TOD地区居住性向上のための施設と人口の関係分析

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TOD 地区居住性向上のための施設と人口の関係分析

Analyzing the Relationship between Facilities and Population to Improve Livability within TODs

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Improvement in livability is a vital requirement of the TOD development concept. The purposes of this research are to study the livability condition of TODs by evaluating whether the daily needs of residents of all ages within the existing TODs in Hefei City can be met, identifying the TODs that need further development and proposing appropriate strategies to help residents within different TODs access equal resources. Hefei City, as a representative second-tier Chinese city developing TODs, was used as a case study. Results of this research show only a small portion of residents within TODs can reach elderly care facilities. The higher livability of TODs is mainly concentrated in well-developed areas such as new and old city centers and traffic hubs.

Keywords : Livability, Transit-oriented development, Second-tier cities, POI data, Hefei city
居住性，公共交通指向型都市開発，二線都市，関心地点，合肥市

1. Introduction

The transit-oriented development (TOD) concept is used in different cities as a common method to coordinate the relationship between the rail transit system and urban development. The TOD concept is to integrate land and transport to attract more people to gather around transit nodes and improve the quality of people's lives. It can help create neighborhoods around transit stations where residents can access traffic, jobs, and other amenities within a walkable distance[1]. A successful TOD needs to satisfy the needs of different age groups, including children and elders, to improve the quality of life[2]. China has also introduced the TOD concept in urban development since 2020. However, the development situation of TODs differs from expectations. For example, many TODs focus on maximizing access to public transportation and reducing vehicle dependency without paying enough attention to the quality of life in a neighborhood[3]. With the development of the economy, this issue is receiving increasing attention, and people have realized the importance of the living environment and pursued a high-quality lifestyle. If the needs of residents continue to be ignored, the TODs will fail to attract more people and will also cause the loss of the existing population, which is not conducive to the sustainable development of the TOD concept.

Therefore, it is necessary to evaluate the quality of life of residents based on existing TODs and propose corresponding strategies for their further development. However, previous research on TOD has mostly focused on analyzing the relationship between transportation and land, with few studies considering the quality of life for residents. Finding a suitable method that can help measure residents' quality of life is crucial.

Livability has been proposed to evaluate the quality of life in the urban environment[4][5][6][7]. The development of livability not

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only considers factors such as urban form but also the possibility of education, culture, and entertainment. Livability has become a popular tool to help measure the quality of life. In recent years, the Chinese government has advocated in the Standard for the Planning and Design of Urban Residential Areas (GB50180-2018) that was issued by the Ministry of Housing and Urban-Rural Development of China in 2018 to improve the basic life demands for residents within a reasonable walking distance[8]. Meanwhile, some Chinese cities have considered regional livability in their urban planning as well. For example, Shanghai utilized the "15-minute Community Life Circle" (15min-CLC) strategy in 2016 to increase the livability of communities by providing residents with sufficient basic daily services within walking distance[9]. It can be found that the development strategies for improving livability proposed in China are mainly related to meeting the needs of a neighborhood.

TODs can attract a large number of people to live or work due to their high transportation accessibility and land-use mix. It is feasible to evaluate livability by analyzing whether the service facilities within the existing TODs can meet the daily needs of residents of all ages. Therefore, this research aimed to propose a method to evaluate livability within TODs by analyzing the current situation of residents' access to surrounding service facilities.

This research selected the TODs in Chinese second-tier cities for analysis. The research on livability mainly focuses on first-tier cities in China, which are known for their economic development, high population densities, and significant cultural and historical importance, such as Beijing, Shanghai, Guangzhou, and Shenzhen. However, there is little research on helping second-tier cities improve livability. Compared to the highly developed TODs in first-tier cities, the TODs in second-tier cities are still in the developing stage. Second-tier cities usually have a good economic foundation and sufficient population to develop TODs. However, these cities still need to focus on the construction of infrastructure and land development within the TODs, and the demands of residents within the TODs are often ignored. In addition, the development speed and available resources of TODs in second-tier cities vary depending on the location of the urban area. To ensure that residents within different TODs have equal access to resources, this research selected some TODs from the same period in a second-tier city and evaluated their livability. Hefei City, as a second-tier city that has applied the concept of TOD in urban planning since 2017, faces the problems mentioned above inevitably in the existing TODs. Therefore, Hefei City was selected as a representative city for analysis in this research.

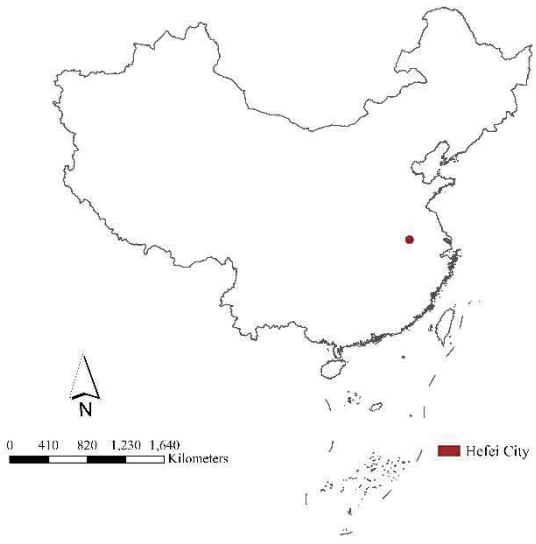

Figure 1. The location of Hefei City in China

Hefei City, the capital city of Anhui Province, was analyzed as a case in this research. Hefei City has been experiencing rapid urban development since 2010. Hefei is a second-tier city located in East China (Fig. 1) with a large population and an imbalanced resource distribution that is currently developing TODs. Hefei City introduced the TOD concept as a guideline to reduce traffic pressure and environmental pollution in 2017. At present, the TOD network has gradually taken shape in Hefei City. The latest Hefei master plan emphasizes the need to strengthen service facilities and create a friendly living environment for all ages. As regions where people tend to gather, evaluating the livability of existing TODs can ensure the quality of life for residents while attracting more people in order to achieve sustainable development of TODs. Therefore, this is research intended to evaluate the livability of the existing TODs in Hefei City. This research can be used as a guide for improving the quality of life in second-tier cities with a high population and a developing neighborhood environment.

