of multidestination tour is the peripatetic tour which can avoid tourists' unnecessary diversions between tourist attractions but may easily result in the problem of excessively long tourist routes. When there is more than one entrance in the suburban or rural destination area, the open-ended types allow visitors to move between origin and destinations using multiple entrances and exits, improving the freedom for tourists in developing tourism itineraries and relieving the demand pressure on the principal tourist distribution center during the peak season.

Based on the typical mobility patterns, nodes in the rural tourism bus route network are categorized into tourism nodes and transport nodes in this study. Tourism nodes refer to the tourist attractions in a rural area, which are classified into major attractions and minor attractions based on the rating. In addition, tourism bus routes should pass through distributing and transferring stations in the target destination. For rural destinations, these nodes refer to regional transport hubs, stations, and tourist distributing centers. In general, regional transport hubs cover integrated rail stations and bus terminals. Some destinations may also have airports nearby. Large numbers of tourists converge in these nodes, the routes connected to which can allow the connection between tourism destinations and external areas. It is also necessary to incorporate the existing suburban and rural public transit stops into tourism bus networks to integrate regional transport supplies. Routes connecting various nodes are classified as different types with various service functions. Express routes take on the function of tourist transport services between major nodes, including rail stations, bus terminals, principal tourist distribution centers, and major attractions. Major routes mainly connect Origin and Destination (OD) pairs with large tourist demand. In addition, branch routes take accessibility to all tourism destinations as the primary objective.

*3.2. Rural Tourism Bus Route Design Problem.* The rural tourism bus route design problem is the analysis of a fully weighted graph represented by a directed graph $G = (N, A)$. In this paper, $N$ denotes the set of candidate bus nodes in the rural tourism bus route network, $T$ denotes the set of tourist attractions in the study area, and $M$ represents the set of major tourist attractions, $M \subset T$. $H$ is the set of transport hub nodes, and $C$ is the set of other general nodes on the existing rural bus network. Thus, $N = (T \cup H \cup C)$. The arcs $A$ are direct links connecting two consecutive nodes. The weight of each segment can be determined by the actual rural road network impedance along with the quality of service on this route segment. Parameters and variables used in the model and their notation are summarized in Table 1.

For the rural tourism bus network design problem, its major target is to gain an optimal set of tourist bus routes in the target destination under certain resource constraints. As shown in a previous study, travel time, road scenery, sightseeing places, outdoor activities, and facilities were significant factors in tourist route choice, and these route features are mainly considered in tourism bus route design [36]. Given the mismatch between the quality of the bus service and tourist expectations in the early phase of rural destination development, it is reasonable to take the maximization of tourist passenger benefits and satisfaction as the primary objective, which can stimulate the preference for sustainable transport modes by tourists. Consequently, this research gives priority to the travel cost factor. In addition, the quality of the tourist bus service variable is introduced to evaluate tourists' travel experience on a bus and the aesthetics along the route while guaranteeing transport efficiency. Thus, this paper also lays emphasis on maximizing the tourism bus quality of service. The overall quality of the tour bus services relates to several variables including the road scenery, road design attribute, and route popularity.

*3.3. Road Scenery Variable.* The road scenery refers to the sum of natural scenery and the artificial building environment along a rural road network. The utilization of scenery

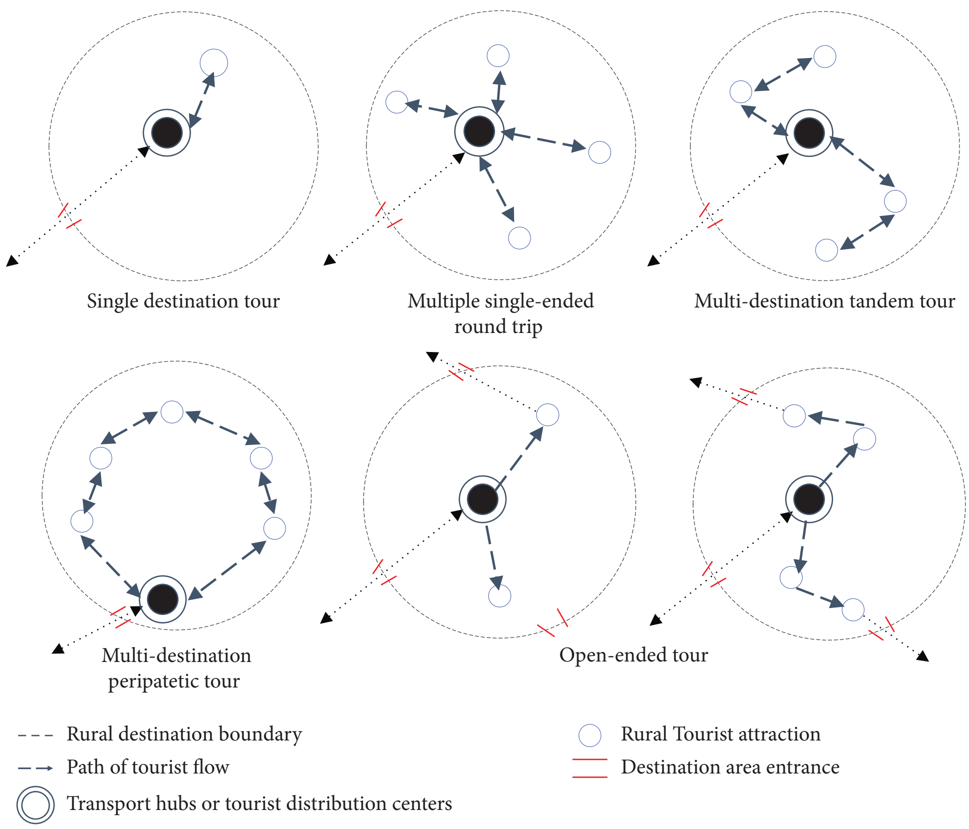


FIGURE 1: Typical mobility patterns of rural tourists.

along a road is the basic embodiment of road aesthetics. The quantitative evaluation index system of road scenery is constructed as illustrated in Table 2, and its scoring is based on a five-grade marking system.

*3.4. Road Design Attribute Variable.* In general, tourists expect a comfortable and enjoyable experience during a ride on a bus in their tourism trips, which is directly linked to their visual, kinaesthetic, and equilibrium senses based on the design attributes of rural roads. The higher the road classification and the better the road condition, the smoother the traffic and the more comfortable it is for passengers. In addition, road alignment is also a vital prerequisite for passengers to gain a comfortable travel experience. In this study, the road design indicators are selected from the perspective of passenger in-vehicle experience, taking into account the road alignment and technical standards (Table 3).

