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Accessibility Assessment of Educational Facilities in 15-Minute Neighborhoods of Zhifu District, Yantai City Based on QGIS

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Abstract: This study aims to assess the accessibility of educational public facilities (kindergartens, primary schools, and middle schools) within the 15-minute neighborhoods (using a 1,000-meter walking distance as reference) in Zhifu District, Yantai City using GIS technology. Specifically, it addresses the practical problems of uneven spatial distribution of educational resources in the district—such as insufficient coverage of facilities in peripheral areas, difficulty for residents in these areas to access nearby education services, and the resulting imbalance in educational equity. By revealing spatial coverage patterns and accessibility disparities, this study proposes layout optimization strategies to provide a scientific basis for balancing public resource allocation and enhancing resident convenience.

Keywords: 15-Minute Neighborhoods; Educational Facilities; Zhifu District; Resource Allocation Optimization; Accessibility

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1. Introduction

1.1. Research Background

The concept of “life circle” originated in Japan as a sociological framework to coordinate urban-rural economic activities and promote regional balance[1]. In China, this concept gained prominence in 2016 when the State Council explicitly advocated for “building convenient and efficient life circles”[2], leading to nationwide theoretical and practical explorations. The Technical Guide for Community Life Circle Planning (2021 Edition) defines community life circles as basic units that integrate functions like “learning convenience” within a 15-minute walking range (approximately 1,000 meters)[3]. The report of the 20th National Congress of the Communist Party of China in 2022 further emphasized promoting high-quality, balanced development of basic education and enhancing the accessibility of educational facilities[4].

Despite high enrollment rates nationally, regional disparities persist, especially between urban cores and peripheries[5]. In Zhifu District, Yantai’s central urban area, educational facilities are densely clustered in old urban zones, while peripheral new communities and mountainous/coastal areas face shortages. Middle schools exhibit the lowest coverage, with over 30% of residential areas lacking nearby services. These imbalances contradict national goals of “high-quality and balanced development.”

Addressing these issues in Zhifu District is critical for improving local residents' quality of life and serves as a microcosm for optimizing urban public resource allocation in similar Chinese contexts.

1.2. Research Objectives

This study aims to:

(1) Develop a GIS model to evaluate spatial accessibility of educational facilities in Zhifu District, identifying coverage gaps;

(2) Analyze causes of accessibility disparities (e.g., road connectivity, terrain);

(3) Propose layout optimization strategies to improve accessibility and resource equity.

1.3. Study Area

Yantai City is a prefecture-level city in Shandong Province, located in the northeast of Shandong Peninsula. Zhifu District, the core urban district of Yantai City, covers 179.18 $km^2$with a 100% urbanization rate and a population of 880,000 (2023). It exemplifies the "core-periphery" spatial pattern common in rapidly urbanizing eastern Chinese cities, integrating mature old urban areas with rapidly expanding new zones. This makes it a typical case for studying educational resource allocation challenges, such as adapting to population inflow and balancing efficiency with equity.

1.4. Research Contributions

The findings of this study offer practical implications for enhancing educational facility accessibility in Zhifu District, Yantai City, with potential applications for other regions facing similar challenges. Specifically, the research:

(1) Demonstrates how GIS-based spatial analysis can identify precise coverage gaps—such as the low accessibility of middle schools in peripheral areas—enabling data-driven optimization strategies, like adding five middle schools to raise coverage to 90%. This approach aligns with China's policy goals of balanced compulsory education resource allocation.

(2) Provides a replicable framework for integrating "15-minute neighborhood" planning with local geographical constraints, emphasizing the need to adapt facility layouts to natural environments rather than applying one-size-fits-all models.

(3) Contributes methodologically by validating the use of QGIS and real-world data for low-cost, high-precision accessibility assessments, which is particularly valuable for resource-limited settings. These insights bridge technical analysis and policy implementation, supporting sustainable urban development in rapidly urbanizing areas.

2. Literature Review and Theoretical Basis

2.1. Current Research Status at Home and Abroad

As the origin of "living sphere" research, Japan proposed the "broad living spheres" concept in 1965 and initiated field explorations. Japanese scholars then conducted practical research: Koide Takehayasu analyzed Nagano City's living sphere; Ono Tadahiro divided the Suō region into a four-tier structure; Yamashita Katsuhiko proposed a three-tier structure for Iwate Prefecture.

Influenced by Japan, South Korea introduced three major living sphere classifications in its national plan and divided residential areas by service radius[5]. China's Taiwan region first introduced living sphere research in 1979, delineating 35 living spheres and adjusting them dynamically. In recent years, mainland Chinese experts have also conducted relevant research[6].

For example, Zeng Xiangkai studied Guiyang's central urban area, finding a "core strength with peripheral weakness" structure of public service facilities[7]. Tang Yuting analyzed Urumqi's central urban area, proposing an optimization framework for basic support facilities[8]. Hu Wenzhi investigated Kunming's Guandu District, focusing on NIMBY effects and proposing optimization strategies[9].

