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Research and Application on Location Model of Community Exits and Entrances

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Abstract. To further study the location problem of the entrances and exits of the community, based on the shortest path algorithm to obtain the shortest distance between any two points. According to the actual situation of the community location, the proportion of parking spaces in different parking areas in a theme park is weighted analyzed by the method of proportion coefficient, which is used as the weight coefficients of each corresponding shortest path in the traffic network diagram. Finally, taking the minimum path weighted value of the vehicle into and out of the community as the goal, the location model of theme park gateway is constructed, and the location scheme of the community entrance and exit is determined. At the same time, the research on the location of the entrance and exit of the Dong daqiao community in Chaoyang district of Beijing is used as an application case of this algorithm, the result shows that using weighted shortest path algorithm to determine the community entrance and exit can minimize the distance cost of the vehicles, which can effectively save travel time, and improve the travel efficiency of the travelers.

1. Introduction

Community gateway location selection refer to the planning process of selecting the best agent to entrances and exits in a number of alternative gateway in a community [1], There are many methods about community gateway location selection, and the shortest path location method [2] is one of the most popular methods. For the shortest path problem, Dijkstra [3] proposed a single-source shortest path algorithm that solves the shortest path from an initial point to all points. Floyd [4] gave an algorithm to find the shortest path between any two points in a given weighted graph.

At home and abroad, a lot of studies has been done on the shortest path problem, and many optimization algorithms have been improved. Nicholson [5] proposed forward and reversed alternation search algorithm of Dijkstra, Dantzig [6] proposed pruning algorithm of reach. Jianmei Liu [7] proposed the dynamic shortest path calculation method based on improved Dijkstra algorithm, Dequan Zhang [8] proposed Floyd acceleration algorithm and optimization method, Lan Lin [9] proposed a dynamic network shortest path problem complexity and approximation algorithm, Guangzheng Long [10] proposed an optimization of the shortest path algorithm by introducing the concept of parallel processing.



At this stage, the study of multiple short-circuit problems can be divided into two directions: one is the strict equivalent shortest path algorithm, the other is the generalized K shortest path (K Shortest Paths, KSP). KSP algorithm proposed by Hoffman [11] for the first time to solve the shortest path. With further research, the algorithm and its application have been fully studied, Tao Xu [12] has made a more comprehensive summary of this, Lixing Wang [13] proposed an algorithm for optimizing the autoregressive phenomenon in multiple shortest paths, Zhijian Wang [14] modified the Dijkstra algorithm by modifying the temporary labeling method.

At present, the study of the shortest path algorithm is used for location selection, most of which take the shortest path obtained directly by the algorithm as the basis of the final location selection, while the analysis of other factors in the gateway location is lacking, which leads to the application of the shortest path algorithm to the location selection does not analyze the weight of the shortest path, so the algorithm of weighted analysis of the shortest path needs to further study. Therefore, based on the shortest path algorithm, according to the actual location situation of the community, the proportion of parking spaces in different parking areas in community is weighted analyzed by the method of proportion coefficient, which is used as the weight coefficients [15] of each corresponding shortest path. Finally, taking the minimum weighted path value of the vehicles into and out of the theme park as the goal, constructing the community gateway location model, and qualitatively put forward the location scheme of the community entrances and exits.

2. Model construction based on weighted shortest path algorithm

The graph is made up of a number of given points and lines connecting two points, which is usually used to describe a particular relationship between certain things, with points representing things, with a line between two points representing the relationship between the two things [16]. For the location problem in the community gateway, assuming the community gateway, intersections and parking areas as points, the roads as lines, the length of the roads as the edge weights, we can construct a graph of community traffic network.

2.1. Assumptions for model construction

The construction of the model can be described as follows:

Assuming every gateway, intersection, and parking area is simplified as a particle.

Assuming the number of alternative community gateway is λ , the number of intersections is β and the number of parking areas is θ , namely $\lambda + \beta + \theta = n$, which shows the sum of the number of alternate gateway, intersections and parking areas is n . The n points are regarded as the vertices of the directed graph and numbered sequentially, such as: gateway are numbered as No. λ_i ($i=1,2,\dots, \lambda$), intersections are numbered as No. β_i ($i=1,2,\dots, \beta$) and parking area are numbered as No. θ_i ($i=1,2,\dots, \theta$).