*3.5. Route Popularity Variable.* The route's popularity concerns tourist attractions, sightseeing places, and activities along the road. The higher evaluated popularity of a particular road segment reveals the higher significance of that segment in the tourism network. The popularity of each individual attraction is represented by the network service data, including the search index in search engines, posts on social networks, and the number of likes for the attraction.

$$h_t = \frac{r_t}{2} \cdot u_t \cdot (\omega_1 b_t + \omega_2 ch_t). \tag{1}$$

Calculates $h_t$, the popularity of attraction $t$. $r_t$ represents the classification and grade of attraction $t$. $u_t$ stands for the number of likes for attraction $t$, $b_t$ is the web search index, and $ch_t$ indicates the check-ins. The raw data for the number of likes, web search indexes, and check-ins are logarithmized as $x = \log x'$ to weaken the impact of disparities between value ranges. The route popularity $H_k$ is the sum of the popularity index of all attractions on a bus route $k$.

$$H_k = \sum_{t\in T} h_t \times y_t^k, \tag{2}$$

where $y_t^k$ is a binary parameter, equal to 1, if attraction $t$ is on the bus route $k$, that is within the visible area of route $k$; otherwise, it is equal to 0.

The quality of tourism bus service evaluation is established with a comprehensive consideration of the aforementioned indicators, and the weights of each indicator can be determined by the entropy method, reflecting the discrete degree of the indicators within the system as well as their importance. The calculation steps are presented as follows:

(1) The data are normalized, and the weight $w_{ps}$ of sample $s$ for indicator $p$ is calculated:

$$w_{ps} = \frac{\theta_{ps}}{\sum_{s=1}^{n} \theta_{ps}}. \tag{3}$$

Table 1: List of notations.

| Parameters | |
|---|---|
| $r_t$ | The classification and grade of attraction $t$ |
| $u_t$ | The number of likes for attraction $t$ |
| $b_t$ | The web search index for attraction $t$ |
| $ch_t$ | The check-ins for attraction $t$ |
| $\theta_{ps}$ | Value of sample $s$ for indicator $p$ |
| $\omega_p$ | The weight of indicator $p$ |
| $m$ | The number of indicators in the tourism bus service evaluation |
| $N_K$ | The total number of tourism bus routes |
| $Q_k^{i-1,i}$ | The passenger demand between bus stops $i-1$ and $i$ |
| $S_k^{i-1,i}$ | The value of service evaluation indicator between bus stop $i-1$ and $i$ on route $k$ |
| $\mu$ | The cost per unit of time |
| $d_{a,i,k}$ | The walking distance to bus stop $i$ on route $k$ |
| $q_k^i$ | The passenger demand at bus stop $i$ on route $k$ |
| $v_p$ | The tourist walking speed |
| $f_k$ | The vehicle departure frequency on route $k$ |
| $l_k^{i-1,i}$ | The distance between bus stops $i-1$ and $i$ on route $k$ |
| $v_{b,g}$ | The speed of the tour bus in-vehicle type $g$ |
| $\rho$ | The in-vehicle crowding coefficient |
| $Z_{k,g}$ | The number of seats in the vehicle of type $g$ |
| $A_{k,g}$ | The capacity of type $g$ vehicles |
| TTR | The total number of transfers on the tourism bus network |
| TTU | The number of unsatisfied passengers |
| $t_{tr}$ | The average walking time per transfer |
| T | The transfer time amplification factor |
| $\lambda$ | The transfer penalty |
| $Q_0'$ | The direct passenger flow with no transfer as a proportion of the total passenger demand |
| $T_{\max}$ | The maximum travel time for a tourism bus route |
| $\gamma$, $\varphi$, $\alpha$, $\beta$ | Parameters to be calibrated |
| *Variables* | |
| $y_t^k$ | A binary variable which equals to 1 if attraction $t$ is within the visible area of route $k$, and 0 otherwise |
| $x_i^k$ | A binary variable which equals 1 if stop $i$ is eventually selected as a stop of bus route $k$, and 0 otherwise |
| $\delta_{i,j}^k$ | A binary variable which equals 1 if route $k$ includes the arc $(i, j)$ between stops $i$ and $j$, and 0 otherwise |

Table 2: Rural scenery evaluation index and grading standard.

| Evaluation content | Description | Grade |
|---|---|---|
| Mountain view | Solitary and single view, only distant mountains | 1-2 |
| | Multiple views, including distant mountains, medium distance views, and close-up views | 3–5 |
| Waterscape | Water scenery and river valleys nearby | 1-2 |
| | Along the banks of streams, rivers, lakes, and seas | 3–5 |
| Field and meadow | Sparse and untidy field grass | 1-2 |
| | Fields are neat and rich in variety or have large meadows | 3–5 |
| Farmland and village | Have ordinary and irregular villages | 1-2 |
| | Farmhouses with moderate distance from a county road that have been environmentally improved to consist of an independent landscape | 3–5 |
| Forest | Solitary view with trees or a small woodland area | 1-2 |
| | Woodland views on both sides of the road | 3–5 |

Table 3: Road design attribute index and grading standard.

| Evaluation content | Description | Grade |
|---|---|---|
| Road classification | Highway, arterial, collector, local, and others | 5, 4, 3, 2, 1 |
| Road alignment | Smooth visuals, good continuity, and body comfort | 5 |
| | Relatively smooth visuals and good continuity, no obvious discomfort during the trip | 4~3 |
| | Poor visuals and continuity, discomfort during the trip | 2~1 |

(2) The information entropy value of indicator $p$ is calculated:

$$e_p = -\ln n^{(-1)} \sum_{s=1}^{n} w_{ps} \ln w_{ps}. \tag{4}$$

(3) The weight of indicator $p$ is calculated. Here, $m$ is the number of indicators:

$$\omega_p = \frac{1 - e_p}{m - \sum_{p=1}^{m} e_p}. \tag{5}$$

In tourism bus route planning, the travel cost and the quality of the bus service are taken into account, which highlights the necessity to develop a multiobjective function to optimize the tour bus route plan. The model is based on the following assumptions:

(1) The tourist OD demand distribution between tourism bus network nodes is known. Concerning the fluctuation of tourism demand, 80% of the peak hour tourism demand should be adopted when applying the proposed model.

(2) The location of the nodes in the bus route network and the travel time between these nodes are known.

(3) The bus departure frequency on each route is known.

(4) There are no loops in the route.

(5) Each bus route passes through at least one transport hub.

(6) The parameters in the model, including the tourist walking speed, vehicle operating speed, road segment length, vehicle capacity, and cost per unit of travel time, are all given in specific situations.