Current research on community living spheres and educational facility accessibility has achieved breakthroughs: a systematic theoretical framework, diversified methodological exploration, and policy support at the practical level. These achievements provide a foundation for this study and cross-regional comparative frameworks[10].

However, there are limitations: research scales focus on macro-regions, lacking micro-scale attention; educational facility studies lack dynamic response perspectives; and the quantitative depth of technical methods is limited.

2.2. Theoretical Basis

2.2.1. 15 - Minute Community Life Circle Planning Theory

This theory originated from Japan's "Broad Life Sphere" and was defined in China's 2021 Technical Guide as a unit meeting residents' full - life needs within a walkable range, integrating multiple functions. Its core is to delimit life circles based on a 15-minute walk (about 1,000 meters) for spatial accessibility and balanced facility allocation. It has three key dimensions:

(1) Spatial Scale Adaptation Principle: Using a 1,000-meter walking distance aligns with the Guide's “learning convenience” requirement. This study uses 1,000-meter buffer zones to assess educational facility accessibility.

(2) Hierarchical Service Logic: Based on Japanese scholar Yamashita Katsuhiko’s theory, educational facilities are stratified by service radius. Zhifu District’s secondary school distribution validates the tiered allocation framework.

(3) Equity-Oriented Mechanism: Adapting Korea's life-circle model, spatial accessibility is an equity indicator. The study finds 30% of residential areas lack nearby secondary schools, needing optimization to reduce disparities.

2.2.2. Accessibility Theory

Accessibility theory refers to the difficulty of overcoming spatial barriers and is a key indicator for measuring public service equity. It dates back to classical location theory, with transportation always important. Modern-day accessibility was first defined by Hansen. Since then, scholars have explored its meaning and evaluation methods[11]. Its theoretical principles are:

(1) Quantitative Dimensions: Transforming accessibility into measurable parameters with walking distance and time cost.

(2) Barrier Factors: Topography, road connectivity, etc., affect accessibility and need to be considered in evaluations.

(3) Policy Integration: China's Technical Guide requires enhancing accessibility by placing service elements in densely - populated and well - connected areas.

2.2.3. Buffer Zone Analysis

A buffer zone is the space around a spatial object at a certain distance, divided into different forms. Buffer zone technology is a mature GIS spatial analysis method in transportation[12]. This paper uses it to analyze residents' accessibility to educational facilities in Zhifu District by establishing circular buffer zones with a 15-minute walk radius, revealing local educational resource layout deficiencies and providing optimization references.

2.3. Development of measurement and calculation techniques

Many Chinese scholars have long used computer technology for regional resource layout planning via buffer zone analysis. For example, Zhao Lijun et al. used GIS buffer zone analysis technology to study Beijing's urban land expansion, optimizing resource layout [13]. Xu Zhuokui et al. used the Euclidean distance buffer zone analysis method to study shopping mall location layout, laying a theoretical foundation [14]. However, the research at this stage was immature, with issues like theory - practice discrepancies and incomplete consideration of local conditions, and there was little cross -

research.

After 2010, related technologies and buffer zone research were more widely applied in real-life scenarios. For instance, Lin Lu et al. integrated multiple methods to explore the spatial distribution in Mawei District, Fuzhou, and proposed areas for land management optimization [15]. Dai Chen et al. conducted buffer zone overlay analysis and combined methods to quantify land - use environmental suitability for Qinzhou City's planning [16]. Kang Chuanli et al. proposed an improved A algorithm in GIS for optimal path planning in Guilin's Qixing Park [17]. Nevertheless, some research still faces challenges such as GIS software commercial drawbacks, insufficient data timeliness, and inconsistent research standards. This study is based on the free and open-source QGIS system, combined with plugins like Quick OSM, and uses new reference data to fill certain gaps in related research fields.

3. Research Methodology

3.1. Acquisition of Zhifu District Map

QGIS (Quantum Geographic Information System) is open-source GIS software. It's free, reducing research costs, and cross-platform, ensuring continuity. It offers core GIS operations and has an extensive plugin ecosystem.

QGIS is the key for this study. It integrates multi-source spatial data of Zhifu District into a unified coordinate system to build a basic spatial database. Its spatial analysis functions create heatmaps and buffer analyses for educational facilities, providing data for accessibility assessment. Through its visualization, analysis results become thematic maps to assist decision-making.

In this study, the administrative boundary base map of Zhifu District was obtained from the National Geographic Information Resource Directory Service System (www.webmap.cn), which provides authoritative data. This base map shows the district's scope and divisions and serves as a framework for spatial analysis. Then, it was imported into QGIS, and the built-in QuickOSM plugin was used to query and acquire the road network data, establishing the district's basic map.

