Study on Evaluation of Urban and Rural High-quality Living Space Based on Accessibility Analysis——Taking Shahe City, Hebei Province as an example

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Abstract. The change of planning thought from "taking things as the center" to "taking people as the center" requires that the allocation mode of supporting public service facilities in urban and rural residential areas should also change from simple service radius to accessibility analysis. In this study, Dijkstra algorithm is used to analyze the spatial network with the help of the spatial data of urban transportation network and six types of public service facilities. Based on the concept of equalization of urban and rural public service facilities, this paper constructs an evaluation index system of high-quality living space of urban and rural residents based on accessibility, determines the weight by calculating the information entropy of each index, and compares and analyzes the accessibility evaluation results on the scale of urban and rural residential areas. Try to construct the full coverage and partial coverage of the 15-minute living circle of various facilities under four modes of driving at higher or lower speeds and walking for adults or the elderly. The research results show that the hardware construction of the city's transportation network system and public service facilities is efficient and convenient, with high accessibility and accessibility, showing the characteristics of urban-rural equivalence. However, under the low speed and walking mode, there is still room for layout optimization and improvement of some road systems and facilities.

Keywords: People-oriented, Accessibility-oriented, High quality living space, 15 minutes life circle.

1. Introduction
China's urbanization process is undergoing a transformation from high-speed expansion and growth to high-quality development and upgrading. The report of the 19th National Congress of the Communist Party of China puts forward that improving people's livelihood and well-being should be the fundamental purpose of development, requires promoting the equalization of basic public services, creating a social governance pattern of co-construction, co-governance and sharing, and pays more attention to the current situation of rural continuous decline, and puts forward for the first time the "Implementation of Rural Revitalization Strategy". Under such a background, urban and rural planning has changed from the planning development mode of population growth or land growth in the past to life-oriented planning with people as the core and paying more attention to the equalization of urban and rural living space quality and the optimization of rural public service facilities spatial layout.
Rural space is no longer the same as the agricultural world. The basic ideas and requirements of the ethical norms of spatial fairness are based on the creed of universal human rights ("All men are created equal") and human dignity, and have now been extended to human beings and their living spaces and areas designed and lived in [1]. For a long time, there is a structural imbalance between supply and demand in public service facilities in rural areas of China, which seriously restricts the realization of equalization of basic public services in urban and rural areas [2]. According to the "Main Data Bulletin of the Third National Agricultural Census", as of the end of 2016, only 25.1% of villages in China had e-commerce distribution stations, 32.3% had kindergartens and nurseries, 47.5% had comprehensive stores or supermarkets of over 50 square meters, and 59.2% had sports and fitness places [3]. According to the Statistical Bulletin of Social Service Development in 2019, the coverage rate of comprehensive service facilities in urban communities (92.9%) is much higher than that in rural communities (59.3%).

Secondly, equalization requires that the construction and development of rural public space should be guided by the collective needs of villagers, with strong accessibility and convenience for the use of villagers. However, in reality, the accessibility of rural public space is far from meeting the requirements and standards of villagers.

The quality of living space is the residents' longing for a better life, and the availability of living resources has a profound impact on the quality of life of urban residents. Foreign urban social geography holds that six elements, such as educational facilities, medical and health facilities, leisure and entertainment facilities, commercial service facilities, living service facilities and public transportation facilities, are the main infrastructure components that constitute living resources [4]. The latest Standard for Planning and Design of Urban Residential Areas issued in 2018 replaces the traditional residential area-community-group planning with community living circle, and proposes to rationally set up facilities with reference to the technical requirements of 15-minute, 10-minute and 5-minute living circle and residential neighbourhood. It is one of the major innovative directions of urban planning transformation to gradually move from residential planning to community living circle planning. However, the scale of theoretical research on life circle is mostly concentrated at the city level. In recent years, the scale of domestic scholars' research on life circle has gradually narrowed and shifted to the community level. However, the data are still mainly based on survey data, and there are many limitations in research methods. Most of them still use straight-line distance as the service radius, and plan and practice by constructing buffer zone or calculating Euclidean distance.