## 4. Mathematical Model

### *4.1. Objective Function*

$$\min C_p = \sum_{k\in K} \left(C_{a,k} + C_{w,k} + C_{iv,k}\right) + C_{tr}, \tag{6}$$

$$\max \overline{SL}_{\text{network}} = \frac{1}{N_K} \sum_{k\in K} \sum_{i\in I_k} Q_k^{i-1,i} \cdot x_i^k \cdot \left(\omega_1 \cdot S_{sce,k}^{i-1,i} + \omega_2 \cdot S_{rd,k}^{i-1,i} + \omega_3 \cdot S_{pop,k}^{i-1,i}\right). \tag{7}$$

The first objective function is expressed in equation (6) to minimize the total travel cost of the tour bus passengers $C_p$ in the target rural destination. $C_{a,k}$, $C_{w,k}$, and $C_{iv,k}$ represent the total costs of walking to bus stops, waiting at the stops, and the in-vehicle travel cost for passengers on the tour bus route $k$, respectively. $C_{tr}$ refers to the total transfer cost. The second objective function is (7), which is to maximize the quality of the tour bus network service in the rural destination. $\overline{SL}_{\text{network}}$ indicates the average quality of service for the tour bus routes. $K$ is the set of tourism bus routes, $N_K$ represents the total number of tourism bus routes, and $I_k$ is the set of nodes on route $k$. $x_i^k$ is a binary variable which equals 1 if stop $I$ is eventually selected as on stop of bus route $k$, and $Q_k^{i-1,i}$ denotes the passenger demand between bus stops $i$-– 1 and $i$. $S_{\text{sce},k}^{i-1,i}$, $S_{rd,k}^{i-1,i}$, and $S_{\text{pop},h}^{i-1,i}$, respectively, stand for the road scenery, road design attribute, and route popularity between bus stop $I$-– 1 and $i$ of tourism bus route $k$, and $\omega_p\,(p = 1, 2, 3)$ represents the weights of different variables in the evaluation of the tour bus service quality.

Equation (8) describes the calculation formula of the total cost for accessing bus stops on tourism bus route $k$,

$$C_{a,k} = \mu_a \left(\sum_{i\in I_k} \frac{d_{a,i,k}}{v_p} \cdot q_k^i \cdot x_i^k\right), \tag{8}$$

where $d_{a,i,k}$ is the walking distance to bus stop $i$ on route $k$, $v_p$ represents the tourist walking speed, $q_k^i$ is the passenger demand at bus stop $i$ on route $k$, and $\mu_a$ is the cost per unit of tourist walking time.

The bus passenger waiting time (9) is the time waiting for vehicles to arrive at a bus stop, and the average waiting time of passengers is a function of the vehicle departure frequency:

$$C_{w,k} = \mu_w \left(\sum_{i\in I_k} \frac{\gamma}{2 f_k} \cdot q_k^i \cdot x_i^k\right). \tag{9}$$

In the expression, $\mu_w$ is the cost per unit of the waiting time, $f_k$ indicates the vehicle departure frequency on route $k$, and $\gamma$ is a parameter to be calibrated, which equals 1 when passengers arrive in a uniform distribution.

In (10), the calculation of the bus passenger in-vehicle travel cost involves the tourism bus route length, vehicle speed, the calculated cost per unit of travel time, and the in-vehicle crowding level.

$$C_{iv,k} = \mu_{iv} \left[\sum_{i\in I_k} \frac{l_k^{i-1,i}}{v_{b,g}} (1+\rho)^{\varphi} \cdot Q_k^{i-1,i} \cdot x_i^k\right]. \tag{10}$$

In the expression, $l_k^{i-1,i}$ represents the distance between bus stops $i$-– 1 and $i$ on route $k$, $v_{b,g}$ is the speed of the tour bus in-vehicle type $g$, $\mu_{iv}$ refers to the cost per unit of travel time, and $\varphi$ is a parameter to be calibrated that is set to be 1 based on previous research [37] to simplify the calculation. Most passengers have a relatively high demand for comfort for a bus ride in tourism travel and desire individual seats. When the number of passengers exceeds the available seats or the capacity of the vehicle, tourist discomfort will continue to grow. Thus, the in-vehicle crowding coefficient on road segment ($i$–– 1, $i$) is defined as $\rho$, which is calculated as demonstrated in the following equation:

$$\rho = \begin{cases} 0, & \text{if} Q_k^{i-1,i} < Z_{k,g}, \\ \dfrac{\alpha\left(Q_k^{i-1,i} - Z_{k,g}\right)}{A_{k,g}}, & \text{if} Z_{k,g} < Q_k^{i-1,i} < A_{k,g}, \\ \dfrac{\alpha\left(Q_k^{i-1,i} - Z_{k,g}\right)}{Cp_{k,g}} + \dfrac{\beta\left(Q_k^{i-1,i} - A_{k,g}\right)}{A_{k,g}}, & \text{if} Q_k^{i-1,i} > A_{k,g}, \end{cases} \tag{11}$$

where $Z_{k,g}$ is the number of seats in the vehicle of type $g$ on tourism bus route $k$, $A_{k,g}$ refers to the capacity of type $g$ vehicles on route $k$, and $\alpha$ and $\beta$ are parameters to be calibrated.

The transfer time cost covers the walking time cost and the waiting time at the transfer stations. It is noticeable that the same time spent waiting for buses may be felt psychologically to be longer than the same amount of in-vehicle time [38]. In view of this, the transfer time amplification factor $\tau$ ($\tau > 1$) is set to manifest the passenger's perceived transfer waiting time. Furthermore, studies have uncovered that for most passengers, the acceptable number of transfers is less than or equal to two. Thus, the transfer penalty is introduced to tackle the situation when the number of transfers is more than two and passengers' demands are not effectively satisfied. Equation (12) explains the calculation of the transfer time cost.

$$C_{tr} = \mu_{tr}\left[\left(\text{TTR}\cdot\left(\tau\left(t_{tr} + \frac{\gamma}{2f_K}\right)\right) + \lambda\cdot\text{TTU}\right)\right], \tag{12}$$

where $\mu_{tr}$ is the cost per unit of the transferring time. It is noteworthy that the parameters for cost per unit of time, including $\mu_a$, $\mu_w$, $\mu_{iv}$ and $\mu_{tr}$, vary in diverse travel processes, impacted by factors including passengers' socio-economic characteristics, trip purposes, and so on. Specifically, as noted in previous research, the value of time may be higher for trips during working time than nonworking time [39]. TTR is the total number of transfers on the tourism bus network and TTU refers to the number of unsatisfied passengers. Here, an unsatisfied transfer is counted as the number of transfers being larger than two. $t_{tr}$ is the average walking time per transfer, and $\lambda$ is the transfer penalty.

### *4.2. Constraints*

#### *4.2.1. Public Transport Hub Constraint*

$$\sum_{j\in U}\delta_{i,j}^{k} \geq 1, \quad \forall i \in S, \forall k \in K. \tag{13}$$

Constraint (1) ensures that the tour bus routes pass through at least one public transport hub to effectively connect the tourism bus network with the existing rural public transport network. $\delta_{i,j}^{k}$ is a binary variable that is equal to 1 if route $k$ includes the arc $(i, j)$ between stops $i$ and $j$, and is equal to 0 otherwise. Here, $S$ denotes the set of major nodes in the rural tourism bus network, $S = (H \cup M)$. And, $U$ denotes the set of general nodes, $U = N - S$.

#### *4.2.2. Tourist Passenger Demand Constraint.* 

The number of transfers is a major manifestation of the ease of travel. Concerning convenience for tourists, equation (14) is used to ensure that the ratio of direct tourism passenger flow without transferring to total passenger demand is maintained above a certain level:

$$Q_0' \geq (W_0)_{\min}, \tag{14}$$

where $Q_0'$ refers to the direct passenger flow with no transfer as a proportion of the total passenger demand, and $(W_0)_{\min}$ represents the minimum acceptable proportion of tourist bus users with no transfer. The number of transfers is defined as the transfer number required to access the final attraction after entering the tour bus route network.