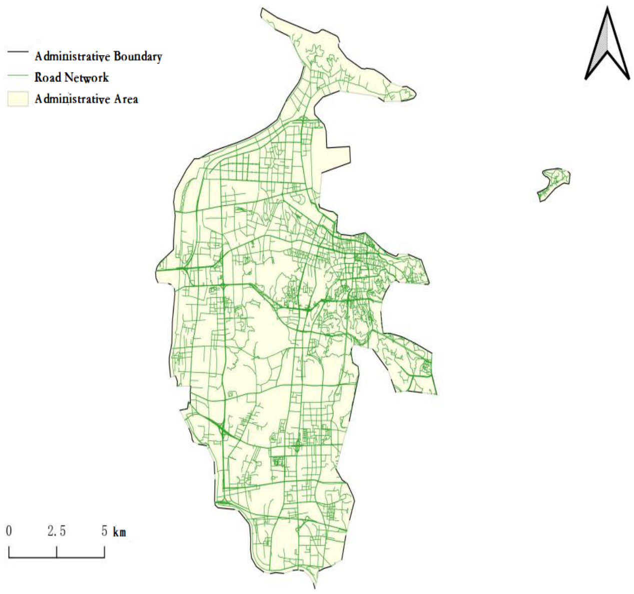

Figure 1. Distribution map of administrative boundaries, road networks, and administrative areas

3.2. Residential Area and Educational Facility Data Acquisition

The programming flexibility of Python enables efficient screening and extraction of target data, ensuring accurate geolocation of residential points and educational facilities to provide core data support for subsequent spatial analysis.

Utilizing Amap API's POI query functionality, Python scripts were executed to retrieve data on residential areas and educational facilities (kindergartens, primary schools, secondary schools) in Zhifu District. In April 2025, the following were obtained:

200 residential areas, 71 kindergartens, 48 primary schools, and 30 secondary schools.

Using QGIS, 1,000-meter buffer zoneswere created around residential areas. The Dissolve function integrated these into a single layer, and the Field Calculator computed the coverage area of 15-minute neighborhoods. Results show that the total coverage area is 106.35 km² and the average area per neighborhood is 0.53 km².

3.3. QGIS Layer Import and Data Analysis

To ensure spatial alignment and prevent coordinate discrepancies, all layers (residential areas, educational facilities, road networks) were standardized to EPSG:32650 - WGS 84/UTM zone 50N before import. This step guarantees accuracy in buffer analysis, heatmap generation, and subsequent operations. Kernel Density Analysis (KDE) is a non-parametric statistical method for estimating the distribution density of spatial point data, revealing element aggregation in space. It's widely used in identifying facility hotspots and optimizing resource allocation. This method centers on point data, constructing a density surface to show geographic element aggregation and distribution[18]. Its core is to superimpose a kernel function (e.g., Gaussian kernel) at each data point to calculate density values in the study area, expressed by a formula.

$$f(s) = \frac{1}{nh}\sum_{i=1}^{n} k\left(\frac{c_s - c_i}{n}\right) \tag{1}$$

where *f(s)* represents the kernel density function at location s; *n* is the number of facility points; *h* denotes the bandwidth; *k* is the spatial weight; c_s-c_i represents the distance from location s to the core feature point i.

The Natural Breaks Classification (Jenks) method optimizes data classification by identifying inherent groupings in datasets, maximizing inter-class differences and minimizing intra-class variance. In QGIS, this algorithm classifies continuous data for visualized outputs, eliminating subjective threshold biases. After data integration, QGIS's heatmap analysis function based on the Jenks algorithm was used to generate heatmaps for kindergartens, primary schools, and secondary schools. **Figure 2** shows kindergartens are mainly clustered in central and northeastern old urban areas with a peak thermal value of 4.0; **Figure 3** reveals primary schools have a similar core-periphery pattern with a peak thermal value of 3.28; **Figure 4** indicates secondary schools are sparsely distributed in peripheral zones with coverage rates below 20%. This visually reflects the spatial aggregation of educational facilities and provides a basis for identifying dense areas and service gaps.