The purpose of this research is to improve the quality of life and meet the daily needs of existing residents by evaluating the livability of TODs in second-tier cities. The rest of this research is organized as follows: Section 2 reviewed previous studies. Section 3 described the study area, data sources, and methods. Section 4 introduced the results and discussion. Section 5 consists of conclusion of this research.

2. Literature review

2.1 The application of TOD concept

The TOD concept integrates land use and public transport to encourage economic activities around public transport nodes and improve quality of life. Many researchers have discussed

the impact of the application of TOD concept on people's lives. For example, Dong (2021) compared the travel modes and costs between TOD and non-TOD households in California and found that the TOD concept significantly reduced household travel costs[10]. Li (2020) analyzed the TODs in Wuhan, using the Ordinary Least Squares (OLS) model and the Geographically Weighted Regression (GWR) model to capture the local changes in the transit effect in the TODs, and found the TOD concept could have a positive impact on the surrounding housing prices[11]. With the widespread use of the TOD concept, it has become an essential part of the lives of residents in many cities. Therefore, making TODs better serve people is a topic that needs to be considered. As mentioned above, previous research on TOD has rarely analyzed it from the perspective of residents' daily needs, and most studies have focused on megacities, ignoring second-tier cities that are rapidly developing TODs. Therefore, this research aimed to better apply the TOD concept to urban development in second-tier cities by analyzing the needs of residents within TODs.

2.2 Evaluation of the livability

Previous research explored many ways to evaluate livability without a fixed standard. For instance, "The Livability Index 2018: Transforming Communities for All Ages", a report by the American Association of Retired Persons (AARP), suggested a Livability Index to evaluate each community and neighborhood in the United States to guide neighborhoods in better serving all ages. Their Livability Index includes 60 indicators grouped into seven categories of livability: Environment, Health, Engagement, Housing, Neighborhood, Transportation, and Opportunity[12]. The document "Livability in Transportation Guidebook" put forward six livability principles and analyzed how to successfully incorporate the livability concept into transportation planning or design in the United States[13]. Suresh (2022) focused on identifying some spatial indicators of livability[3]. Li (2020) attempted to put forward an indicator system for evaluating rural livability at village level. They regarded rural livability as a rural place equipped with the capacity to achieve the desired quality of life for the residents[14].

Increasing residents' access to various basic service facilities is a popular way to improve livability. Jacobs (1961) stated that providing sufficient daily services and amenities within walking distance of home or workplace is a fundamental standard for a good living environment[15]. Many researchers improved livability from this perspective. For example, Logan (2022) calculated the walking time of all residents in the 500 largest cities in the United States and 43 cities in New Zealand to different types of facilities and determined the optimal distance between residences and essential living facilities to improve livability within the communities[16]. Graells-Garrido (2021) quantified the accessibility of various facilities to identify service facilities that affect the mobility of residents in Barcelona, such as educational and commercial facilities. They suggested building such facilities to increase regional vitality and enhance regional livability[17]. Noworól (2022) compared the number of residents within different walking distances around various facilities in Krakow City to understand residents' preferences for service facilities, thereby improving the livability of local communities effectively[18]. Song (2022) analyzed the spatial accessibility of health service facilities in Guangzhou and evaluated whether the existing health services met the daily needs of residents[19].

2.3 Measuring the livability of TODs

Previous research on calculating livability in TODs mainly analyzed the following aspects: economy, accessibility, and urban land use. For example. Al-malki (2022) attempted to assess the effects of the TOD concept on livability in Doha's

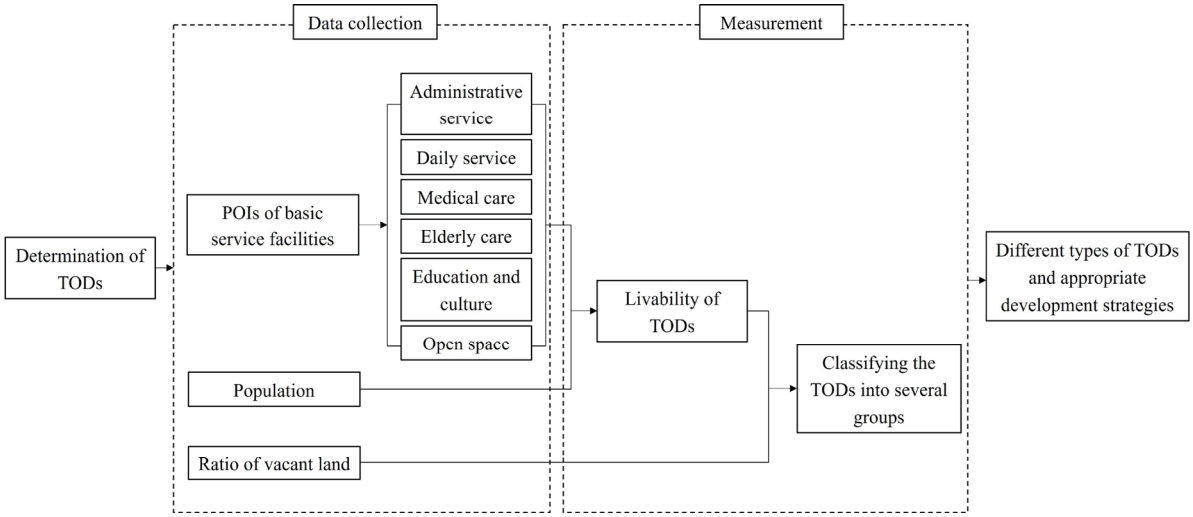

Figure 2. Research flow chart

mixed-use neighborhood by measuring the compactness, complexity, and connectivity of urban form[4]. Marshall (2013) chose indicators from the perspectives of environment, society, and economy to evaluate livability and assessed to what extent the TODs in Denver meet people's requirements for livability[20]. Few studies have analyzed livability from the perspective of a deep understanding of residents' daily needs and quality of life. Therefore, our research attempted to evaluate the livability of TODs by analyzing the daily life needs of residents.