#### *4.2.3. Route Travel Time Constraint.* 

The route travel time is influenced by the size of the study area and the tourist travel distance. If the route travel time exceeds the expected value and the detour distance rises, it will reduce transport efficiency and increase ride time sensitivity for tourists, thereby making them feel worse about the travel experience. Thus, equation (15) describes the constraint for the route operating time, where $T_{\max}$ is the parameter indicating the maximum travel time for tourism bus routes.

$$\sum_{i\in I_k}\frac{l_k^{i-1,i}}{v_{b,g}} \leq T_{\max}, \quad \forall k \in K. \tag{15}$$

#### *4.2.4. Route Nonlinear Coefficient Constraint.* 

To guarantee travel efficiency, the nonlinear coefficient of an individual bus route should be kept within an acceptable range in line with local guidelines for public transport design. To be specific, the coefficient is suggested to be lower than 1.4 in the design of regular bus routes in China [40]. When designing the tour bus route, it is somewhat acceptable to enlarge this factor appropriately to take the road scenery factor into account.

#### *4.2.5. Number of Route Constraint.* 

The simple addition of new tourism bus routes and the increase of the bus departure frequency certainly facilitate the operation and service of a tourism bus, whereas it also intensifies the operating burden for operators. In view of this, the limitation on the number of tourist bus routes is set on the premise of known bus departure frequency.

## 5. Solution Method

The design of tourism bus routes in rural destinations is a typical multi-objective optimization problem. To find the optimal bus routes for tourists in terms of both the travel cost and the service quality, a heuristic algorithm is established according to the idea that the initial route set is first generated based on network hierarchy and tourism demand, and then the route set is iteratively optimized through a genetic algorithm.

*5.1. Initial Alternative Route Set Generation.* The initial tourism bus route set contains three levels of alternative path sets. The flow chart of the generation of initial routes is depicted in Figure 2.

The express routes in set A are derived from the shortest path between the major tourist attractions and the principal tourist distribution center in the rural destination. These routes pay attention to tourist preferences and the significance of tourist attractions and tend to minimize the number of transfers. The major routes in set B are inclined to set up direct links between OD pairs with large tourism demands. The branch routes in set C mainly consider public transit accessibility to different tourism nodes and take the unserved tourism nodes as the starting and ending points of the routes.

To avoid the overlapping of routes, the ratio of passenger arrivals at a node to the number of routes passing this node tends to be maximized when searching for the next node, and this node is optimized if the route nonlinear factor constraint is met. There are mainly two conditions for the stop of node search: (1) reaching the maximum length constraint, or (2) satisfying the stopping probability constraint. The stopping probability $P_s$ is defined as the ratio of the current route length to the maximum route length allowed. A random number $K_r$ is generated, and if $K_r < P_s$, then the search is stopped. Otherwise, the next node continues to be searched for, and a collection of tourist bus branch routes will be generated.

*5.2. Route Set Optimization*

*5.2.1. Strengthen Elitist Genetic Algorithm.* Among the many multiobjective evolutionary algorithms, the strengthen elitist genetic algorithm (SEGA) is one of the most frequently applied multiobjective evolutionary algorithms. To prevent the loss of the optimal individuals of the current population in the next generation, leading to the failure of converging to the global optimal solution, the elitism strategy is proposed. The best individuals that have emerged so far in the evolutionary process of the population are copied directly into the next generation without genetic manipulation, generally replacing the worst individuals in the next generation. The SEGA improves the global convergence of standard genetic algorithms, which has been theoretically proven to be globally convergent. In this section, it will elaborate on the process and operators used in the proposed algorithm to obtain the Pareto front.

*5.2.2. Fitness Function.* The fitness function is a criterion for selecting high-quality individuals in a population according to the objective function. It is necessary to map the objective function to a fitness function with maximal form and nonnegative function values. For maximum problems, the fitness function equals the objective function. In terms of minimum problems, the negative of the objective function is taken as the fitness function.

$$F = -C_p, \tag{16}$$

where $C_p$ is the result of equation (6). The limitation of this method lies in the possible unreasonable distribution problem of the calculated individual fitness and the difficulty in manifesting individual features. Thus, fitness scaling is conducted in this study as follows:

$$\begin{cases} F' = a_1 F + a_2, \\ a_1 = \dfrac{(a_3 - 1)F_{\text{avg}}}{F_{\max} - F_{\text{avg}}}, \\ a_2 = \dfrac{\left(F_{\max} - a_3 F_{\text{avg}}\right)F_{\text{avg}}}{F_{\max} - F_{\text{avg}}}, \end{cases} \tag{17}$$

where $F_{\text{avg}}$ is the average of the original fitness $F$, $F_{\max}$ is the maximum of the original fitness $F$, and $a_3$ is the expected number of replicates for optimal individuals, usually within the range 1.0–2.0. In this case, $a_3 = 1.5$.

*5.2.3. Crossover and Mutation.* The partially matching crossover method is adopted in this study, which has been verified by previous research to be able to avoid repeated coding in the offspring [41]. Firstly, two crossover points are randomly set, and the mapping relationship of numbers between the two crossover points is recorded. Then, the genes between the two crossover points in the randomly selected parent generation are exchanged directly to obtain the offspring. In terms of the mutation operation, the inversion mutation operation is applied. Two reversal points are randomly selected, and the gene values are inserted between these two points into the original position in reverse order.

*5.2.4. Selection.* To reinforce the convergence of the algorithm, the tournament and elitist selection methods are employed. To begin with, $N$ individuals are selected in the population as parents based on the championship principle. Then, offspring are generated through crossover and mutation. To avoid the loss of elite individuals in the parent population, the offspring and parents are directly merged to form a 2N-sized population. Finally, the top $N$ individuals with the highest fitness are chosen using the elitist selection method.

*5.2.5. Proposed Algorithm.* The steps of SEGA applied in this study can be summarized as follows:

*Step 1.* Initialize the parameters including the population size $NP$, maximum evolving algebra $NG$, crossover rate $P_c$, and mutation rate $P_m$.