Assuming the distance of adjacent intersections in the community and the traffic flow are known. The number of line between any two points indicates the distance of the two points, and the arrow indicates the direction of traffic flow.

The above assumption can be represented as Fig. 1.

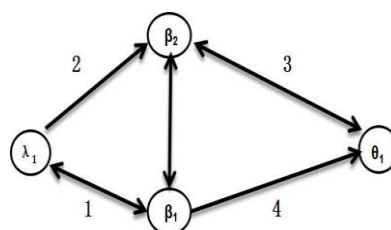


Figure 1. Diagrammatic sketch of traffic directed network.

2.2. Model construction

Based on the above assumptions, we first define the distance weight matrix: $D^m = (d_{ij}^{(m)})_{n \times n}$, and the posterior point matrix $R^m = (r_{ij}^{(m)})_{n \times n}$, where:

$$D_{ij}^{(m)} = \begin{cases} w_{ij}, & \text{while } (i, j) \in E \\ \infty, & \text{other} \end{cases} \quad (1)$$

In the equation (1):

$d_{ij}^{(m)}$ — the shortest distance from the point No. i to the point No. j ;

w_{ij} — the distance weight from the point No. i to the point No. j , if the path does not exist, then

$d_{ij}^{(m)} = 0$;

E — the path set in the graph.

For each element, we can use $R^m = (r_{ij}^{(m)})_{n \times n}$ to record the direction of the shortest directional road.

The specific steps of model construction are as follows:

Step one: construction of directed graph of community traffic network

According to the community structure map, constructing a directed graph of community traffic network.

Step two: determination of D^0 and R^0

When $m = 0$, obtaining the initial distance weight matrix: $D^0 = (d_{ij}^{(0)})_{n \times n}$ and the initial posterior point matrix: $R^0 = (r_{ij}^{(0)})_{n \times n}$.

By definition we can know that if there is a path between point No. i and point No. j , then the value of $d_{ij}^{(0)}$ is equal to the length of the line; if not, then the value of $d_{ij}^{(0)}$ is equal to infinity, and the value of d_{ii} is always equal to zero, so the initial distance weight matrix D^0 can be represented as follows:

$$D^0 = \begin{pmatrix} 0 & d_{12}^{(0)} & d_{13}^{(0)} & \cdots & d_{1n}^{(0)} \\ d_{21}^{(0)} & 0 & d_{23}^{(0)} & \cdots & d_{2n}^{(0)} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ d_{n1}^{(0)} & d_{n2}^{(0)} & d_{n3}^{(0)} & \cdots & 0 \end{pmatrix}$$

When $m=0$, $r_{ij}^{(0)}=j$; $i, j=1,2,3,\dots,n$, the initial posterior point matrix R^0 can be represented as follows:

$$R^0 = \begin{pmatrix} 1 & 2 & 3 & \cdots & j \\ 1 & 2 & 3 & \cdots & j \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & 2 & 3 & \cdots & j \end{pmatrix}$$

Step three: determination of D^n and R^n .

For the $m=1,2,3,\dots,n$, using the equation(2) to obtain the value of $d_{ij}^{(m)}$; using the equation(3) to obtain the value of $r_{ij}^{(m)}$.

The equation (2) and (3) are as follows:

$$d_{ij}^{(m)} = \min\{d_{im}^{(m-1)} + d_{mj}^{(m-1)}, d_{ij}^{(m-1)}\} \quad (2)$$

$$\begin{cases} d_{ij}^{(m)} > d_{im}^{(m-1)} + d_{mj}^{(m-1)}, r_{ij}^{(m)} = m; \\ d_{ij}^{(m)} < d_{im}^{(m-1)} + d_{mj}^{(m-1)}, r_{ij}^{(m)} = r_{ij}^{(m-1)}; \end{cases} \quad (3)$$

Through the value of $d_{ij}^{(n)}$ in the D^n , we can get the shortest path length from the point No. i to the point No. j ; Through the $r_{ij}^{(n)}$ in the R^n , we can get the shortest path direction from the point No. i to the point No. j .