Spatial accessibility is the core variable to study the layout of public service facilities. Scholars at home and abroad have done a lot of research on facility accessibility. The main quantitative measurement methods include models such as nearest distance, opportunity accumulation, weighted Voronoi diagram analysis, gravity model, Hoover model, two-step mobile search, network location model, etc. Wang Jin-qi, etc., put forward the principle of "threshold-accessibility" for the spatial layout and optimization of public service facilities in rural areas, taking rural primary schools as the research object, and directly matching the nearest admission principle with the nearest distance model [2]. Zhao Ying, etc., respectively built the minimum-impedance time model, the average-travel time model and the attraction-travel time weighted model for different living resources and facilities, and carried out the evaluation of living resources allocation [4]. Han Zenglin and other Urban Network Analysis Toolbox tools based on Rhino platform analyse the spatial differentiation of public service facilities allocation in Shahekou District of Dalian [5].

Based on these, this study starts from the concept of equalization of urban and rural public service facilities, takes urban and rural residential areas as the analysis unit, and takes public service facilities, government organizations, transportation service stations, parks and green spaces, commercial service facilities, science-education-culture-health facilities as the analysis objects, constructs an evaluation index system of high-quality living space of urban and rural residents based on accessibility, and uses spatial analysis software and mathematical statistics methods to carry out accessibility evaluation and 15-minute living circle identification of residential areas in Shahe City.
2. Research Methods

2.1. Data Sources

Shahe City is located in the southwest of Hebei Province, at the eastern foot of the southern section of Taihang Mountain. It is 71.5 km long from east to west, 22 km wide from north to south and covers an area of 830 km². The terrain is high in the west and low in the east, with mountains, hills and plains each accounting for one third. With superior transportation location, it is a transportation hub connecting Shanxi-Hebei-Shandong-Henan, one of the important nodes in Beijing-Guangzhou transportation corridor, an important transportation hub and a regional material distribution center in North China. In 2019, the city has a resident population of 427,100, an urbanization rate of 56.89%, a GDP of 18.82 billion CNY, a tertiary industrial structure of 3.6:41.1:55.3, and a contribution rate of -2.1%, 18.4% and 83.7% respectively. The per capita disposable income of urban residents is 31,420 CNY, and the per capita disposable income of rural residents is 31,420 CNY.

The geospatial data of this study mainly adopts the results of the third national land survey, supplemented by the necessary field investigation. The projection coordinate system is CGCS2000_3_Degree_GK_Zone_38, and the geographic coordinate system is GCS_China_Geodetic_Coordinate_System_2000. There are 7393 urban and rural residential areas in the city, with a total area of 66.30 km², 152 public facilities (including water supply, electricity and heat, postal services, telecommunications, fire protection, sanitation and other infrastructure), 52 park green spaces (including parks, zoos, botanical gardens, street parks, etc., as well as green land for relaxing and beautifying the environment), 365 gathering places for government organizations (including party and government organs, social organizations, radio and television stations, newspapers and magazines, etc.), 98 transportation service stations (including bus hubs, long-distance passenger stations, public transportation stations, public parking lots, etc.), 436 science-education-culture-health facilities (including various education, research and development, medical care, stadiums and other facilities), and 849 commercial service facilities (including various commercial and service facilities). The transportation network system consists of railways, highways, rural roads and public streets in towns and villages at all levels, with a total length of 3079.62 km.

Figure 1. Spatial distribution map of transportation network and main facilities in Shahe city
2.2. Evaluation Index System

The accessibility of urban public service facilities directly affects the quality of life of residents, which is related to the spatial layout of various facilities and the accessibility of road networks, as well as the proximity between residential areas and major urban road networks, as well as the residents' travel mode, speed and time. The 2018 edition of "Standards for Planning and Design of Urban Residential Areas" puts forward the construction goal of "creating a safe, hygienic, convenient, comfortable, beautiful, harmonious and diversified living environment". The living environment with the living circle as the community living unit should improve the quality of the living environment by combining the age characteristics, travel range and activity preferences of residents. In this study, the evaluation index system of high-quality living space of urban and rural residents based on accessibility was constructed (Table 1).