3. Method

This research attempted to evaluate the livability of TODs in second-tier cities by analyzing residents' access to various basic facilities in order to understand whether their daily needs can be met and the direction for improving their quality of life. The details of the implementation process are as follows: Firstly, determining the appropriate buffer area for the existing TODs. Secondly, select the daily facilities required by residents of all ages. Thirdly, determine the livability of TODs by analyzing the relationship between facilities and population in TODs to understand whether the facilities can meet the daily needs of residents. Fourthly, classify the TODs based on their current situation of land-use and livability, to find accurate development directions and effective improvement strategies for these TODs. The Fig. 2 shows the research flow chart.

3.1 Study area

This research selected 69 relatively mature TODs on 3 subway lines from Hefei City for discussion. A TOD in Hefei City refers to a subway station and its surrounding area within 500 meters[21]. The aim of this research is to understand whether the daily needs of residents within the TODs can be met. The daily activities of these residents are not limited to the interior of TODs but also expand externally. Therefore, this research suggested considering the distribution of basic facilities within a 10-minute walking distance from the edge of TODs. The 69 existing TODs and their extension areas were regarded as TOD coverage areas, as shown in Fig. 3.

3.2 Data and source

This research aimed to measure the livability of TODs by analyzing residents' access to daily facilities. Based on previous research and the actual situation in Hefei City, the essential facilities in residents' daily lives need to be selected. The Chinese government document "the Standard for the Planning and Design of Urban Residential Areas" mentioned that improving the quality of life for residents requires consideration from the following points: the formation of

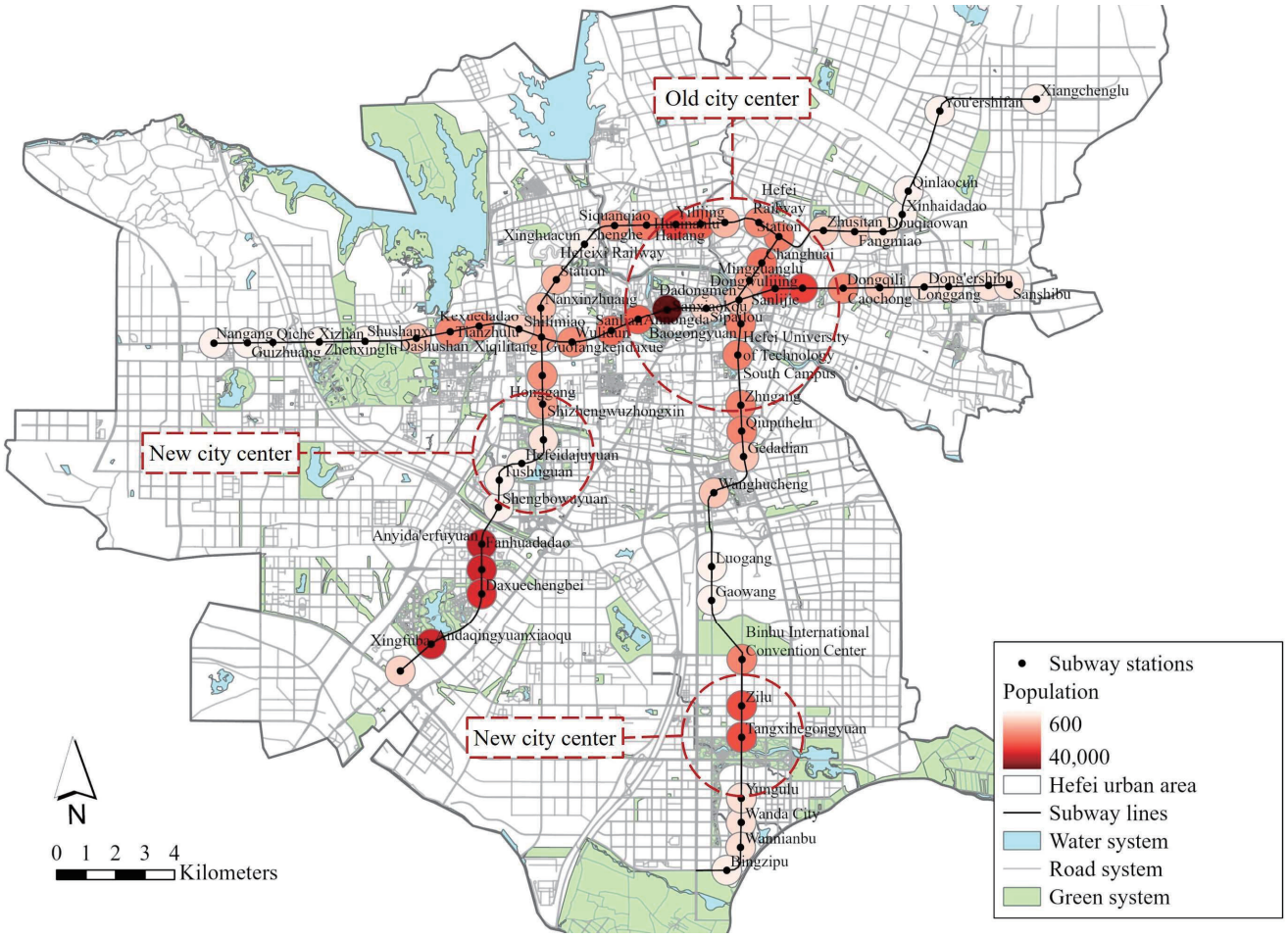

Figure 3. The location of 69 TODs in Hefei City.

convenient daily services; humanistic care for the elderly; education for all ages; diverse recreation; sufficient medical and health care; employment and management facilities; balanced public space; and a healthy environment[8]. Therefore, this research selected six key facilities to evaluate the livability of TODs, namely (C1) daily service facilities, (C2) administrative service facilities, (C3) medical facilities, (C4) elderly care facilities, (C5) open space, and (C6) educational and cultural facilities. The data and source are shown in Table 1.

POI data for six types of daily facilities within TOD coverage areas was collected from the Baidu Map in September 2022. Since POI data includes information on geographical location and some additional attributes (such as name, category, and address). In addition, this research also analyzed the relationship between facilities and population to determine whether residents' daily needs could be met. Since there are significant differences in population distribution among different TODs in Hefei City (Fig. 3), TODs with larger populations have a greater demand for facilities. Therefore, this research collected population data for each TOD from the 2017 Hefei Statistical Yearbook[22] to evaluate the livability of TODs accurately.