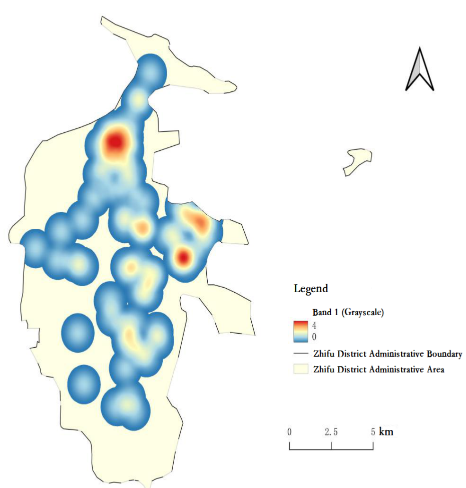

Figure 2. Kindergarten Distribution Heatmap

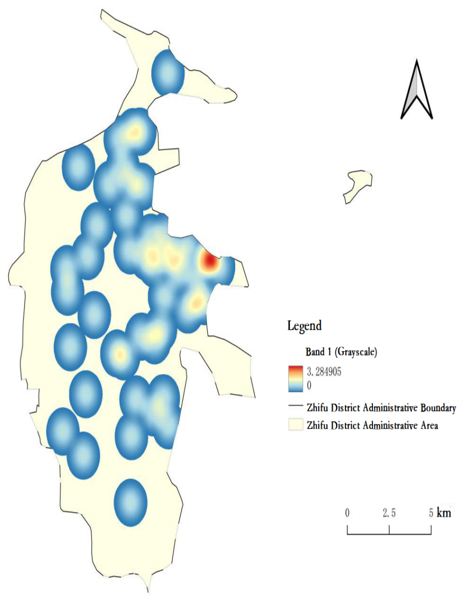

Figure 3. Primary School Distribution Heatmap

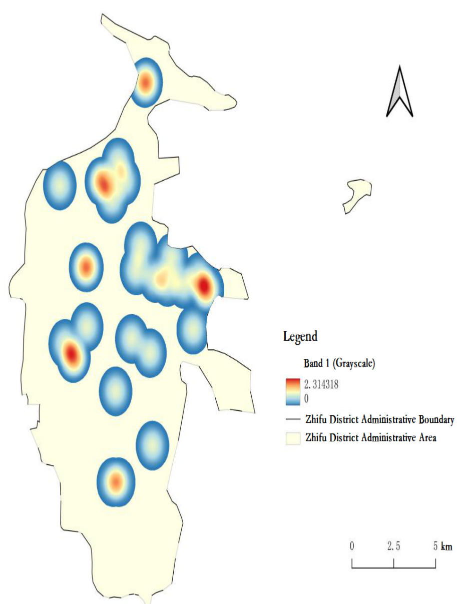

Figure 4. Middle School Distribution Heatmap

Additionally, we used the Jenks algorithm to create 1,000-meter buffer zones around residential areas to visualize facility coverage intensity. Different colors were assigned according to the number of educational facilities in each buffer zone to quantitatively visualize the coverage intensity around residential points. As the facility count rises, the color of coverage areas changes from red to blue. **Figure 5** shows most residential areas have 1 - 3 kindergartens within walking distance. **Figure 6** indicates over 32% of residential areas have more than 3 primary schools nearby. **Figure 7** shows over 30% of residential areas lack nearby middle schools, and peripheral zones have severe shortages.

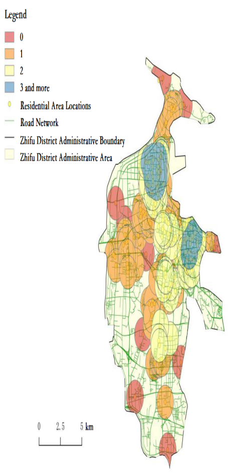

Figure 5. Kindergarten 1000-Meter Buffer Zones

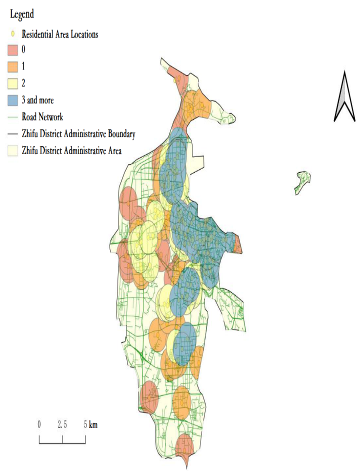

Figure 6. Primary School 1000-Meter Buffer Zones

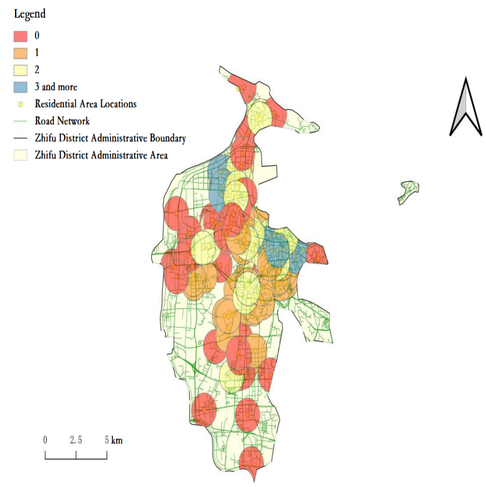

Figure 7. Middle School 1000-Meter Buffer Zones

4. Data Sources and Processing

4.1. Data Sources

For base maps, administrative boundaries were obtained from the National Geographic Information Resource Directory Service System (www.webmap.cn) and imported into QGIS to generate layer data. Detailed road networks were acquired through QGIS's QuickOSM plugin, reprojected to the appropriate coordinate system to create road network layers.

For point-of-interest (POI) data: spatial distribution of charging facilities, residential areas, and villages/towns was precisely located using a combined approach of Amap POI scraping and QGIS geographic data collection, ensuring comprehensive and accurate coverage.

4.2. Data processing

Data on kindergartens, primary schools, and secondary schools within 1,000 meters of residential areas were analyzed in SPSS, with line charts showing distribution patterns: **Figure 8** (Kindergarten Quantity Distribution) indicates 55% of residential areas have 1-3 kindergartens; **Figure 9** reveals 32% of areas have more than 3 primary schools; **Figure 10** (Middle School Quantity Distribution) confirms 30% of areas lack nearby middle schools.

l**Kindergartens:** A total of 71 kindergartens were distributed across the study area. The average number of kindergartens within 1,000 meters of each residential area was 3.2 (range: 0–9), with 6.5% of residential areas having no kindergartens nearby (**Figure 8**).

l**Primary schools:** 48 primary schools were identified. The average number within 1,000 meters of residential areas was 2.8 (range: 0–7), and 13.5% of residential areas lacked nearby primary schools (**Figure 9**).

l**Middle schools:** 30 middle schools were recorded. The average number within 1,000 meters of residential areas was 1.5 (range: 0–5), with 30.5% of residential areas having no nearby middle schools (**Figure 10**).