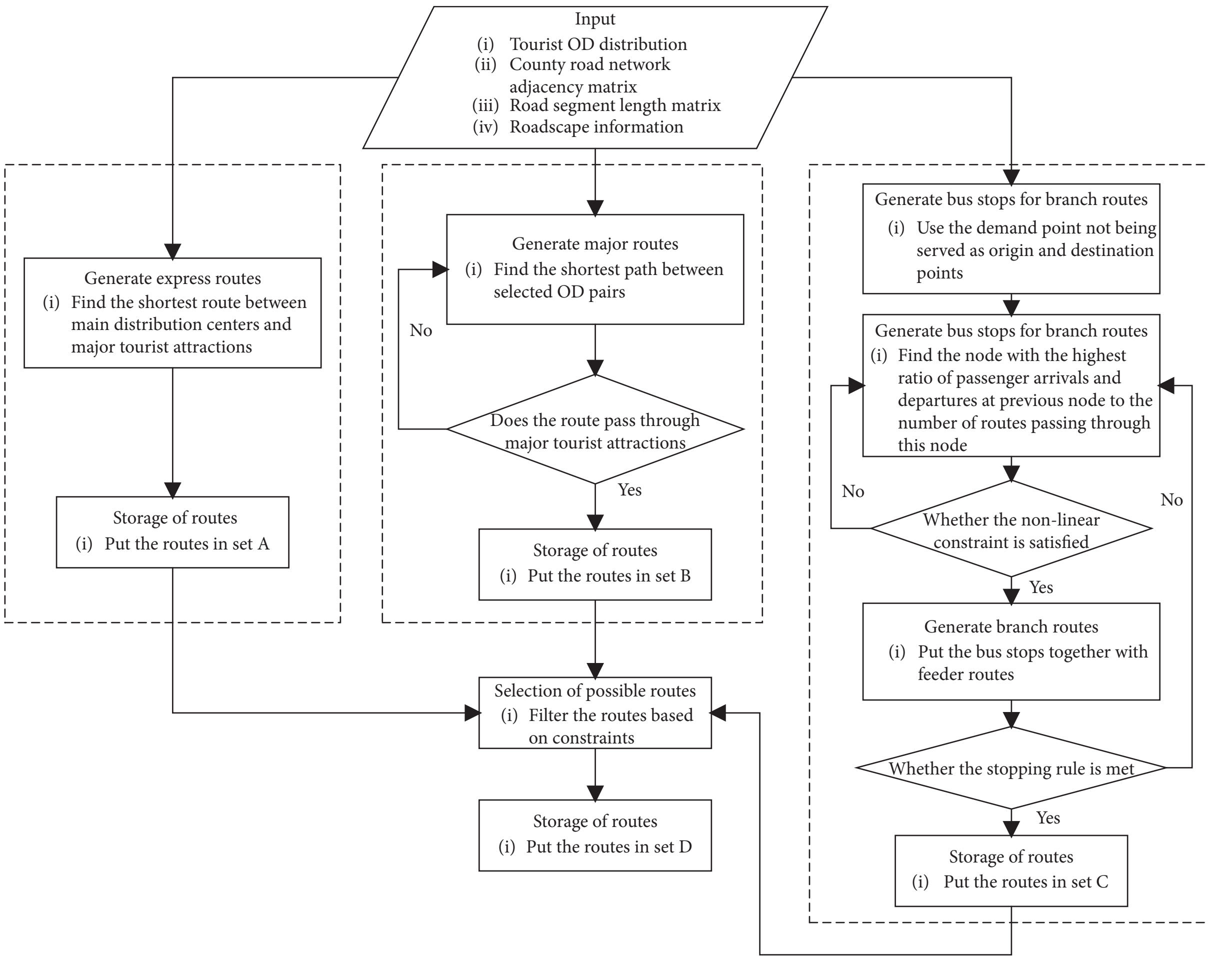


Figure 2: Flowchart of initial tourism bus route set generation.

*Step 2.* Initialize a population of *NP* individuals according to the proposed method.

*Step 3.* Calculate the objective function value and the fitness value of each individual.

*Step 4.* Select *NP* individuals as parents using the championship selection method.

*Step 5.* Perform a partially matching crossover operation and an inversion mutation operation to generate *NP* offspring.

*Step 6.* Calculate the objective function and the fitness values of each offspring.

*Step 7.* Combine the *NP* parents and the *NP* offspring to obtain 2*N* individuals.

*Step 8.* Select *NP* individuals as parents with the elitist selection method.

*Step 9.* Check whether the maximum allowable number of generations *NG* is reached. If not, return to Step 4; otherwise, go to Step 10.

*Step 10.* Stop the iteration and output the best solution.

## 6. Numerical Example

This section describes how the proposed model is verified based on a real-case example in Lishui, China, to prove its feasibility and the effectiveness of the algorithm. The solution methods are coded in Python 3.7.2 and implemented on a personal computer with an Intel Core i5-1135G7@ 2.40 GHz, 2.42 GHz, and 16.00 GB of RAM.

*6.1. Study Area.* The studied rural tourism destination, Lishui county in Nanjing, is shown in Figure 3. It is located in the south-central part of Nanjing, 45 km from the main city, with an area of 1067.26 km$^2$. With abundant tourism resources like natural scenic areas and leisure resort areas, Lishui is one of the most popular nonurban tourism destinations for residents in the Yangtze River delta. Around 62% of the local tourists and 55% of the foreign tourists self-

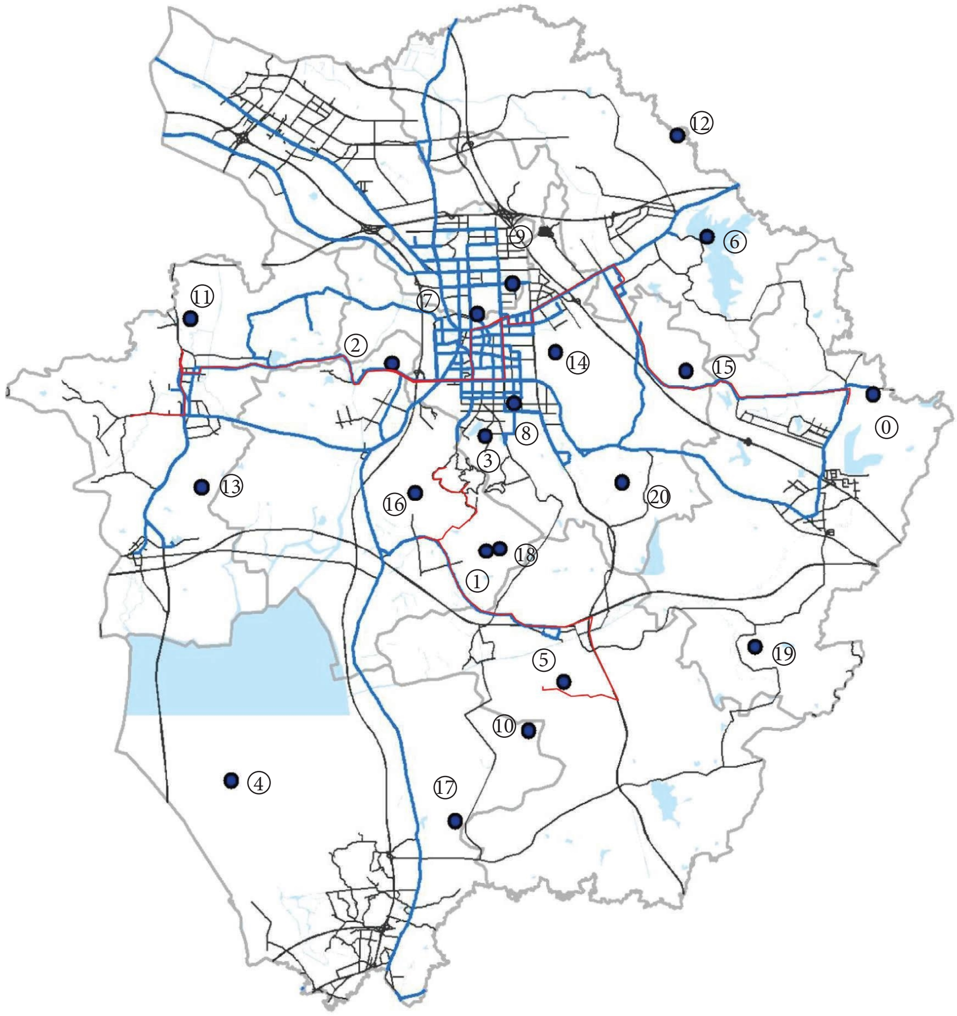


Figure 3: Tourism resources and existing bus network in Lishui district.