3.3 The current distribution characteristics of six types of facilities in the TODs

Understanding the distribution characteristics of facilities within the TOD coverage areas can provide an overall grasp of the future development of a city. The density distribution method was applied to obtain the distribution characteristics of facilities in this research since the distribution situation of facilities in different cities is obviously different due to local contexts and policies. As mentioned above, the POI data can provide information on the number of facilities and the geographical location of facilities. The Euclidean distance was used to measure the distance from the residence within TODs to the six types of facilities.

There are some studies analyzing the travel distance between residences and various facilities, but the calculation methods vary. For instance, Logan (2022) calculated the walking time of each neighborhood block from the block centroid to each amenity[16]. In previous studies, a common approach was to determine the center point of a community based on its geometric shape, then analyze residents' access to various facilities by measuring the distance from the center point to various facilities. However, there is no clear community boundary for many Chinese cities, and many residential buildings are scattered in different regions of a city. Obviously, the previous research methods are not applicable to Chinese cities.

This research proposes to use POI data to obtain the geographical relationship between residences and facilities in a city. It is possible to understand residents' access to various facilities directly by measuring the distance from the residential POIs to the POIs of the nearest facilities without considering the community boundaries. Then analyze these distances through the density distribution method to understand the distribution characteristics of various facilities. Therefore, this method is suitable for different cities and helps people quickly understand the distribution of facilities in a city.

3.4 Evaluating the livability of each TOD in Hefei City

This research aimed to determine the livability of each TOD by considering whether the facilities for residents within the TODs could meet their daily needs. The balance between

Table 1. Data and data sources

Data Types		Measurements	Data Sources
Facility Types	Daily service (C1)	Counting the number of POIs of food markets, maintenance shops, express delivery stations, supermarkets, banks, ATMs, convenience stores, public toilets.	The website of Baidu Map. (Accessed on September 22, 2022)
	Administrative service (C2)	Counting the number of POIs of police stations, community service centers, subdistrict offices.	
	Medical care (C3)	Counting the number of POIs of hospitals, clinics.	
	Elderly care (C4)	Counting the number of POIs of elderly care facilities.	
	Education and culture (C5)	Counting the number of POIs of cultural and educational facilities, fitness services.	
	Open space (C6)	Counting the number of POIs of parks.	
Population		China population census yearbook	The website of National Bureau of Satisitics of China. (Accessed on April 11, 2022)

supply and demand was emphasized when considering the equal distribution of resources in previous studies. For example, Wu (2021) tried to evaluate the matching index between the supply of facilities and the demands of residents within communities to find optimization strategies for different communities[23].

In Fig. 3, there are significant differences in population distribution among different TODs in Hefei City. There are many residents in the TODs located in the new and old central areas of Hefei City. This research can understand the supply of facilities in different TODs by counting the number of six types of facilities within the TOD coverage areas through the POI data. Due to uneven population distribution, Wu (2023) mentioned that the ratio of the number of facilities to the population can reflect the supply relationship between the existing facilities and the population in different regions[24]. Therefore, this research calculated the ratio of the number of facilities provided within the TOD coverage areas to the population within the TODs to obtain the livability of TODs.

Livability at each TOD = Number of facilities within each TOD coverage area / Population at each TOD.

By comparing livability values, it is possible to directly understand which TOD's daily facilities are more complete, as well as the types of facilities that need further development within each TOD.

3.5 Classifying the TODs into several clusters in Hefei City

This research proposes using classification methods to divide TODs into several groups and improve them as effectively as possible. Classifying TODs and putting forward appropriate strategies for different clusters has been a common approach in previous research, since the same cluster of TODs can use the same strategies, which can greatly improve development efficiency and reduce government investment. For example, Su (2021) classified the TODs in five Chinese megacities according to their TOD degree, then provided recommendations for planning different TODs to minimize costs[25]. Higgins (2016) classified the 372 TODs in Toronto into a set of classes based on a latent class method to guide them to maximize the potential return on investment[26].

The current situation of land-use was used as one of the factors for classification. Since the current situation of land-use in TODs located in different regions of Hefei City varies greatly, and the future development direction is also different. For example, there is a large amount of vacant land in TODs located on the edge of the urban area, which indicates that future