Table 1. Evaluation index system of high-quality living space of urban and rural residents

| Primary index | Secondary index | Index connotation | Calculation method |
|---------------|-----------------|-------------------|--------------------|
| Distance index | Public facilities | From residential areas to various facilities, search for the shortest path according to the transportation network system | Solution of Nearest Facilities Based on Network Analysis |
| Government organizations | | | |
| Transportation service stations | | | |
| Park and green space | Commercial service facilities | | |
| Science-education-culture-health facilities | Transportation network | Distance from residential areas to the nearest road | Neighborhood Analysis Based on Neighborhood Analysis |
| Travel index with vehicles | Public facilities | From residential areas to various facilities, the shortest time based on higher travel speed | Solution of OD Cost Matrix Based on Network Analysis |
| Government organizations | | | |
| Transportation service stations | Parks and green spaces | | |
| Commercial service facilities | Science-education-culture-health facilities | | |
| Travel index without vehicles | Public facilities | From residential areas to various facilities, the shortest time based on adult walking speed | Solution of OD Cost Matrix Based on Network Analysis |
| Government organizations | | | |
| Transportation service stations | Parks and green spaces | | |
| Commercial service facilities | Science, education-culture-health facilities | | |
According to the age attributes of vehicles and travelers, the travel speed attribute is assigned to all levels of transportation facilities in the city (Table 2). Considering that the Railways can also be used as one of the transportation facilities for residents to travel to a certain extent, but it does not have the conditions for walking without means of transportation, so the travel speed without means of transportation is set to 0. In order to prevent the software from reporting errors, 0.00001 is used to calculate the time cost.

Table 2. Standard of speed attribute assignment for different traffic facilities

| Level                | Travel speed with vehicles | Travel speed without vehicles |
|----------------------|----------------------------|------------------------------|
|                      | High speed | Low speed | Adult | Elderly |
| Railways             | 3000       | 2000      | 0     | 0       |
| Highways             | 1200       | 700       | 50    | 70      |
| Rural Roads          | 1000       | 500       | 50    | 70      |
| Urban Village Streets | 1000       | 500       | 50    | 70      |

2.3. Research Methods

2.3.1. Dijkstra algorithm. In this study, Dijkstra algorithm is used in the analysis of the nearest facility point and OD matrix. This algorithm was proposed by Wybe Dijkstra in 1959. It is an algorithm to generate the shortest path according to the increasing order of path length. It solves the shortest path problem in the weighted graph. In this study, the speed is set as the weight.

Let \( G = (V, E) \) be a directed graph, \( V \) is a node set, \( E \) is an edge set, and the edge is expressed as \( (i,j) \), and the two nodes connected are \( i \) and \( j \). \( C_{ij} \) is the transit time of edge \((i,j)\), calculated as length/speed, which indicates the time distance between node \( i \) and node \( j \). The node set with the shortest path is represented by \( S \), and there is only the starting node in the initial \( S \). The combination of nodes that have not found the shortest path is represented by \( U \), and the corresponding nodes in \( U \) will be added to the set \( S \) every time the shortest path is found. Until all the network nodes are in \( S \), the shortest path from the source point to each vertex on the graph is a sequence of increasing path length, and the shortest path value is the sum of all the values of \( C_{ij} \) in the set \( S \).

2.3.2. Entropy weight method. In this study, entropy weight method is used to calculate residential accessibility. According to the explanation of the basic principle of information theory, information is a measure of the degree of system order and entropy is a measure of the degree of system disorder. If the information entropy of the index is small, the greater the information provided by the index, the greater the role it should play in the comprehensive evaluation, and the higher the weight should be. On the contrary, if the value of an index in the system is equal, then the information entropy of this index is 1, and the weight is about low.

The evaluation index system based on the high-quality living space of urban and rural residents constructed in this study is divided into three layers: the total index accessibility, three first-class indexes and 19 second-class indexes. Firstly, the weight of the secondary index corresponding to each primary index is calculated according to the entropy weight method, so that the evaluation value of the primary index can be calculated. Then calculate the information entropy according to the evaluation values of the three first-class indicators, and finally calculate the accessibility of residential areas. The specific calculation process and results are as follows.