These statistics indicate that middle schools have the lowest coverage and most uneven distribution among the three types of educational facilities.

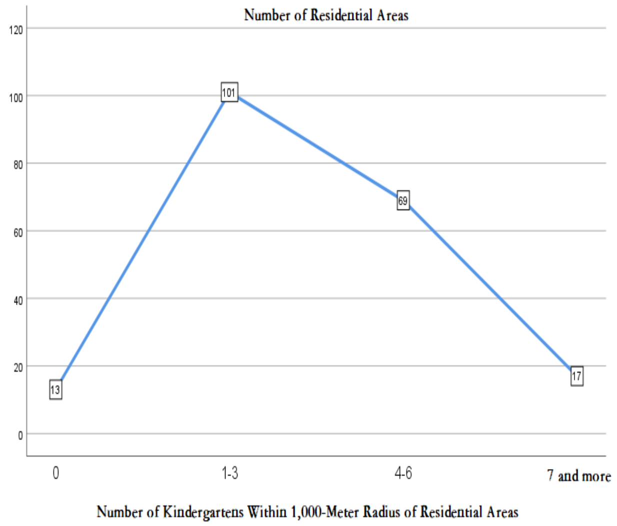

Figure 8. Kindergarten Quantity Distribution Within 1,000-Meter Periphery of Residential Areas

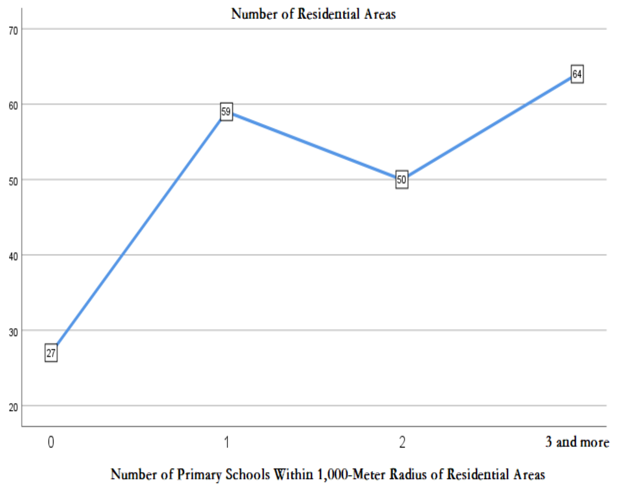

Figure 9. Primary School Quantity Distribution Within 1,000-Meter Periphery of Residential Areas

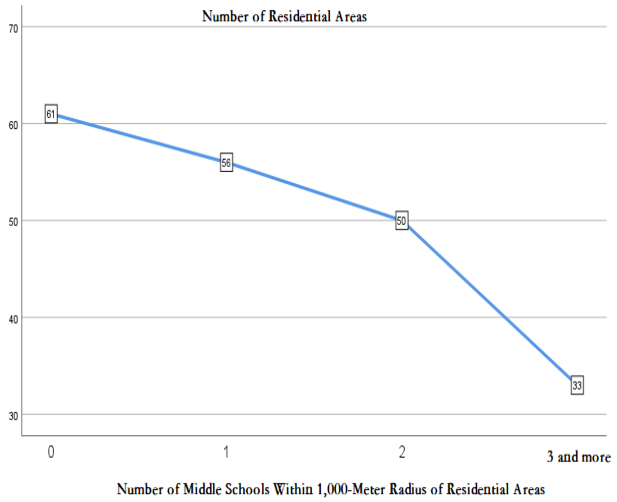

Figure 10. Middle School Quantity Distribution Within 1,000-Meter Periphery of Residential Areas

5. Research Findings

5.1. Characteristics of Educational Facilities

QGIS heatmap analysis reveals distinct spatial agglomeration of educational facilities in Zhifu District, exhibiting a "densely distributed core area with sparse peripheral zones" concentric ring structure. For kindergartens and primary schools, clusters concentrate in older urban areas of central and northeastern Zhifu District. This region features in high population density, long-standing development history and early-established and mature facilities with peak thermal values reaching 4.0 and 3.28 respectively, indicating strong alignment between facility density and population demand.

For secondary schools, agglomeration intensity is comparatively lower, primarily focused in areas north of the central district. Peripheral zones display significant low-thermal-value areas, demonstrating inadequate coverage of secondary schools in rapidly growing marginal regions[19].

5.2. Accessibility Assessment of 15-minute Living Circle

Based on the analysis of the 1000-meter walking buffer zone, there are relatively significant differences in the living circle coverage of the three types of educational facilities.