Step four: determination of $d(\lambda_i, \theta_j)$ and $d(\theta_i, \lambda_j)$

Through the D^{14} , assuming that when the gateway No. λ_i as origin, the parking area No. θ_j as destination, the shortest distance between the two points to said $d(\lambda_i, \theta_j)$, and when the gateway No. θ_i as origin, the parking area No. λ_j as destination, the shortest distance between the two points to said $d(\theta_i, \lambda_j)$.

Step five: determination of W_{θ_i} and W_{θ_j}

In order to distinguish the path of the parking area as the origin or destination, using W_{θ_j} indicates that when the gateway as origin and the parking area No. θ_j as destination, the proportionality coefficient of the number of parking spaces for the No. θ_j parking area in the community; W_{θ_i} indicates that when the parking area No. θ_i as origin and the parking area as destination, the proportionality coefficient of the number of parking spaces for the No. θ_i parking area in the community; W_{θ_i} and W_{θ_j} are used as the weight coefficients of each corresponding shortest path in the traffic network diagram. When $i=j$, W_{θ_i} and W_{θ_j} indicate the parking space weighted value of the same parking area, in this case, they have the same value, which can be represented as formula (4):

$$W_{\theta_i} = W_{\theta_j} = \frac{N_{\theta_j}}{\sum_{j=1}^{\theta} N_{\theta_j}}, i = j; i, j \in (1, 2, \dots, \theta) \quad (4)$$

Step six: determination of entrance and exit

Determination of entrance: When the gateway as origin, and the parking areas as destination, on the basis of step five, making the parking weight as the weight coefficient of the corresponding shortest path, aiming at minimizing the total path value of vehicles from the origin to all of parking areas, constructing the community entrance location model, which can be represented as equation (5):

$$\min Z(\lambda_i) = \sum_{j=1}^{\theta} W_{\theta_j} \times d(\lambda_i, \theta_j), i = (1, 2, \dots, \lambda; j = 1, 2, \dots, \theta) \quad (5)$$

Form the equation (5), we can know that when the gateway No. λ_i as the origin, and the parking areas as destination, $Z(\lambda_i)$ indicates the total shortest path value of the vehicles from an alternative entrance to the all of parking areas, and the numerical value indicates the distance costs of the vehicles enter the community, so we should choose the smallest $Z(\lambda_i)$ as community entrance.

Determination of exit: When the parking areas as origin, a gateway as destination, on the basis of step five, making the parking weight as the weight coefficient of the corresponding shortest path, aiming at minimizing the total path value of vehicles from all of parking areas to an alternative exit, constructing the community exit location model, which can be represented as equation (6):

$$\min Z(\lambda_i) = \sum_{i=1}^{\theta} W_{\theta_i} \times d(\theta_i, \lambda_j), i = (1, 2, \dots, \theta; j = 1, 2, \dots, \lambda) \quad (6)$$

Form the equation (6) we can know that when the parking areas as origin, and the gateway (λ_j) as the destination, $Z(\lambda_j)$ indicates the total shortest path value of the vehicle from all of parking areas to an alternative exit, and the numerical value of $Z(\lambda_j)$ indicates the distance costs of the vehicles out of the community, so we should choose the smallest $Z(\lambda_j)$ as the community exit.

3. Example case

3.1. Case background

East Bridge community is located in Chaoyang District, Beijing, has more than 50 years of history. The community east form Jintong road , west to the East Bridge road, south from Jinghua street, north to Chaoyang street. The total area of the community is 2000 square meters.

3.2. Process of case analysis

The process of case analysis can be described as follows:

Step one: construction of directed graph of community traffic network. From the community structure map (as shown in Fig. 2), we can see that the community has three alternative gateway, eight intersections, and three parking areas.



Figure 2. Community structure map.

According to the community structure map, we can construct a directed graph of community traffic network, in the directed graph, the three alternative gateway can be numbered as No. λ_i ($i = 1, 2, 3$), the eight intersections can be numbered as No. β_i ($i=1,2,3...8$), and the three parking areas can be numbered as No. θ_i ($i=1,2,3$), namely $\lambda+\beta+\theta=n=14$, the 14 points are regarded as the vertices of the directed graph, the connection between any two points indicates the distance between two points, and the arrow indicates the direction traffic flow. The specific directed graph of community traffic network can be as shown in Fig. 3 (The unit is meter).