drove or took taxis to their final destinations in Lishui in 2021. The gathering of massive self-driving tourism demand on the rural road network around attractions during peak periods brings serious congestion and parking difficulties to local authorities, drastically reducing the comfort of tourists and hindering the sustainable development of the tourism and transport system.

Currently, there are 83 regular routes and 477 operating vehicles on the existing bus network, of which 78% are new energy and clean energy vehicles. This bus network is densely distributed in the center of the Lishui district, whereas the routes in the outskirts are loosely distributed. In an attempt to provide tourists with a more convenient and enjoyable travel experience on public transport and support the development of the local tourism industry, three dedicated tourism bus routes were developed by Lishui Public Transport Corporation in 2017 at the early development stage of Lishui tourism. These routes pass through the most maturely developed tourist attractions including Wuxiangshan Forest Park and Fujiabian Science and Technology Park and provide transport services to tourists with low automobility along with the existing rural bus network.

With the implementation of regional development strategies such as rural revitalization and regional tourism integration in recent years, the exploitation of tourism resources in the Lishui area has entered a rapid development stage in the life cycle of the destination. Many natural and rural tourism resources have been explored in depth, causing the reorganization of the regional tourism spatial layout from a scattered pattern to a plate pattern. These changes have made different tourist attractions increasingly closely connected and brought larger tourist demand, which challenges the transport system for tourism objectives, especially the insufficient provision of the public transport service. Demand for some newly explored attractions is not covered by the existing public transport service, and the convenience and comfort for tourists using the current tourism routes along with the rural bus network can be reinforced further. Given an origin and a destination, it is instrumental to generate a set of feasible routes from which the route(s) that gives the best compromise between travel costs and the quality of the bus service can be selected.

*6.2. Quality of Service Evaluation.* To estimate the quality of the tour bus services in (7), this paper evaluates the road scenery, road design attribute, and popularity of different road segments in the Lishui district. For the popularity indicator, tourist attractions, sightseeing places, and activities on both sides of the target road segment are included in the evaluation. The raw data for the number of likes and check-ins of different attractions were collected from the popular social media platform, Weibo, on March 7, 2022. The web search index was drawn from the Baidu search engine on the same day. Then, the popularity values were calculated based on (1) and (2) To simplify the calculation, the weighting factors in (1) are set to 0.5. Concerning the calculation of the road scenery indicator and road design indicator of each segment, pictures and data were acquired from a field survey conducted on March 3, 2022, and Baidu Street view to obtain information on road alignment, classification, and sceneries within the visible areas. This information was offered to 14 experts in urban transport planning and design, including 2 professors, 4 associate professors, and 8 doctoral and graduate students, to score the road scenery indicator and road design indicator based on the criteria described before. Here, the mean value of the experts' scores is taken as the indicator value (Table 4).

After the normalization of the subindexes, the entropy method stated in Equations (3) to (5) is employed to find the weighting factors of the road scenery variable, road design attribute variable, and popularity variable of 0.165, 0.340, and 0.495, respectively. The evaluated qualities of service on each road in the Lishui district are displayed in Table 4.

*6.3. Parameter Settings.* The major parameters for the example are presented in Table 5. The speed of the tour buses should allow tourists to appreciate the scenery of certain areas. In this paper, the average speed of all operating tourist buses is assumed to be 40 km/h concerning rural road conditions and the current operating speed on existing routes in Lishui. The formula proposed in previous research [42] is applied to calculate the general value per minute for practical applications. Here, the unit monetary value of the time is correlated with the average monthly working time and the income of the residents in the source regions of the tourists. Nowadays, the tourist flows of the Lishui District mainly stem from Nanjing City and the Yangtze River Delta region. The average departure frequency, the capacity of tourist buses, the number of seats, and the maximum travel time for a route are set based on related work [43] and the operation of the existing tourism bus routes in the Lishui district.

Experimental tests are conducted to find the appropriate values for the control parameters in the designed algorithm. Based on the experimental results and parameters in previous literature, the final settings employed in this study are as follows: the number of generations, 400, population size, 50, crossover probability, 0.9, and mutation probability, 0.05. To avoid exceptional cases caused by the randomness of the genetic algorithm, tests are carried out several times in the computational example.

*6.4. Results and Interpretations.* Figure 4 illustrates the convergence process for the total generalized travel cost for rural tourism bus passengers and the quality of tourism bus services in the iteration process. It is evident that with the rise of iterations, the travel cost objective declines, and the quality-of-service objective increases. At the beginning of the generation, a large rate of change can be noticed in both objective values, which then tend to gradually become stable in the later generation, reflecting the convergence of the developed algorithm.

Figure 5(a) manifests the change in the number of nondominated solutions as the number of generations increases. To reveal the improvement of Pareto optimality against the number of generations, the average global fitness values in different generations are also displayed in Figure 5(b) based on the fitness function. In general, the proposed algorithm enhances the global Pareto optimality against the number of generations.

The Pareto front of the proposed algorithm is described in Figure 6. When the quality of tourism bus service is improved, the total generalized travel cost for all tourism bus passengers also increases, which reflects the conflicting nature of the two objectives of the model. The Pareto front contains a set of nondominated solutions, all of which can be considered optimal to some extent, depending on the relative importance of the two objectives. In practice, these alternative optimums can provide planners and local authorities with different plans for rural tourism bus routes for the final optimization decision-making.