Calculated based on the proportion of the buffer zone area to the total administrative area of Zhifu District, in terms of kindergartens and primary schools, the coverage ranges are close, reaching 50.96% and 49.89% respectively. This indicates that residents in half of the residential areas can obtain kindergarten and primary school services within a 15-minute walking distance from home. However, the two show a "staggered coverage" feature in spatial distribution; the high - coverage areas of kindergartens are concentrated in the old urban areas, while primary schools are more evenly covered in the emerging communities in the central part, reflecting the response of recent primary school planning to population migration. For middle schools, the coverage range is 32.85%, significantly lower than that of kindergartens and primary schools, and the coverage rate in the peripheral areas is less than 20%. Combined with the road network analysis, it is found that the road connectivity within the service radius of middle schools is poor. In some mountainous and coastal areas, due to geographical environment restrictions, the actual walking accessibility is low.

5.3. Differences in the Coverage of Educational Facilities in Residential Areas

From the perspective of kindergartens and primary schools, according to the relevant data statistically analyzed by SPSS, more than 55% of residential areas have 1 - 3 kindergartens within a 1000-meter radius around them, and only 6.5% of residential areas have no kindergartens; the number of residential areas with more than 3 primary schools within a 1000-meter radius around them is the largest, accounting for more than 32%, and the proportion of residential areas with no primary schools reaches 13.5%. Both show the characteristics of "high-basic coverage and local concentration", that is, more than 90% of residential areas are covered by at least 1 kindergarten or primary school, indicating that the layout of kindergartens and primary schools basically meets the requirements of the 15-minute living circle. This shows that the layout of kindergartens and primary schools in Zhifu District is relatively balanced as a whole, which can meet the nearby education needs of most residents for preschool and primary education.

From the perspective of middle schools, more than 30% of residential areas lack middle schools within a 1000-meter radius around them, which is much higher than the proportion of lacking kindergartens and primary schools within this range; the proportions of residential areas with 1 and 2 middle schools within a 1000-meter radius around them are only 28% and 25% respectively, also lower than the proportions of the former two. The number of middle schools is relatively scarce, and there is a lack of balance in spatial distribution, making it difficult to provide basic nearby enrollment guarantees for most residential areas.

6. Optimal Allocation

The "Standards for Planning and Design of Urban Residential Areas" stipulates that "the population of residents corresponding to the residential area within the 15-minute living circle ranges from 50,000 to 100,000 people, and a complete set of service facilities meeting daily life needs should be matched. Its service radius should not be greater than 1,000m", and it must cover 14 types of public facilities, including middle schools. Aiming at problems such as unbalanced layout of educational facilities and low coverage rate of some facilities, this research takes the three types of educational facilities that are relatively insufficient around residential areas in Zhifu District as the objects, and conducts a configuration optimization research.

6.1. Applying K-means Clustering to Simulate the Process of Newly-added Facilities

During statistics, to simplify the work, corresponding labels are often assigned to different samples, and then the relationship between the research data and their corresponding labels is studied and predictions are made. This learning method is supervised learning. However, in real life, most samples are difficult to be classified by labels. Learning a prediction model from these unlabeled data and learning the statistical laws or structures in the data is unsupervised learning. The core task of unsupervised learning is clustering, which refers to dividing a certain dataset into several categories, so that the similarity of data objects within a category is high, while the similarity of data objects between categories is low. The K-means algorithm is one of the most widely used algorithms in clustering algorithms [20, 21]. By applying the K-means clustering tool in QGIS, the process of newly-added facilities can be simulated, providing data support for determining the optimal number of newly-added facilities.

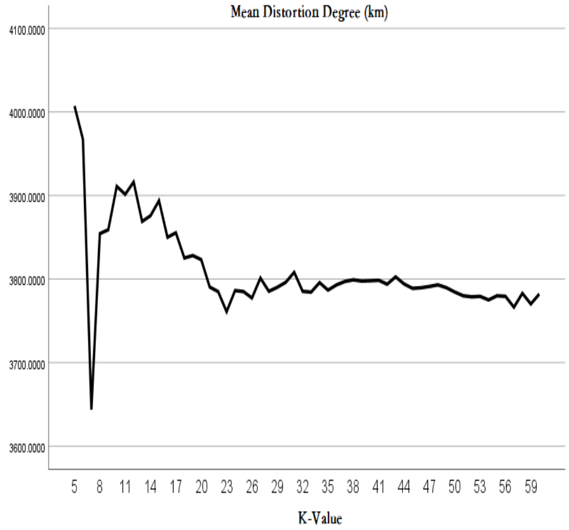

Figure 11. Average Distance from Newly-added Facilities to the Living Circles without Existing Facilities