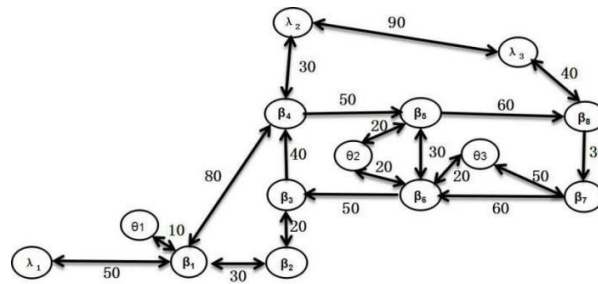


Figure 3. Directed graph of community traffic network.

Step two: determination of D^0 and R^0 .

From Fig. 3, the initial distance weight matrix $D^0=(d_{ij}^{(0)})_{14 \times 14}$ and the initial posterior point matrix $R^0=(r_{ij}^{(0)})_{14 \times 14}$ can be represented respectively as follows:

$$D^0 = \begin{matrix} & \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \begin{matrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \\ \beta_5 \\ \beta_6 \\ \beta_7 \\ \beta_8 \\ \theta_1 \\ \theta_2 \\ \theta_3 \end{matrix} & \left(\begin{array}{cccccccccccccccc} 0 & \infty & \infty & 50 & \infty & \infty & \infty & \infty & \infty & \infty & \infty & \infty & \infty & \infty & \infty \\ \infty & 0 & 90 & \infty & \infty & \infty & 30 & \infty & \infty & \infty & \infty & \infty & \infty & \infty & \infty \\ \infty & 90 & 0 & \infty & \infty & \infty & \infty & \infty & \infty & \infty & 40 & \infty & \infty & \infty & \infty \\ 50 & \infty & \infty & 0 & 30 & \infty & 80 & \infty & \infty & \infty & \infty & 10 & \infty & \infty & \infty \\ \infty & \infty & \infty & 30 & 0 & 20 & \infty & \infty & \infty & \infty & \infty & \infty & \infty & \infty & \infty \\ \infty & \infty & \infty & \infty & 20 & 0 & 40 & \infty & \infty & \infty & \infty & \infty & \infty & \infty & \infty \\ \infty & 30 & \infty & 80 & \infty & \infty & 0 & 50 & \infty & \infty & \infty & \infty & \infty & \infty & \infty \\ \infty & \infty & \infty & \infty & \infty & \infty & \infty & 0 & 30 & \infty & 60 & \infty & 20 & \infty & \infty \\ \infty & \infty & \infty & \infty & \infty & 50 & \infty & 30 & 0 & \infty & \infty & \infty & 20 & 10 & \infty \\ \infty & \infty & \infty & \infty & \infty & \infty & \infty & \infty & 60 & 0 & \infty & \infty & \infty & 30 & \infty \\ \infty & \infty & 40 & \infty & \infty & \infty & \infty & \infty & \infty & 30 & 0 & \infty & \infty & \infty & \infty \\ \infty & \infty & \infty & 10 & \infty & \infty & \infty & \infty & \infty & \infty & \infty & 0 & \infty & \infty & \infty \\ \infty & \infty & \infty & \infty & \infty & \infty & \infty & 20 & 20 & \infty & \infty & \infty & 0 & \infty & \infty \\ \infty & \infty & \infty & \infty & \infty & \infty & \infty & \infty & 20 & 50 & \infty & \infty & \infty & \infty & 0 \end{array} \right) \end{matrix}$$

$$R^0 = \begin{matrix} & \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \begin{matrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \\ \beta_5 \\ \beta_6 \\ \beta_7 \\ \beta_8 \\ \theta_1 \\ \theta_2 \\ \theta_3 \end{matrix} & \left(\begin{array}{cccccccccccccccc} \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \\ \lambda_1 & \lambda_2 & \lambda_3 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & \beta_7 & \beta_8 & \theta_1 & \theta_2 & \theta_3 \end{array} \right) \end{matrix}$$