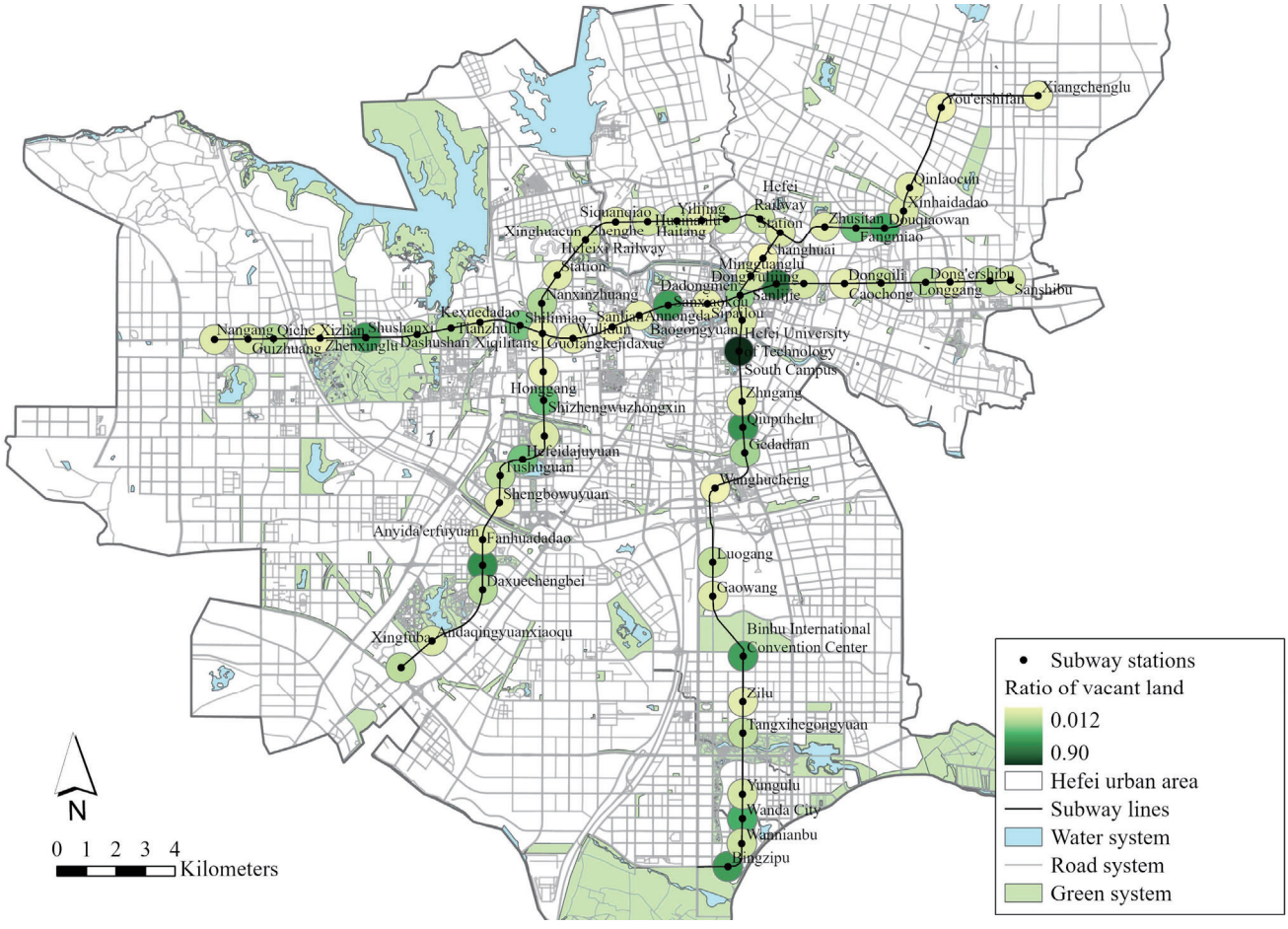

Figure 4. The current situation of land-use for the 69 TODs.

development strategies can focus on how to utilize the vacant land. The TODs located in the central area of Hefei City need to consider regional renewal or land function mixing in the future development strategy due to the limited vacant land. In this research, the proportion of vacant land within the TOD coverage areas was applied to represent the current land-use situation of TODs. The current situation of land-use for 69 TODs is shown in Fig. 4. Therefore, this research is intended to classify the TODs based on their livability and current land-use development. Then, this research proposed corresponding improvement strategies based on the classification results.

4. Results and discussion

4.1 The current distribution characteristics of service facilities

Figure 3 shows the situation of residents arriving at various facilities. The shortest distance from residences within TODs to the nearest facilities within TOD coverage areas was calculated. Then the density distribution method was used to reveal the current distribution situation of facilities in TOD coverage areas. Most residents within TODs can reach educational and cultural facilities, administrative facilities, medical care facilities, daily life facilities, and open space within a straight distance of 500 meters in Hefei City. However, the current situation of elderly care facilities in Hefei City is different from other types of facilities. Only 17.3% of residences can reach elderly care facilities within 500 meters. This is because population aging, as a new issue, has not been given much attention in previous urban planning and development in Hefei City.

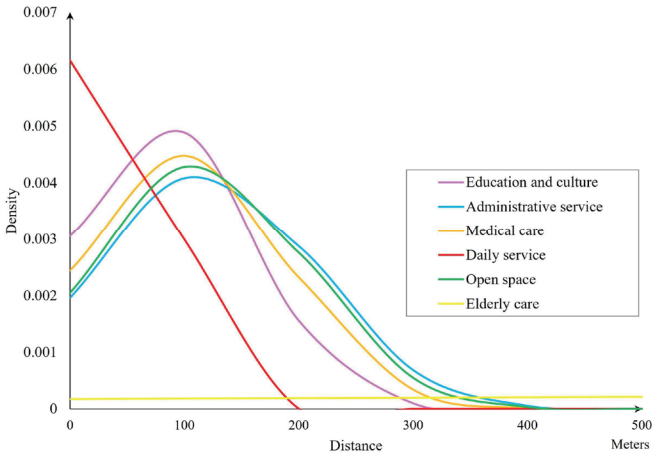

Figure 5. The distribution characteristics of facilities within TOD coverage areas.

4.2 Evaluating the livability of 69 TODs in Hefei City

Figure 4 shows the livability of 69 TODs in Hefei City. This research calculated the number of service facilities within the