Firstly, the data are standardized \( P_{ij} \) to eliminate the influence of data dimension on the results. In this paper, the extreme value standardization method (Formula 1) is adopted, and 19 secondary indicators represent time cost or shortest distance, so they are all negative indicators, and the shorter the time or distance, the higher the accessibility should be. The three primary indicators are obtained by entropy method on the basis of weighted summation of secondary indicators, so they are all positive indicators.
\[
\begin{align*}
P_{ij} &= \frac{x_{ij}-x_{ij\min}}{x_{ij\max}-x_{ij\min}} \quad \text{(Positive indicator)} \\
P_{ij} &= \frac{x_{ij\max}-x_{ij}}{x_{ij\max}-x_{ij\min}} \quad \text{(Negative index)} 
\end{align*}
\]

(1)

Secondly, calculate the information entropy \(E_i\). As shown in Formula 2 and Formula 3. Where \(n\) is the number of residential areas participating in the calculation of accessibility.

\[
Y_{ij} = \frac{P_{ij}}{\sum_{i=1}^{n} P_{ij}}
\]

(2)

\[
E_i = -\ln(n)^{-1} \sum_{i=1}^{n} Y_{ij} \ln Y_{ij}
\]

(3)

If \(Y_{ij}=0\), Formula 4 is defined.

\[
\lim_{Y_{ij}\to 0} Y_{ij} \ln Y_{ij} = 0
\]

(4)

Thirdly, the weight \(W_j\) is calculated. As shown in Formula 5, \(j\) is the number of indicators.

\[
W_j = \frac{1-E_i}{k-E_i}
\]

(5)

At last, the comprehensive evaluation value \(V_i\) is calculated. As shown in Formula 6.

\[
V_i = \sum_{j=1}^{k} W_j P_{ij}
\]

(6)

The information entropy and weight of each index calculated by entropy weight method are shown in Table 3.

| Primary index          | Information entropy | Weights | Secondary index                   | Information entropy | Weights |
|------------------------|---------------------|---------|-----------------------------------|---------------------|---------|
| Distance index         | 0.9985              | 0.3801  | Public facilities                 | 0.9988              | 0.1453  |
|                        |                     |         | Government organizations          | 0.9994              | 0.0695  |
|                        |                     |         | Transportation service stations   | 0.9985              | 0.1856  |
|                        |                     |         | Park and green space              | 0.9963              | 0.4483  |
|                        |                     |         | Commercial service facilities     | 0.9993              | 0.0881  |
|                        |                     |         | Science-education-culture-health facilities | 0.9996              | 0.0435  |
|                        |                     |         | Transportation network            | 0.9998              | 0.0196  |
|                        |                     |         | Public facilities                 | 0.9965              | 0.4988  |
|                        |                     |         | Government organizations          | 0.9995              | 0.0688  |
|                        |                     |         | Transportation service stations   | 0.9983              | 0.2337  |
|                        |                     |         | Parks and green spaces            | 0.9995              | 0.0688  |
|                        |                     |         | Commercial service facilities     | 0.9994              | 0.0854  |
|                        |                     |         | Science-education-culture-health facilities | 0.9997              | 0.0445  |
| Travel index with vehicles | 0.9983              | 0.4182  | Public facilities                 | 0.9987              | 0.2496  |
|                        |                     |         | Organizations                     | 0.9994              | 0.1129  |
|                        |                     |         | Transportation service stations   | 0.9985              | 0.3056  |
|                        |                     |         | Parks and green spaces            | 0.9994              | 0.1129  |
|                        |                     |         | Commercial service facilities     | 0.9993              | 0.1456  |
|                        |                     |         | Science-education-culture-health facilities | 0.9996              | 0.0733  |
| Travel index without vehicles | 0.9992              | 0.2017  | Public facilities                 | 0.9987              | 0.2496  |
|                        |                     |         | Organizations                     | 0.9994              | 0.1129  |
|                        |                     |         | Transportation service stations   | 0.9985              | 0.3056  |
|                        |                     |         | Parks and green spaces            | 0.9994              | 0.1129  |
|                        |                     |         | Commercial service facilities     | 0.9993              | 0.1456  |
|                        |                     |         | Science-education-culture-health facilities | 0.9996              | 0.0733  |
3. Research Results