The Pareto optimal solutions with the extreme value of different objectives are compared with the existing tourism bus services. As depicted in Table 6, at present, three dedicated tourist bus routes along with 86 regular routes undertake travel services for tourists in the Lishui district, but only eight tourist attractions are accessible via these routes. For the route scenarios obtained from the proposed method, the number of tourist routes increases to fifteen, including three express routes, three major routes, and nine branch routes. All attractions in the study area can be reached through this added network. Taking the solution with the minimum total travel cost as an example, the lengths of the added tourist routes after the design are concentrated in the range of 10–40 km. Although long routes with lengths over 20 km account for the majority of these routes, the average route length slightly decreases to 26.59 km. Express routes have relatively short lengths because they link the major attractions and principal tourist distribution centers with the shortest paths. The average nonlinear coefficient of tourist routes

Table 4: Examples of the evaluated quality of service on different roads in the Lishui district.

| Road | Grade | Road scenery indicator | Road design indicator | Popularity indicator | Service quality |
|---|---|---|---|---|---|
| Qunli avenue | Highway | 17 | 10 | 0.008 | 6.24 |
| Qinyin avenue | Highway | 20 | 10 | 1.252 | 7.32 |
| S341 | Highway | 22 | 8 | 2.364 | 7.52 |
| Huaiyuan avenue | Highway | 17 | 7 | 0 | 5.19 |
| Xingzhuang road | Arterial | 13 | 7 | 0.616 | 4.83 |
| Sports park road | Arterial | 12 | 7 | 0.263 | 4.49 |
| Tianshengqiao avenue | Highway | 14 | 8 | 1.798 | 5.92 |
| Zhongshan road | Collector | 8 | 5 | 0.303 | 3.17 |
| Jiaotong road | Arterial | 10 | 7 | 1.030 | 4.54 |
| ... | ... | ... | ... | ... | ... |

Table 5: Major parameters for the numerical example of the Lishui district.

| Parameter | Value |
|---|---|
| Generalized costs for one minute of in-vehicle time (yuan RMB/min) | 0.746 |
| Generalized costs for one minute of waiting time (yuan RMB/min) | 0.746 |
| Generalized costs for one minute of walking time (yuan RMB/min) | 0.746 |
| Average departure frequency of tourist bus routes (vehicles/h) | 4 |
| Passenger capacity of tourist buses | 40 |
| Number of seats on a tourist bus | 20 |
| Maximum number of tourist bus routes | 15 |
| Parameters $\alpha$ in the in-vehicle crowding coefficient calculation | 1 |
| Parameters $\beta$ in the in-vehicle crowding coefficient calculation | 2 |
| Passenger average walking time to bus stations (minute) | 5 |
| Passenger average transfer walking time (minute) | 3 |
| Transfer time amplification factor | 1.5 |
| Transfer penalty | 2 |
| Tourist bus operating speed (km/h) | 40 |
| Maximum travel time for a tourist bus route (minute) | 120 |
| Population size | 50 |
| Maximal number of iterations | 400 |
| Crossover probability | 0.90 |
| Mutation probability | 0.05 |

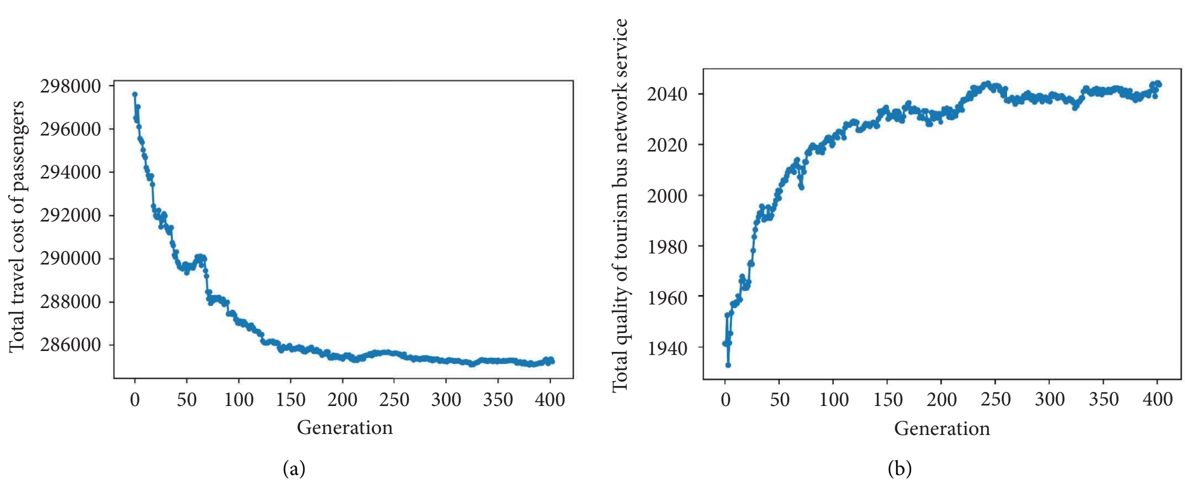


Figure 4: Convergence of different objectives: (a) total travel cost of tour bus passengers; (b) quality of tourism bus network service.

after the design is 1.44, lower than the present value. Moreover, it can be found that this coefficient increases to 1.78 for the solution with the highest quality of service objective value. This may be owing to the detours on roads with a higher quality of service in the outskirts of Lishui to improve the overall quality of tourism bus services.

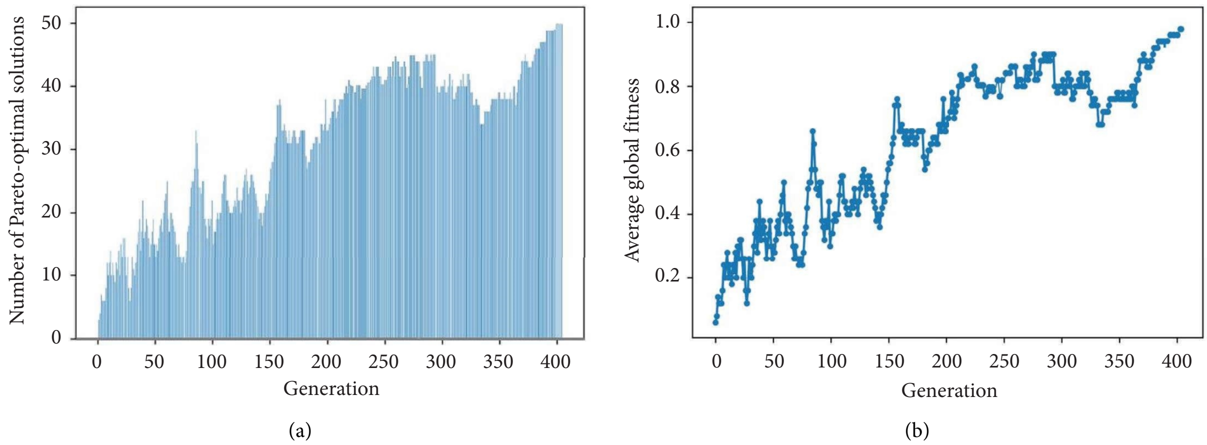


Figure 5: Changes in: (a) number of Pareto-optimal solutions; (b) Average global fitness as the number of generations increases.