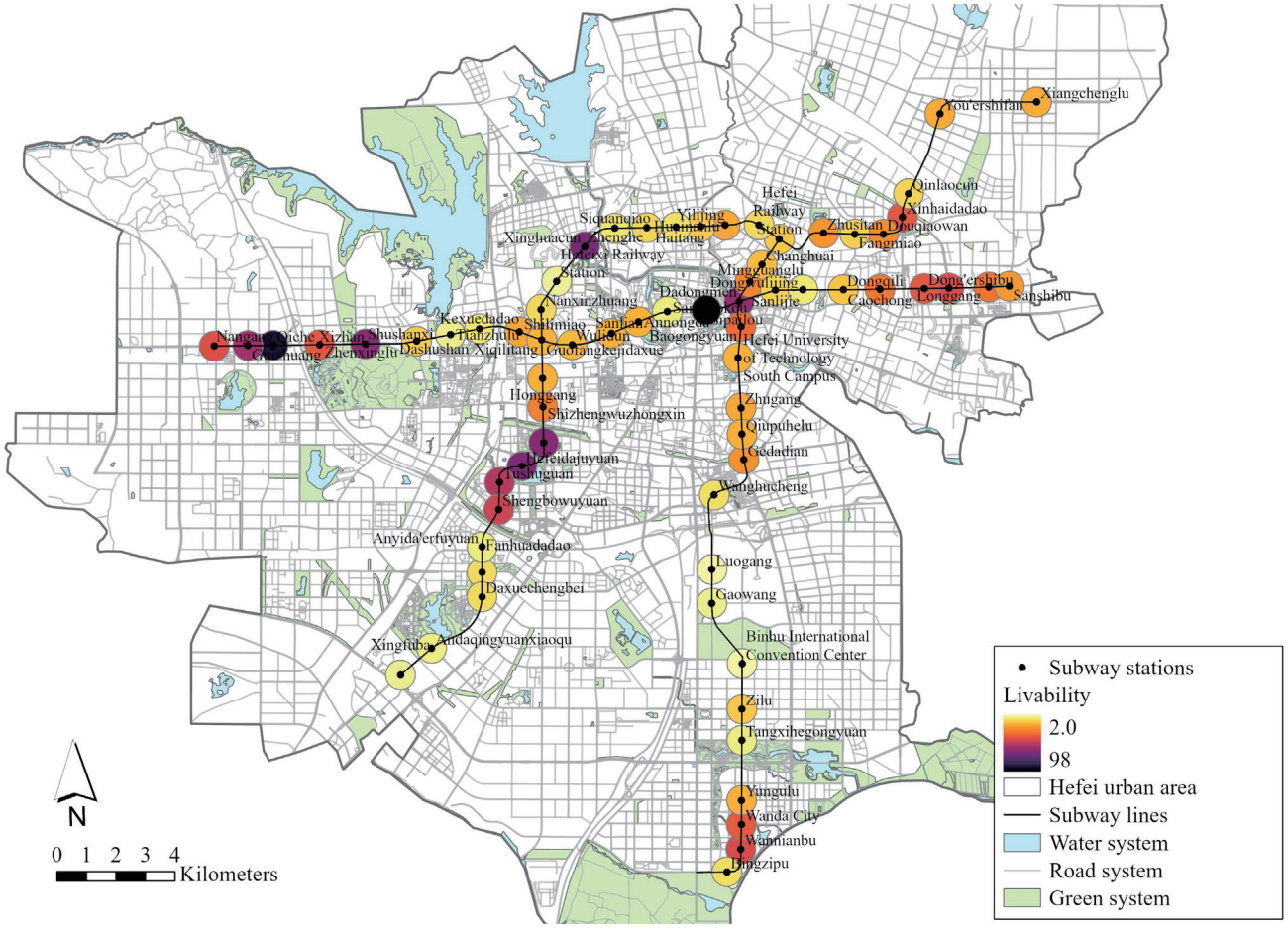

Figure 6. The distribution of livability of 69 TODs in Hefei City.

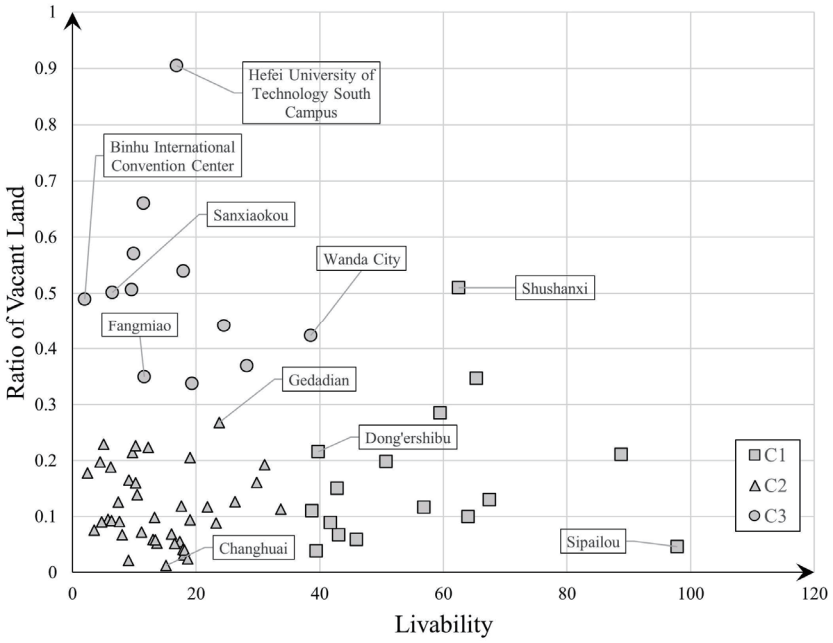

Figure 7. The relationship of livability and current land-use.

