RESEARCH OF EDUCATIONAL RESOURCES EQUILIBRIUM AND OPTIMIZATION BASED ON GIS IN NORTHERN ZHENGZHOU

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DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

The balanced development of education is one of the important goals of the scientific development of education in China. It has been included in the "National Medium and Long-term Education Reform and Development Plan Outline (2010-2020)". The socialist harmonious society has great practical significance and far-reaching historical significance. However, education balance involves the educational resources on the supply side and the demand-side population of the right age have varying degrees of complexity in terms of time, space, and attribute characteristics, resulting in a series of problems, including how to measure education in a certain area. Whether development is balanced, and how to dynamically monitor whether education is balanced development. GIS (Geographic Information System), as an important tool for space-time analysis, has application potential in solving the above problems. This study selects the three northern districts of Zhengzhou City as the study area, and explores the use of GIS to spatialize and dynamically update them; establish a balanced evaluation index system that covers evaluation indicators in multiple dimensions such as educational opportunities, resource allocation, and education quality. And through a variety of spatial analysis methods such as overlay analysis, buffer analysis, network analysis, etc., quantitatively carry out comprehensive evaluation of education balance in the study area; on this basis, combined with the development of education in the study area in recent years, education is carried out from the perspective of education balance Adjustment and optimization analysis of resource space layout. The main research work of this study includes: (1) Using statistical yearbooks and the Internet, we have obtained multi-source data of residential areas, roads, and traffic related to education balance in the study area, and spatialized processing of related data, including AutoNavi POI (point of interest) data Crawling, spatial distribution of educational resources, spatialization of demographic data. (2) Designed a set of index systems that can evaluate the balance of education in space, including educational opportunities, allocation of educational resources, and educational quality, involving spatial elements such as distance to school, transportation accessibility, and student-teacher ratio, Non-spatial factors such as class allocation and excellent high school admission rate, the combination of the two can quantitatively evaluate the education balance of the three northern districts of Zhengzhou at the street level. (3) Use Location Allocation Model (LA) to carry out education development policy simulation and put forward layout suggestions. Generally speaking, the balanced development level of education in the three northern districts of Zhengzhou City is relatively high in the central urban area. There are still large differences between the urban and suburban areas, and the overall equilibrium degree decreases from the southwest to the northeast. Based on the results of the LA model, it can be seen that at least 14 middle schools must be added in the three northern districts of Zhengzhou to make the school service area to the residential area. The solution results of the comprehensive minimum facilities model can be obtained to optimize the layout of educational facilities in the three northern districts of Zhengzhou. According to the actual needs of the local area, the corresponding educational facilities are equipped to promote the realization of educational balance from the hardware.

ABSTRAK

Pembangunan pendidikan yang seimbang adalah salah satu tujuan penting dalam perkembangan saintifik pendidikan di China. Ini telah dimasukkan dalam "Garis Besar Rancangan Pembaharuan dan Pembangunan Pendidikan jangka menengah dan panjang nasional (2010-2020)". Masyarakat harmoni sosialis mempunyai kepentingan praktikal yang besar dan kepentingan sejarah yang luas. Walau bagaimanapun, keseimbangan pendidikan melibatkan sumber pendidikan di sisi penawaran dan populasi sisi permintaan pada usia yang tepat mempunyai tahap kerumitan yang berbeza-beza dari segi masa, ruang, dan ciri-ciri atribut, yang mengakibatkan serangkaian masalah, termasuk bagaimana mengukur pendidikan di kawasan tertentu. Adakah pembangunan seimbang, dan bagaimana memantau secara dinamik sama ada pendidikan adalah pembangunan yang seimbang. GIS (Sistem Maklumat Geografi), sebagai alat penting untuk analisis ruang-waktu, memiliki potensi aplikasi dalam menyelesaikan masalah di atas. Kajian ini memilih tiga daerah utara Kota Zhengzhou sebagai kawasan kajian, dan meneroka penggunaan GIS untuk membuat spasialisasi dan mengemas kini secara dinamis; mewujudkan sistem indeks penilaian seimbang yang merangkumi petunjuk penilaian dalam pelbagai dimensi seperti peluang pendidikan, peruntukan sumber, dan kualiti pendidikan. Dan melalui pelbagai kaedah analisis spasial seperti analisis overlay, analisis buffer, analisis rangkaian, dan lain-lain, secara kuantitatif melaksanakan penilaian keseimbangan pendidikan di kawasan kajian; atas dasar ini, digabungkan dengan perkembangan pendidikan di daerah kajian dalam beberapa tahun terakhir, pendidikan dilakukan dari perspektif keseimbangan pendidikan Analisis penyesuaian dan pengoptimuman tata letak ruang sumber. Kerja penyelidikan utama kajian ini merangkumi: (1) Dengan menggunakan buku tahunan statistik dan Internet, kami telah memperoleh data multi-sumber kawasan kediaman, jalan raya, dan lalu lintas yang berkaitan dengan keseimbangan pendidikan di wilayah kajian, dan pemrosesan data terkait yang spasial, termasuk data AutoNavi POI (tempat menarik) Merangkak , pengagihan ruang sumber pendidikan, spasialisasi data demografi, dan lain-lain. (2) Merancang satu set sistem indeks yang dapat menilai keseimbangan pendidikan di ruang angkasa, termasuk peluang pendidikan, peruntukan sumber pendidikan, dan kualiti pendidikan, yang melibatkan elemen spasial seperti jarak ke sekolah, aksesibilitas pengangkutan, dan nisbah murid-guru, Bukan -faktor spasial seperti peruntukan kelas dan kadar kemasukan sekolah menengah yang sangat baik, gabungan keduanya dapat menilai secara kuantitatif keseimbangan pendidikan tiga daerah utara Zhengzhou di tingkat jalanan. (3) Gunakan Model Peruntukan Lokasi (LA) untuk melaksanakan simulasi dasar pembangunan pendidikan dan mengemukakan cadangan susun atur. Secara umum, tahap perkembangan pendidikan yang seimbang di tiga daerah utara Kota Zhengzhou agak tinggi di kawasan bandar tengah. Masih terdapat perbezaan yang besar antara kawasan bandar dan pinggir bandar, dan tahap keseimbangan keseluruhan menurun dari barat daya ke timur laut. Berdasarkan hasil model LA, dapat dilihat bahawa sekurang-kurangnya 14 sekolah menengah mesti ditambahkan di tiga daerah utara Zhengzhou untuk menjadikan kawasan perkhidmatan sekolah ke kawasan perumahan. Hasil penyelesaian model kemudahan minimum yang komprehensif dapat diperoleh untuk mengoptimumkan susun atur kemudahan pendidikan di tiga daerah utara Zhengzhou. Mengikut