3.1. Residential Reachability Analysis

Using the network analysis function of ArcGIS and OD matrix analysis method, the reachability analysis results of all urban and rural residential areas are obtained (Table 4). Settlements that can reach all six types of facilities are defined as "reachable", settlements that cannot be reached by any certain facility are defined as "un-reachable", settlements that cannot be reached by some facilities are defined as "partial-reachable", and settlements that can only reach facilities with vehicles are defined as "conditional-reachable".

|                   | Cities and Towns | Villages | Amount |
|-------------------|------------------|----------|--------|
|                   | Number | Area | Number | Area | Number | Area |
| Reachable         | 418    | 633.46 | 6511   | 5627.90 | 6929   | 6261.37 |
| Conditional-reachable | 24     | 31.67  | 84     | 37.59   | 108    | 69.26   |
| Partial-reachable | 0      | 0.00   | 146    | 135.31  | 146    | 135.31  |
| Un-reachable      | 9      | 6.03   | 201    | 157.59  | 210    | 163.62  |
| Amount            | 451    | 671.17 | 6942   | 5958.39 | 7393   | 6629.56 |

In terms of quantity, 93.72% of all 7393 residential areas can reach all facilities, and the area accounts for 94.45% of the total area of residential areas, that is, the scale of residential areas with various restrictions is relatively small. Among them, the reachable number of urban residential areas accounts for 92.68% and the area accounts for 94.38%, while the accessible number of rural residential areas accounts for 93.79% and the area accounts for 94.45%. There is no significant difference between urban and rural areas. However, rural areas are the main un-reachable settlements, within 210 un-reachable settlements with a total area of 163.62 hectares, there are 201 rural residential areas with a total area of 157.59 hectares.

From the perspective of spatial distribution (Figure 2), un-reachable rural residential areas are mainly distributed at the end of the road network in the western mountainous areas, which are relatively far away from the nearest roads, and some of them are scattered in the central and eastern plains, which is mainly caused by the fact that the nearest roads are not connected to the urban transportation network system yet. Under the influence of transportation network system, these un-reachable rural residential areas cannot be connected with any facilities. Some reachable residential areas are mainly restricted by local transportation network system, that means some facilities are distributed in these "isolated islands", which makes residential areas have reachable characteristics for such facilities. For example, science-education-culture-health facilities are widely distributed, and some of them cannot be connected with the urban trunk transportation network, but they solve the living needs of the surrounding residents within the "isolated islands". In addition, the facilities of government organizations and commercial service industries are relatively widely distributed. Due to the influence of Beijing-Guangzhou Railway passing through the city, some residential areas and facilities within the built-up areas of cities and towns are un-reachable by foot, so most of these phenomena occur in the urban villages.
3.2. Residential Accessibility Analysis

Furthermore, 6929 reachable residential areas are calculated by using the time weighted model established by Dijkstra algorithm, and the residential accessibility is calculated by combining the weight weights determined by entropy weight method (Table 5). The lowest accessibility is 0, the highest is 0.9993, the average value is 0.8254, the standard deviation is 0.1195, and the accessibility is relatively high. The results of 10 equal parts by using the equal spacing method show that the highest proportion is between 0.8-0.9, with the number of residential areas accounting for 36.67% and the area accounting for 38.67%, followed by the accessibility between 0.9-1.0, with the number of residential areas accounting for 31.39% and the area accounting for 38.32%. The accessibility of urban residential areas is obviously higher than that of rural residential areas, with average values of 0.9202 and 0.8193, and the difference is relatively small, with standard deviations of 0.0666 and 0.1196, respectively.