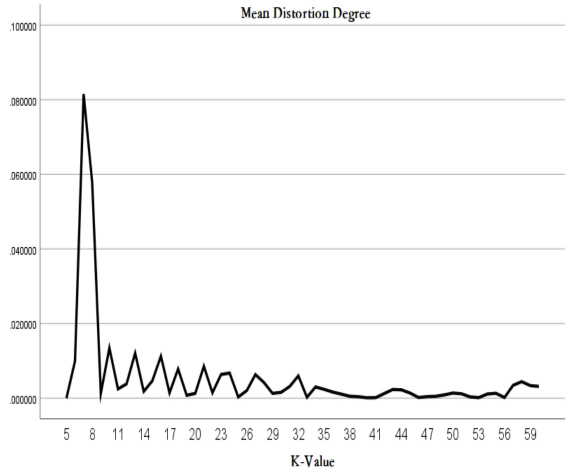

Figure 12. Rate of Change in the Average Distance from Newly - added Facilities to Living Circles without Existing Facilities

Using the Elbow Method: When analyzing the clustering results with the Elbow Method, it is found that as the value of K increases, the average distortion degree (the average distance from data points to the center of their respective clusters) generally shows a downward trend. This indicates that when the number of clusters increases, the average distance between data points and the cluster centers decreases, and the division of data by clustering becomes more refined to a certain extent. When the value of K increases to 10, the curve tends to be flat, and the downward trend of the average distortion degree slows down. This shows that continuing to increase the number of clusters leads to a diminishing marginal benefit in reducing the average distance, and the improvement of the clustering effect by newly - added clusters is no longer significant. The growth rate of travel convenience brought by adding facilities slows down. Therefore, 5-10 is selected as the optimal range for the number of newly - added educational facilities.

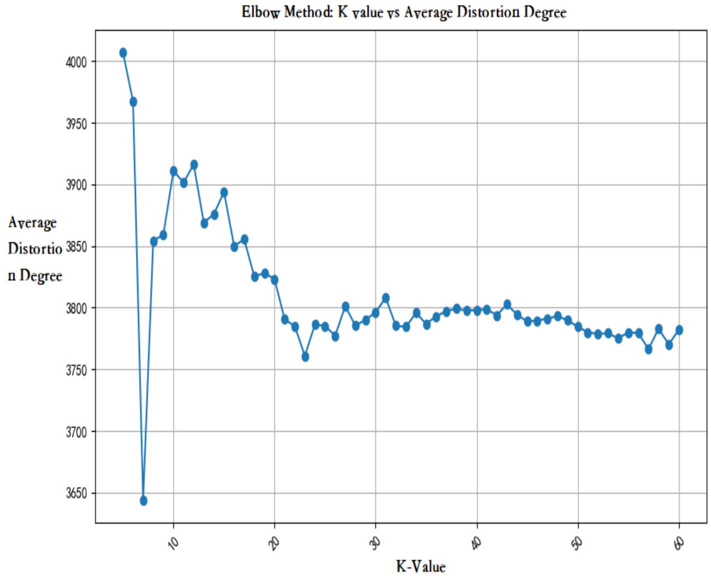

Figure 13. Data of Elbow Observation Method

6.2. Determination of New Site Selection

The facility minimization model is one of the classic models for facility location problems. From the perspective of the government, its goal is, on the premise of meeting specific service coverage or demand constraints, to minimize the number of facility points by optimizing the quantity, location, and scale of facilities, while expanding the coverage as much as possible. In this way, the government can meet the needs of as many residents as possible with the fewest public service facilities under the condition of minimizing financial investment.

Currently, the coverage area of kindergartens reaches 93.5% of all residential areas, and that of primary schools reaches 86.5%, while the coverage area of middle schools is only 69.5%. Based on the facility minimization model, by adding 3 new kindergarten sites, covering 6 more residential areas, the coverage area of kindergartens in residential areas can be increased to 96.5%; by adding 5 new primary schools, covering 17 more residential areas, the coverage area of primary schools in residential areas can be increased to 95%; by adding 5 new middle schools, covering 43 more residential areas, the coverage area of middle schools in residential areas can be increased to 90%.