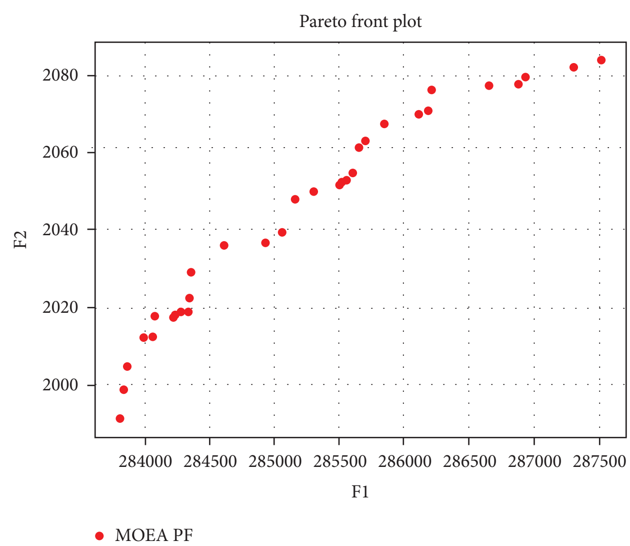


Figure 6: Objective values of Pareto optimal solutions generated by the designed algorithm.

Table 6: Results of tourist bus routes after the design compared to the existing network.

| Studied variables | Existing | Result with minimized generalized cost | Result with maximized quality of service |
|---|---|---|---|
| Tourist bus route amount | 3 | 15 | 15 |
| Total suburban and rural bus route amount | 86 | 96 | 96 |
| Accessible tourist attractions via the routes | 8 | 21 | 21 |
| Total generalized cost for all bus passengers in tourists | 323684.27 | 283806.37 | 287512.17 |
| Total level of service for tourist routes | 491.6 | 1991.41 | 2083.75 |
| Total tourist route length (km) | 87.39 | 398.85 | 428.10 |
| Average length of all tourist routes | 29.13 | 26.59 | 28.54 |
| Average nonlinear coefficient of all tourist routes | 1.61 | 1.44 | 1.78 |
| Ratio of bus trips with no transfer per trip | 29.38% | 83.38% | 83.20% |
| Ratio of bus trips with one transfer per trip | 46.80% | 15.55% | 15.78% |
| Ratio of bus trips with more than one transfer per trip | 23.82% | 1.07% | 1.02% |
| Total transfer cost for all tourist passengers | 13517.94 | 3858.20 | 3876.29 |

Table 7: Tourism bus routes after design and optimization in the Lishui district.

| No. | Type of tourism bus route | Attractions served by the route | Route length (km) | Travel time (hour) | Nonlinear coefficient |
|---|---|---|---|---|---|
| 1 | Express | ② | 15.3 | 0.51 | 1.37 |
| 2 | Express | ③ | 13.1 | 0.44 | 1.31 |
| 3 | Express | ⓪ | 20.2 | 0.67 | 1.40 |
| 4 | Major | ③-②-⑪-⑬-④ | 38.3 | 1.28 | 2.29 |
| 5 | Major | ①-③-⑳-⓪ | 31.7 | 1.06 | 1.70 |
| 6 | Major | ⑪-②-⑦-⑭-⑮-⓪ | 42.7 | 1.42 | 1.59 |
| 7 | Branch | ③-⑯-⑤-⑩-⑰ | 27.9 | 0.93 | 1.79 |
| 8 | Branch | ③-⑧-⑭-⑨ | 12.9 | 0.43 | 1.84 |
| 9 | Branch | ②-⑯-①-⑱-⑤-⑩-⑰ | 38.5 | 1.28 | 2.02 |
| 10 | Branch | ①-③-⑧-⑦ | 17.4 | 0.90 | 1.22 |
| 11 | Branch | ⓪-⑮-⑥-⑫ | 26.6 | 0.89 | 1.89 |
| 12 | Branch | ⓪-⑲-⑤-⑰ | 34.6 | 1.15 | 1.40 |
| 13 | Branch | ④-⑯-①-⑱-⑳-⑮ | 44.7 | 1.49 | 1.46 |
| 14 | Branch | ④-⑤-⑩-⑰ | 37.5 | 0.93 | 2.53 |
| 15 | Branch | ⑤-⑲-⑳ | 26.7 | 0.89 | 2.84 |

In general, the increase in the number of tourism bus routes gives rise to the elements of rural bus service coverage for tourism and decreases the tourist travel time but extends the total tourism bus route length. Concerning that the reduction in the average length and the change in the average nonlinear coefficient after optimization may affect the route choice behavior of tour bus passengers, it is assumed that visitors use the added tourist bus route network to fulfill their travel demand. In addition, the ratio of bus trips without transfer is around 83% after the design, which is 2.84 times that of the existing situation. The percentage of tourist bus travels that have to transfer has been clearly reduced, especially those with over two transfers which have decreased to a negligible degree around 1%. This leads to a 71.5% decrease in the total transfer penalty for all tourism bus passengers in comparison to the transfer penalty in the existing suburban and rural bus network. Consequently, the total generalized cost for one day is reduced by 12.32% after the design due to the decline in the total cost of walking to bus stops, in-vehicle travel time for passengers on the bus routes, and total transfer cost, whilst the waiting time at stops remains unchanged. The overall travel efficiency of a rural bus network for tourists is strengthened.

Given the significance of the bus service quality for tourists, the results of tourism bus routes in the Pareto optimal solution with the highest quality of service are demonstrated in Table 7. The three express routes connect the Lishui rail station area with major tourist attractions, with route 1 and route 3 overlapping with the existing routes and route 2 departing from Lishui rail station along with the Lishui bus terminal and going south to serve the Wuxiangshan National Forest Park. The three major routes enable the movement of tourists between major attractions while branch routes cover other nodes in the network.

While the research findings provide a guideline for rural tourism bus routing with objectives concerning tourists, there are some limitations and potential improvements in the future. For example, the objectives concerning operators, such as the operation cost and service frequency, have not been taken into account because the optimization in this study focuses on the tourist perspective and aims to support and promote rural tourism development at the early stage. Optimal routing with operator objectives and bus scheduling requires further in-depth analysis to improve a tourism bus service with the gradual development of rural tourism destinations. In addition, different optimization algorithms can be compared to make the proposed algorithm more effective.

## 7. Conclusions

Rural public transport is an essential component of the sustainable tourism transport system. The concentration of tourist demand during peak periods makes it hard for regular rural bus networks to provide quality travel services to tourists. The plan and route design of tourist buses is thus of great significance to improve the attractiveness of bus mode to rural tourists, and it is critical for tourists to have an enjoyable experience on the bus with the least travel cost. In this paper, the rural tourism bus route design problem is built as an optimization model concerning both minimizing the total travel cost for tour bus passengers and maximizing the quality of a tourism bus service. A SEGA-based approach is implemented to solve this multiobjective tourism bus routing problem. The procedure for generating initial candidate solutions is conducted according to the route type and demand. The real bus network in a rural tourism destination, the Lishui district in Nanjing, is studied as a numerical example to verify the feasibility and efficiency of the proposed model and the solution methods. According to the results, the proposed method can provide an optimized plan for rural tourism bus routes with a lower total travel cost and total transfer penalty while maintaining a higher quality of tourism bus services regarding road scenery, road design attributes, and route popularity. Moreover, the most immediate benefit from the tour bus route design is the significant improvement in tourism destination accessibility by public transport, which also reduces the proportion and cost of tourist transfers.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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