Step three: determination of D_{14} and R_{14} . Using the equation (2) to obtain the distance weight $D_{14}=(d_{ij}(n))_{14 \times 14}$:

	λ_1	λ_2	λ_3	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	θ_1	θ_2	θ_3
λ_1	0	160	250	50	80	100	130	180	210	270	240	60	200	230
λ_2	160	0	90	110	140	160	30	80	110	160	130	120	100	130
λ_3	250	90	0	200	200	180	120	160	130	70	40	210	150	120
β_1	50	110	200	0	30	50	80	130	160	220	180	10	150	180
β_2	80	90	180	30	0	20	60	110	140	200	170	40	130	250
β_3	100	70	160	50	20	0	40	90	120	180	150	60	110	140
β_4	130	30	120	80	110	130	0	50	80	140	110	90	70	100
β_5	180	150	100	130	100	80	120	0	30	90	60	110	20	50
β_6	150	120	130	100	70	50	90	30	0	70	90	110	20	20
β_7	210	180	190	160	130	110	150	90	60	0	150	170	80	50
β_8	240	130	40	190	160	140	180	120	90	30	0	200	110	80
θ_1	60	120	210	10	40	90	100	150	170	230	190	0	160	190
θ_2	170	140	120	120	90	70	110	20	20	90	80	130	0	40
θ_3	170	140	150	90	90	70	110	50	20	50	110	130	40	0

Using the equation (3) to obtain the matrix $R_{14}=(r_{ij}(n))_{14 \times 14}$:

	λ_1	λ_2	λ_3	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	θ_1	θ_2	θ_3
λ_1	λ_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1
λ_2	β_4	λ_2	λ_3	β_4	β_4	β_4	β_4	β_4	λ_3	λ_3	β_4	β_4	β_4	β_4
λ_3	λ_2	λ_2	λ_3	λ_2	β_8	β_8	β_8	λ_2	β_8	β_8	β_8	β_8	β_8	β_8
β_1	λ_1	β_4	β_4	β_1	β_2	β_2	β_4	β_4	β_4	β_4	θ_1	β_4	β_4	β_4
β_2	β_1	β_3	β_3	β_1	β_2	β_3	β_3	β_3	β_3	β_3	β_3	β_1	β_3	β_3
β_3	β_2	β_4	β_4	β_2	β_2	β_3	β_4	β_4	β_4	β_4	β_2	β_2	β_4	β_4
β_4	β_1	λ_2	λ_2	β_1	β_1	β_1	β_4	β_5	β_5	β_5	β_1	β_5	β_5	β_5
β_5	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	θ_2	β_6	β_6
β_6	β_3	β_3	β_5	β_3	β_3	β_3	β_3	β_5	β_5	θ_3	β_5	β_3	θ_3	θ_3
β_7	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_7	β_6	β_6	β_6	θ_3
β_8	β_7	λ_2	λ_3	β_7	β_7	β_7	β_7	β_7	β_7	β_7	β_8	β_7	β_7	β_7
θ_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1	β_1	θ_1	θ_1	β_1	β_1
θ_2	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	θ_2	θ_2	β_6
θ_3	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_6	β_7	β_6	β_6	β_6	θ_3

Step four: determination of $d(\lambda_i, \theta_j)$ and $d(\theta_i, \lambda_j)$. From the D^n , finding out that when the gateway No. λ_i as origin and the parking area No. θ_j as destination, the shortest distance between the two points $d(\lambda_i, \theta_j)$, (as shown in Table 1).

Table 1. Directed distance $d(\lambda_i, \theta_j)$ (Unit: Meter).

	θ_1	θ_2	θ_3
λ_1	60	200	230
λ_2	120	100	130
λ_3	210	150	120

In the same way, finding out that when the gateway No. θ_i as origin, the parking area No. θ_i as origin and the gateway No. λ_j as origin, the shortest distance between the two points $d(\theta_i, \lambda_j)$, (as shown in Table 2).

Table 2. Directed distance $d(\lambda_i, \theta_j)$ (Unit: Meter).