keperluan sebenar kawasan setempat, kemudahan pendidikan yang sesuai dilengkapi untuk mempromosikan mewujudkan keseimbangan pendidikan dari perkakasan.

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GIS	-	Geographic Information System
IDW	-	Inverse Distance Weight Method
LA model	-	Location Allocation Model

CHAPTER 1

INTRODUCTION

1.1 Background of Problem

The basic of education construction has made relatively good achievements in recent years in China. The Ministry of education of the people's republic of china shows that the net enrollment rate of school-age children in elementary and junior high schools reached 99.9% and 103.5% respectively in 2017, in China. This group of data reflects the high popularity of compulsory education in recent years.

However, with the unbalanced development of urban and rural areas and the unbalanced allocation of educational resources, the educational resources have shown an unbalanced development trend. Education wants to ensure the equality of educational rights and opportunities through reforms and improve the overall quality of the whole nation. Hence, the balanced development of education has aroused widespread concern and attention, and has become one of the important research topics related to the development of education.

In recent years, the Ministry of Education of China (MEC) has issued many documents to promote the balanced development of compulsory education, such as the "Opinions on Further Promoting the Balanced Development of Compulsory Education" issued in 2005 and the "On the Implementation of the Scientific Outlook on Development and Further Promoting Compulsory Education" issued in 2010. "Opinions on Balanced Development" all explain the implementation of a balanced education.

In 2016, the "State Council's Several Opinions on Promoting the Integrated Reform and Development of Urban and Rural Compulsory Education in the Counties" focused on reducing the gap between urban and rural education, and formulated simultaneous

construction of urban schools, running rural education, promoting school standardization, and eliminating large classes, coordinate the allocation of urban and rural teachers and other measures.

The balanced development and reform of education is a systematic project with long-term, complex and overall characteristics (Fan, 2016). There is still facing many difficulties about the balanced development of basic education in China at this stage, such as the large gap between urban and rural areas, obvious differences between schools, and the equalization of educational opportunities for different groups has not yet been achieved. The shortage of resource supply and uneven allocation are the main reasons for the above problems (Ren, 2009).

Lu believes that the difference in education investment caused by the uneven regional economic development is the source of regional differences in the level of educational development (Lu, 2011). The balanced development of any public service facilities requires adequate financial support, and the educational services are no exception. If the economy of remote and backward areas does not develop, the demand for capital investment for balanced development of education cannot be met, and the balance of education cannot be further developed. In addition, different starting points for running schools will also cause uneven distribution of educational resources, and the concentrated investment in key schools has accelerated the concentration of high-quality educational resources (Ren, 2009)

In the case of limited resources, it is first necessary to clearly understand the basic situation of the spatial distribution of educational resources in order to achieve a balanced and fair allocation of educational resources. The distribution of schools determines the efficiency and fairness of student enrollment, and the layout of schools should be based on the needs of residents. The research on the macro-theoretical system of balanced development of education has been in-depth and comprehensive in China in recent decades. However, it was often used the qualitative analysis or direct calculation of indicators related to education investment in different regions and schools in the measurement of educational balance. And the indicators fall into

geographic space, which makes it difficult to visually assess the irrationality of the distribution of educational resources.