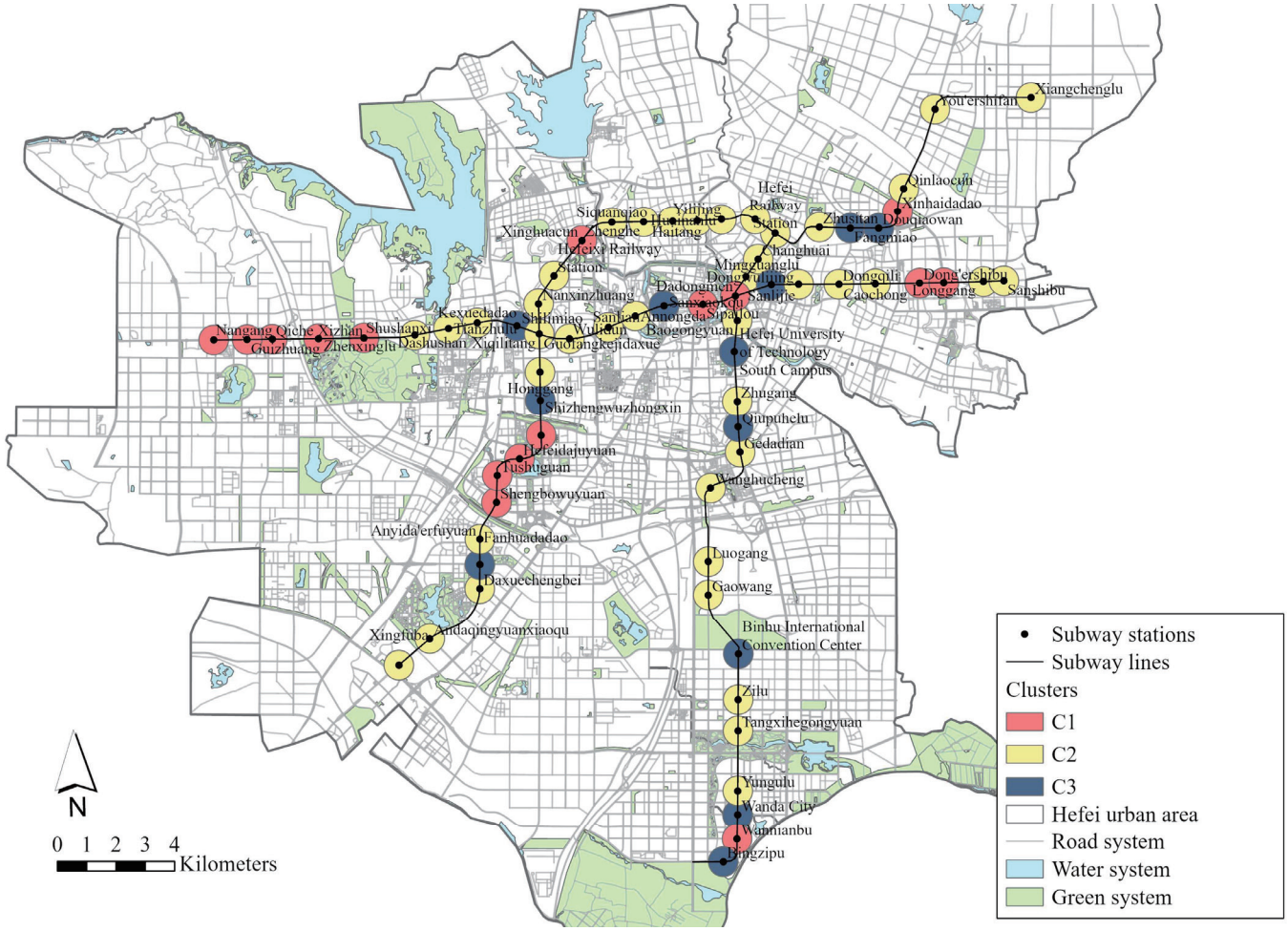

Figure 8. The distribution of 3 clusters in Hefei City.

TOD coverage areas and the population within the TODs to obtain the livability of 69 TODs. According to the calculation results, there are significant differences between these TODs, which indicates significant differences in the resources available to residents within different TODs. The TODs with high livability are mainly concentrated in the center areas, such as *Sipailou*, *Hefeidajuyuan*. It means that these TODs have sufficient facilities compared to the existing population. There

is also a part of TODs with higher livability gathering in traffic hub areas, such as *Qiche Xizhan*, which is a bus terminal. While the livability of most TODs is lower in Hefei City, such as *Binhu International Convention Center*. It indicates that the service facilities in these TODs are not adequate, more facilities should be provided to meet the daily needs of residents in future developments.

The reason for this situation is that, in previous urban development, people did not pay attention to the fair and reasonable allocation of resources. Therefore, some measures need to be taken to improve these TODs with low livability. Since this is not conducive to the implementation of the TOD concept, as it will lead to people moving towards areas with more abundant resources, resulting in excessive population density in some TODs while others will gradually decline. Compared to previous studies that only evaluated factors such as environment, housing, and transportation to obtain livability, this research measured livability from a people-oriented perspective, which is more suitable for the implementation of the TOD concept.

4.3 Classifying the TODs into several clusters in Hefei City

This research divided the 69 TODs into 3 clusters based on their livability and current land-use by applying the k-mean method. The results are shown in Fig. 7. Meanwhile, Fig. 8 shows the distribution of these 3 clusters in Hefei City.

This research provided explanations for these three clusters. C1: high livability, low ratio of vacant land. This group of TODs is mainly distributed in the central areas of Hefei City or well-developed areas, as shown in Fig. 8. The high livability represents that the existing facilities within these TODs can meet the demands of residents. There are 16 TODs belonging to C1. *Sipailou*, *Shushanxi*, and *Dong'ershibu* are representative TODs. C2: low livability, low ratio of vacant land. The TODs in C2 are mainly distributed near C1. There are 41 TODs in Hefei City that belong to C2. This cluster has the largest number in Hefei City. Although these TODs have developed relatively well, their livability is not good enough. *Changhuai*, *Gedadian* are representative TODs. C3: Low livability, high ratio of vacant land. The TODs in C3 have low livability and the large amount of vacant land give them great development potential. There are 12 TODs belonging to C3. *Hefei University of Technology South Campus*, *Binhu International Convention Center*, and *Sanxiaokou* are representative TODs in C3.

Although some TODs are located in the same cluster, their future development strategies are not the same due to their unique characteristics. This research used radar chart to represent the current situation of the six facilities of TODs. For example, *Hefei University of Technology South Campus* is close to the old city center but has a very high proportion of vacant land and low livability. Since this TOD mainly serves the surrounding university campus, it has a simple land function that mainly gathers facilities for open space, daily life, and education (Fig. 9(a)). At the same time, the land development within the TOD coverage area is constrained by the surrounding campus planning. Therefore, this TOD can consider adding medical, elderly care, and administrative facilities to meet the daily needs of different ages in the neighborhood. At the same time, due to limited vacant land, increasing the degree of land-use mix can be used to solve the problem in future development.

Binhu International Convention Center (Fig. 9(b)) is close to a new city center, attracting a large population to gather within this TOD. The current number of facilities cannot meet the large population, resulting in low livability. At the same time, as it is a developing TOD, there is a large amount of undeveloped land in the area. The lack of medical and elderly care facilities within the coverage scope of this TOD needs to be taken seriously, and the lack of administrative facilities is also a key factor for future development.

Sanxiaokou, (Fig. 9(c)) as a TOD located in the central area of Hefei City, although it has many facilities, cannot meet the needs of the existing large population, which leads to its low livability. At the same time, there are large areas of vacant land with planned land functions that have not yet been constructed.

The classification results can quickly identify TODs that urgently need development. In addition, people can accurately grasp the facilities that need further development for each TOD combined with the radar chart. Compared to previous studies, the method adopted in this research is more suitable for the local context of Chinese cities. Firstly, previous research always studied the distribution of facilities within communities (Noworól, 2022). Due to the lack of clear community boundaries in many Chinese cities and the existence of lots of scattered residences, this research proposed using POI data to obtain the geographical location of different residences. Secondly, Li (2019) stated that the more types of facilities, the better the quality of life in the area[27]. Our research considered the types of facilities accessible to residents in the TODs, but also counted the number of different types of facilities, making the method of evaluating the quality of life more accurate. Thirdly, most studies on improving livability did not consider the current land-use situation within the regions. The future improvement directions for developing regions and developed regions are clearly different. As mentioned by Wu (2021), some