	λ_1	λ_2	λ_3
θ_1	60	200	230
θ_2	120	100	130
θ_3	210	150	120

Step five: determination of $W_{\theta i}$ and $W_{\theta j}$. There are three parking areas in the East Bridge community, namely $\theta=3$, the number of parking spaces in the three parking areas is: $N_{\theta 1}=168$, $N_{\theta 2}=89$, $N_{\theta 3}=105$, taking the $\theta=3$ and the value of $N_{\theta i}$ ($i=1,2,3$) into equation (5), the three parking areas weighted value can be obtained respectively, namely: $W_{\theta 1}=0.464$ ($i=j=1$), $W_{\theta 2}=0.246$ ($i=j=2$), $W_{\theta 3}=0.290$ ($i=j=3$). The parking areas weighted value can be used as the weight of the shortest path.

Step six: determination of entrance and exit. Determination of entrance: Taking the values of $d(\lambda_i, \theta_j)$ and the $W_{\theta j}$ into the equation (5), the total minimum path value $Z(\lambda_i)$ that from an alternative entrance to the three parking areas can be obtained respectively, namely: $Z(\lambda_1)=143.74\text{m}$; $Z(\lambda_2)=117.98\text{m}$; $Z(\lambda_3)=169.14\text{m}$, $\min Z(\lambda_i) = Z(\lambda_2)$, it can be seen that the total shortest distance value of the vehicles from the alternative entrance No. λ_2 to all the parking areas is minimum, and the numerical value indicates the distance costs of the vehicles enter the community is minimum, so we should choose the No. λ_2 as the community entrance. In addition, through the matrix R^{14} , the shortest path direction of the vehicles from the entrance No. λ_2 to each parking area can be obtained, namely:

$$\lambda_2 \rightarrow \beta_4 \rightarrow \beta_1 \rightarrow \theta_1; \lambda_2 \rightarrow \beta_4 \rightarrow \beta_5 \rightarrow \theta_2; \lambda_2 \rightarrow \beta_4 \rightarrow \beta_5 \rightarrow \beta_6 \rightarrow \theta_3$$

Determination of exit: taking the values of $d(\theta_i, \lambda_j)$ and the $W_{\theta i}$ into the equation(6), the total minimum path value $Z(\lambda_i)$ from the all of parking areas to an alternative exit can be obtained respectively, namely: $Z(\lambda_1)=118.96\text{m}$; $Z(\lambda_2)=130.72\text{m}$; $Z(\lambda_3)=170.46\text{m}$, $\min Z(\lambda_i) = Z(\lambda_1)$, it can be seen that the total shortest distance value of the vehicles from all the parking areas to the alternative No. λ_1 is minimum, and the numerical value indicates the distance costs of the vehicles out of the community is minimum, so we should choose the No. λ_1 as the community exit. In addition, through the matrix R^{14} , the shortest path direction of the vehicles from each parking area to the exit No. λ_1 can be obtained, namely:

$$\theta_1 \rightarrow \lambda_1 \rightarrow \theta_1; \theta_2 \rightarrow \beta_6 \rightarrow \beta_3 \rightarrow \beta_2 \rightarrow \beta_1 \rightarrow \lambda_1; \theta_3 \rightarrow \beta_6 \rightarrow \beta_3 \rightarrow \beta_2 \rightarrow \beta_1 \rightarrow \lambda_1$$

Through the above analysis, we can see that the No. λ_2 as the community entrance and the No. λ_1 as the community exit, which can make sure the distance costs for the vehicles entering and leaving the community is the least, which effectively saves the travel time and improves the travel efficiency of the community residents.

4. Example case

Community gateway design not only directly affects the level of service in the gateway, but also determines the influencing on the city roads. The optimization of the design of the entrances and exits of the community is beneficial to reduce the traffic pressure of the Community on the peripheral road, and to improve the utilization efficiency of the entrance and exit of the Community.

When using the shortest path algorithm to locate the entrances and exits of the community, we need to consider the impact of parking spaces of community, and then carry out weighted analysis of the shortest paths to construct the model of the entrances and exits for the community.

Using this model to select the entrances and exits of the case community and formulating the best plan for the location selection of the community entrances and exits, that proves the practicality of the theoretical model.

The shortcoming of this study is that when selecting the entrances and exits of the community, the factors such as the future distribution trend of community motor vehicles are not taken into account. The further study is to establish a multi-objective model to achieve the better location selection.

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