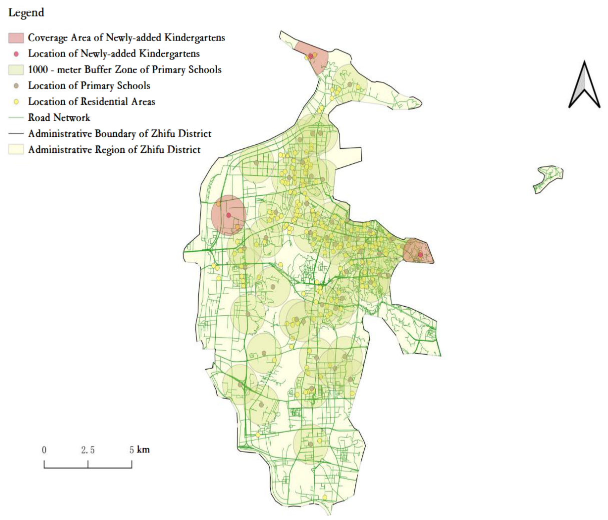

Figure 14. Location and Coverage Range of Newly-added Kindergartens

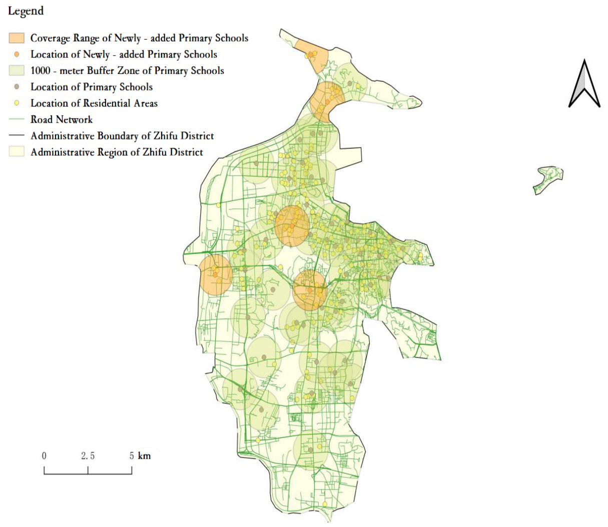

Figure 15. Location and Coverage Range of Newly-added Primary Schools

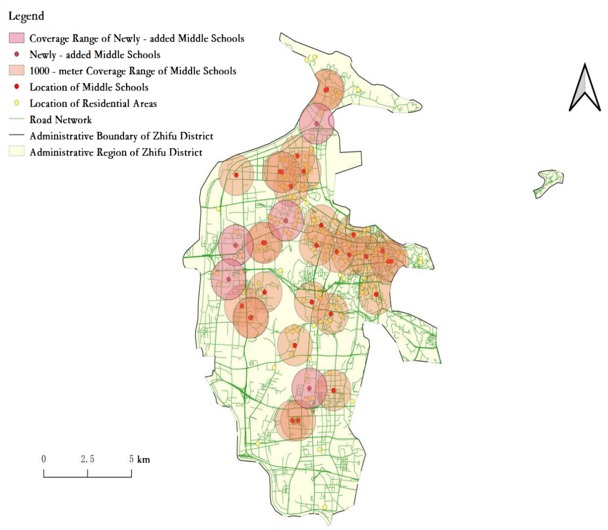

Figure 16. Location and Coverage Range of Newly-added Middle Schools

7. Conclusion

This study quantitatively evaluated educational facility accessibility in Zhifu District using QGIS spatial analysis, yielding three key findings:

Spatial distribution patterns: Educational facilities exhibit a “core-periphery” structure—kindergartens and primary schools are densely clustered in old urban areas (peak thermal values 4.0 and 3.28, respectively), while middle schools are sparsely distributed, with peripheral coverage <20%.

Accessibility disparities: Kindergartens and primary schools achieve 93.5% and 86.5% coverage of residential areas within 1,000 meters, respectively, basically meeting 15-minute neighborhood requirements. However, middle schools cover only 69.5% of residential areas, with over 30% of peripheral communities lacking nearby services, primarily due to poor road connectivity and geographical constraints (e.g., mountainous/coastal terrain).

Optimization effects: Simulations using K-means clustering and the facility minimization model show that adding 3 kindergartens, 5 primary schools, and 5 middle schools can increase their coverage to 96.5%, 95%, and 90%, respectively—effectively narrowing regional gaps.

These findings reveal that the primary challenge in Zhifu District lies not in overall shortage of educational facilities, but in spatial mismatch between supply and demand, particularly for middle schools in rapidly expanding peripheral zones. This mirrors the common dilemma faced by eastern coastal cities in China amid urbanization—old urban areas have excessive facilities while new communities lag behind. Additionally, the study validates the applicability of the 1,000-meter walking standard in the “15-minute neighborhood” framework, providing micro-level evidence for revising urban planning standards.

To translate these findings into practice, policy implications include three dimensions:

First, strengthen institutional guarantees. Governments should formulate normative documents to clarify standards for supporting educational facilities in new residential areas, ensuring full coverage of 15-minute education circles.

Second, prioritize resource inclination to underdeveloped areas. By analyzing urban-rural and regional gaps, financial investment should be tilted toward peripheral zones with low facility coverage (e.g., middle schools in mountainous/coastal areas of Zhifu District) to narrow quality disparities.

Third, integrate long-term planning with population dynamics. Align educational resource layout with territorial spatial planning, regularly assess facility accessibility, and adjust plans based on population flow—ensuring resources keep pace with urban expansion.

These strategies, grounded in the 14th Five-Year Plan of Yantai City, bridge technical analysis and policy practice, promoting equitable and sustainable educational development.

The research shows that optimizing the allocation of educational facilities needs to coordinate policy guidance, technical support, and long-term mechanisms. It is necessary to use technical tools such as GIS spatial analysis to accurately identify gaps and scientifically layout; and also take existing policy documents as the guideline, strengthen the rigid constraints of planning and resource inclination, so as to ensure that the allocation of educational resources resonates with population flow and urban development. Looking to the future, with the profound changes in new urbanization and population structure, the allocation of educational resources needs to further focus on “precision, balance, and sustainability”. Government departments should continuously deepen the development concept of “people-centered”, promote the optimal allocation of educational resources, and let high-quality educational resources become an important support for improving the livability of cities and enhancing residents’ sense of happiness, laying a solid foundation for realizing “running education that satisfies the people”.

Disclosure statement

The author declares no conflict of interest.

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