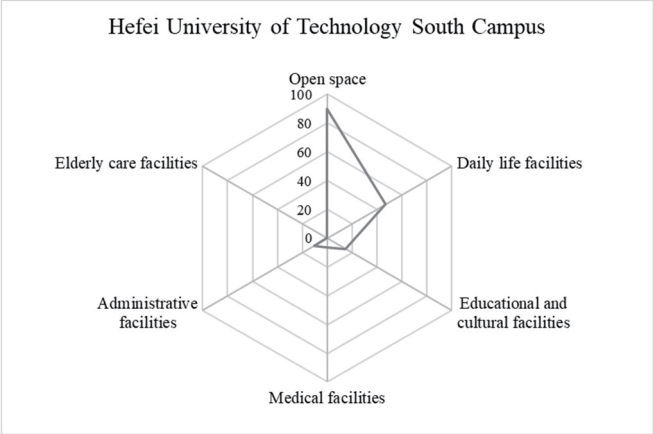

Figure 9(a). *Hefei University of Technology South Campus*

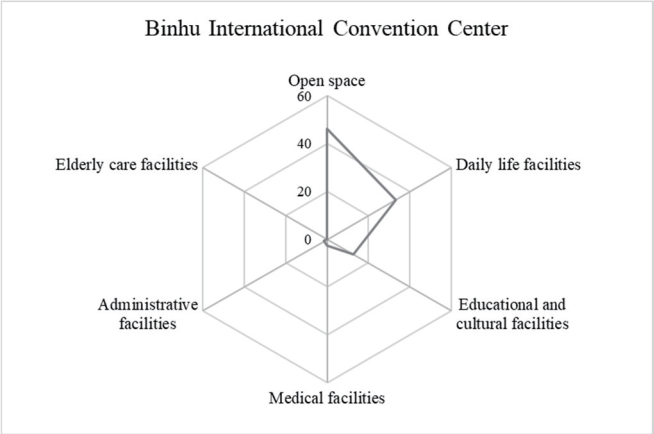

Figure 9(b). *Binhu International Convention Center*

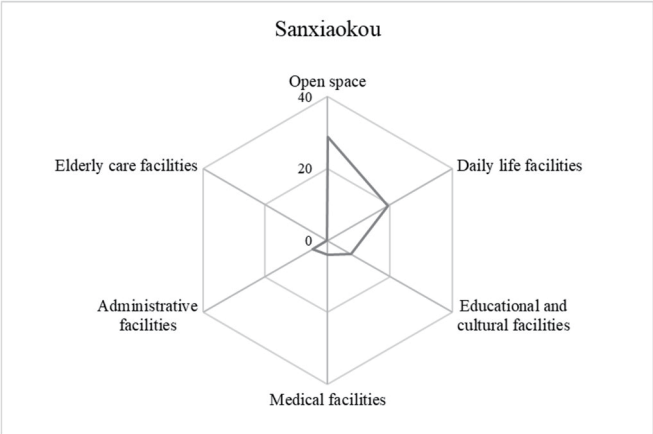

Figure 9(c). *Sanxiaokou*

Figure 9. Representative TODs within different clusters

high-density areas can integrate different types of daily needs by increasing the sharing of facility functions[23]. Therefore, our study proposed to classify TOD based on the current situation of land-use to find suitable improvement strategies.

5. Conclusion

The transit-oriented development (TOD) concept aims to integrate land and transport to attract a greater number of people to congregate around transit nodes and enhance their quality of life. In recent years, this concept has been extensively implemented in various Chinese cities, including Beijing, Shanghai, and Shenzhen. However, many existing TODs primarily concentrate on maximizing access to public transportation and reducing vehicle dependency, often neglecting the crucial aspect of the quality of life in a neighborhood. Previous studies on the TOD concept have rarely considered the quality of life experienced by residents. Evaluating livability has been employed to assess the quality of life of residents within existing TODs. This research examined whether the service facilities within the current TODs can be capable of meeting the daily needs of residents of all age groups, thereby ensuring the livability of TODs. In contrast to the highly developed TODs in first-tier cities, the selected TODs in second-tier cities are presently in the developmental phase. These second-tier cities still need to prioritize the construction of infrastructure and land development within their TODs, often disregarding the demands of residents.

Hefei City, as a representative second-tier city actively developing TODs, was selected as a case study. Therefore, the objectives of this research are as follows: Firstly, it aimed to evaluate whether the existing TODs in Hefei City adequately meet the daily needs of residents of all age groups. Secondly, it identified TODs requiring further development and propose suitable strategies to ensure equitable access to resources within TODs.

The methodology employed in this research identified the specific facilities that require attention in future developments. For instance, the scarcity of elderly care facilities is an issue that cannot be overlooked considering the current situation within the selected TODs in Hefei City. Nevertheless, it is important to note that different cities possess distinct development directions influenced by previous policies. This methodology can be applied to various cities, enabling stakeholders to swiftly comprehend the current distribution of facilities and develop a fundamental understanding of directions for improving TODs.

There are several findings in this research:

(1) This study analyzed the distribution situation of various service facilities within TOD coverage areas using POI data and found that only a small portion of residents can access elderly care facilities within TOD coverage areas. The reason for this phenomenon is that the aging population has not been given sufficient attention in the previous policies of Hefei city. This is also a common problem recently observed in many Chinese cities.

(2) By analyzing the relationship between the number of facilities and the population, this study assessed the livability of TOD areas. The results reveal that TODs with higher

livability in Hefei City are mainly concentrated in well-developed areas such as the new and old city centers and transportation hubs. However, most TODs in Hefei City suffer from the issue of having relatively completed land development but lower livability. In addition, there is a small portion of TODs characterized by lower livability due to plenty of vacant land, and these TODs are evenly dispersed throughout Hefei City.

(3) This study utilized cluster analysis to classify the 69 TODs into 3 clusters based on their livability and land-use situation. This approach allows for a more precise understanding of the existing issues within the TODs.

Furthermore, it is important to acknowledge the limitations of this research. One limitation is that the number of POIs may not always accurately reflect the service capacity of facilities within TODs. This is due to the presence of certain facilities that possess strong service capabilities despite having a lower number of POIs. Thus, future research should consider incorporating appropriate weighting for POIs to address this limitation. In essence, our ongoing research aims to enhance this methodology, making it more precise and applicable across a broader range of cities.

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