Table 5. Accessibility of Urban and Rural Residential Areas  

|          | Cities and Towns | Village | Amount |
|----------|------------------|---------|--------|
|          | Number | Area   | Number | Area   | Number | Area   |
| 0.0-0.1  | 0      | 0.00   | 2      | 0.23   | 2      | 0.23   |
| 0.1-0.2  | 1      | 0.49   | 3      | 1.29   | 4      | 1.77   |
| 0.2-0.3  | 0      | 0.00   | 7      | 2.90   | 7      | 2.90   |
| 0.3-0.4  | 0      | 0.00   | 44     | 9.58   | 44     | 9.58   |
| 0.4-0.5  | 0      | 0.00   | 110    | 20.73  | 110    | 20.73  |
| 0.5-0.6  | 0      | 0.00   | 247    | 60.51  | 247    | 60.51  |
| 0.6-0.7  | 2      | 0.08   | 488    | 239.39 | 490    | 239.47 |
| 0.7-0.8  | 14     | 19.19  | 1295   | 1085.97| 1309   | 1105.15|
| 0.8-0.9  | 111    | 116.44 | 2430   | 2304.97| 2541   | 2421.41|
| 0.9-1.0  | 290    | 497.27 | 1885   | 1902.34| 2175   | 2399.62|
| Amount   | 418    | 633.46 | 6511   | 5627.90| 6929   | 6261.37|

From the perspective of spatial distribution (Figure 3), the accessibility of plain is higher than that of mountainous areas, and that of towns is higher than that of rural areas. The results of classification of
accessibility by quantile method show that the 20% residential areas with the highest accessibility are mainly distributed in the central city area of the eastern plain, and some are distributed in the key new development cities in the central part. The lowest accessible 20% residential areas are mainly distributed in western mountainous areas and central hilly areas.

Figure 3. Spatial distribution of accessibility of urban and rural residential areas

3.3. 15-minutes Life Circle Analysis

According to the travel speeds of different transportation facilities set in table 2, the 15-minutes living circle of each public service facility can be calculated, and these circles are spatially superimposed and analyzed. The number of residential areas in the 15-minutes living circle partially covered by various facilities can be obtained by using the merging function of ArcGIS (Table 6), and the number of residential areas in the 15-minutes living circle completely covered by various facilities can be obtained by using the intersection function of ArcGIS (Table 7). Generally speaking, because walking speed is much slower than driving speed, the number of residential areas covered by the living circle calculated by walking is much smaller than that calculated by driving, whether in the partial coverage of a single facility or in the complete coverage of all facilities. However, this difference is mainly reflected in the complete coverage area, while it is not so significant in the partial coverage area, which shows that the spatial agglomeration among various facilities is not obvious.

Table 6. Partially covered by the 15-minutes living circle  Unit: numbers, hectare

|                | Cities and Towns | Village | Amount |
|----------------|------------------|---------|--------|
|                | Number | Area    | Number | Area   | Number | Area       |
| Higher driving speed | 451   | 671.17  | 6721   | 5916.41| 7172   | 6587.58    |
| Lower driving speed  | 450   | 671.12  | 6706   | 5914.31| 7156   | 6585.42    |
| Adult walking speed   | 431   | 664.31  | 5904   | 5692.30| 6335   | 6356.61    |
| Elderly walking speed  | 429   | 652.66  | 5612   | 5612.81| 6041   | 6265.47    |
Table 7. Complete covered by the 15-minutes living circle  

| Cities and Towns | Village | Unit: numbers, hectare |
|------------------|---------|------------------------|
|                  | Number  | Area                   |
| Higher driving speed | 447     | 668.39                 |
| Lower driving speed | 421     | 645.30                 |
| Adult walking speed  | 68      | 113.18                 |
| Elderly walking speed | 37      | 73.52                  |
|                  | Number  | Area                   |
| Higher driving speed | 5817    | 5595.89                |
| Lower driving speed  | 4423    | 4405.56                |
| Adult walking speed  | 69      | 98.70                  |
| Elderly walking speed | 12     | 30.56                  |
|                  | Number  | Area                   |
| Higher driving speed | 6264    | 6264.29                |
| Lower driving speed  | 4844    | 5050.87                |
| Adult walking speed  | 4865    | 5595.89                |
| Elderly walking speed | 137     | 211.87                 |

From the perspective of spatial distribution (Figure 4- Figure 11), the residential areas completely covered by public service facilities in 15 minutes based on walking speed are only concentrated in the core area of the central city, with a small number and area, and are basically urban residential areas. Although the living circle coverage in western mountainous areas and central hilly areas is relatively low, with the support of transportation, the absolute coverage is not low, and the coverage rate can reach 94.49% at higher driving speed and 76.19% at lower driving speed. However, there is a significant difference between urban and rural areas. The coverage rate of urban residential areas can reach over 96% regardless of high speed or low speed, while that of rural residential areas is only 74%. This shows that the road grade in rural areas needs to be improved.
4. Urban and Rural High-quality Living Space Optimization Suggestions

According to the above analysis results, the vast majority of residential areas can be quickly connected to the main public service facilities through the transportation network, but the high-quality living space needs to improve from the following three aspects.

First, the layout optimization of convenient transportation network system. In this study, the transportation network including railways, highways, rural roads and streets within towns and villages is used to analyze accessibility, which has high accessibility and wide coverage. However, based on the evaluation results of walking 15-minute living circle and travel index without vehicles, the accessibility and coverage are obviously reduced. Studying the allocation of living resources around the residential area fully embodies the concept of "people-oriented" space justice and harmonious community construction. Therefore, besides meeting the hardware construction of transportation, more attention should be paid to people-oriented travel mode, especially for the connection mode of facilities necessary for daily work and life, it is necessary to increase the road network density in key areas.

Second, optimize the layout of public service facilities. To improve people's quality of life by improving the spatial accessibility and balance of facilities distribution, it is necessary to optimize the spatial layout of kindergartens, primary and secondary schools, pharmacies, health clinics, supermarket markets, convenience stores, parks and public transport stations. In this study, the information entropy of walking index to transportation service stations, travel index to public facilities and distance index to
park green space are the lowest indexes, which shows that the differences between urban and rural residential areas in the city are the most significant, and there is room for spatial layout optimization. In addition to parks and green spaces in central towns, country parks, wildlife parks and wetland parks should be appropriately increased to promote the equalization of urban and rural areas for leisure and beautification. The traffic accessibility of public facilities needs to be improved, and the road level around key facilities should be upgraded to speed up cargo transshipment and personnel flow. The distribution of transportation service stations such as bus hubs should be increased moderately, the space should be inclined to the urban-rural fringe, and a certain number of bus stations should be arranged in the central towns and villages with large population density.

Third, the layout optimization of urban and rural residential areas. The formation of residential concentration points is a historical process. For the settlements that have been formed in the early history, even if the modern urban transportation network is inaccessible and some public service facilities cannot be radiated, there will still be a certain number of people gathered here. For this part of residential areas, it is not appropriate to adopt the mode of mechanical demolition, nor to build various public service facilities on a large scale. Instead, it is necessary to improve the travel conditions by opening broken roads and hardening roads, analyze the service scope of facilities across administrative boundaries such as cities and counties, improve the living space quality of existing residential areas, and implement the relocation project on the premise of respecting residents’ wishes when conditions permit. On the other hand, for newly-built urban and rural residential areas, attention should be paid to the simultaneous supporting construction of various public service facilities, and work, shopping, entertainment, medical treatment or service should be combined with the development and construction of residential areas in accordance with the requirements of safety, comfort, convenience and beauty, so as to plan and construct with the goal of high-quality living space.

5. Conclusion

The analysis shows that the transportation network of Shahe City is relatively complete, and the accessibility of various public service facilities is relatively high. With the support of transportation, more than 90% of urban and rural residential areas can reach the facilities conveniently and efficiently, which shows that the construction of urban and rural hardware facilities is equal. However, with the changing trend of planning thought from "taking things as the center" to "taking people as the center", we should also pay attention to the problems such as uneven spatial distribution and low accessibility of some facilities, small coverage of 15-minute walking living circle, inaccessible urban and rural residential areas of various facilities, and differences between urban and rural areas in facilities accessibility by walking or low-speed driving.

In a word, the construction goal of high-quality living space should be achieved by comprehensively implementing the optimization and adjustment of transportation network system, public service facilities and spatial layout of urban and rural residential areas. In addition, this study relies on the current transportation network system to carry out accessibility analysis, which is influenced by the research scale. It is necessary to deepen the existing research results in terms of walking space conditions and the subdivision of facilities.

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