Geographic information system, as a spatial information technology based on computer science, has superior processing and analysis capabilities for spatial geographic information. It can provide effective and efficient information technology means for analyzing the distribution of educational resources in the research on the balance of educational resources. (Chen, 2008).

The GIS technology is now quite mature and has been widely used in all walks of life after decades of rapid development, especially as an important information management and analysis tool in urban management and planning. It not only has the data storage, processing and query functions of conventional information systems, but also integrates various map making and analysis functions for geospatial data that including overlay analysis, hot spot analysis, network analysis, accessibility analysis, etc. (Wang, 2003). The GIS data management, map processing, spatial analysis and other functions in geospatial data analysis and planning models, it can express the model calculation results more clearly and intuitively. At the same time, it can make that easier for people to understand and think, which is conducive to the comparison of government decision-making and planning schemes.

Based on the above powerful functions of GIS, it can be used from the perspective of residents to quantitatively evaluate the distribution of educational resources, distance to school, school accessibility, resource supply and demand, etc. And it can deeply and comprehensively analyze the current distribution status of educational resources. It also can directly express the results in a visual way, reveal the uneven distribution of educational resources, and expand the research methods of the balanced development of traditional education.

The GIS has also played a powerful role in the layout and planning of public service facilities. The use of GIS can comprehensively consider various factors such as population distribution, resource allocation, topography, traffic conditions, surrounding environment, and establish a comprehensive analysis and evaluation

model to propose the best solution for the layout of public service facilities. It usually based on national planning standards in traditional educational resource layout planning. While it also meets the needs of school-age students in quantity by controlling the scale of school land. However, the planning plan obtained in this way may not fully consider the actual accessibility of the school, which makes the commuting distance of students farther. The reason is the planned service radius is a straight-line distance, but people travel based on the road network.

Through the powerful spatial data processing and model establishment and calculation functions of GIS, the analysis and evaluation model can be flexibly adjusted. At the same time, it is possible to adjust the realization goals, constraints and model parameters of the model in accordance with the actual situation, and display the results in an intuitive map visualization.

Therefore, the scientific application of GIS to the balanced analysis and layout optimization of educational resources will help improve traditional methods and increase research efficiency and scientificity.The balanced development of educational resources and the optimization of their layout have important research significance. Therefore, the rich, efficient and powerful geospatial information analysis functions of GIS should be fully utilized. The spatial comprehensive analysis of the distribution of educational resources can make the results more scientific and reasonable, and then it can more effectively provide support for the reasonable distribution of educational resources and the decision-making of the government and educational authorities.

As for the three northern districts of Zhengzhou, the complex zoning and population composition make the balanced development of education face greater challenges. Jinshui district of Zhengzhou city belongs to the old city, its infrastructure is relatively complete but old. Zhengdong New District was originally part of Jinshui District. It was separated from Jinshui District for development. Baisha Town in the east was designated as part of Zhengdong New District in 2015. Its core CBD (Central Business District) is well developed but its eastern and northeastern infrastructures are not perfect.

Huiji District was originally a suburb far from the city center with a small population. Although urbanization has developed rapidly in recent years, its industrial foundation and financial strength are still relatively weak compared to other municipal districts in Zhengzhou. As Zhengzhou City continues to expand north and east, the issue of equalization of public services within its jurisdiction has become more prominent. There is a certain gap between the eastern part of Zhengdong New District and the northern part of Huiji District in terms of economic development, transportation, medical care, and education. Residents may feel strongly about the uneven development of regional educational resources.

In summary, this study selected the three northern districts of Zhengzhou as the study area.It combined with GIS technology for analysis and tool development, evaluated the balance of educational resources in the area. It also based on the evaluation results, further designed the layout adjustment and optimization plan.

1.2 Research Purpose

1.2.1 Promote the Balanced Development of Education.

It promotes the balanced development of education. Education equality is a citizen's right protected by relevant laws and regulations such as international human rights law and my country's constitution (Hu, 2015). The Educational equity affects social equity, while social equity affects the construction of a harmonious society (Shi, 2008). The ultimate goal of promoting balanced development of education is to achieve educational equity. A reasonable and effective school layout adjustment, and resource allocation can gradually promote the balanced development of education.

This research will explore the current situation of the distribution and layout of educational resources. How to carry out reasonable resource redistribution and layout adjustments and promote the balanced development of education and ultimately achieve education equity. And try to propose solutions to solve the current

contradiction between the supply of educational resources and population demand, and promote the balanced development of education.

1.2.2 Enrich and Expand the Application Of GIS.

This research attempts to expound and discuss the social issue of pedagogy of balanced development of education based on the spatial perspective of geography. The researcher uses GIS-related technology and knowledge, and has made new attempts in the exploration of how to analyze the balanced development of education. It introducing more GIS methods to discuss issues related to the balanced development of education and the distribution of educational resources. It is not only the enrichment of educational research, but also the practice of geographic methods in the field of social sciences, which enriches and expands the application of GIS in the field of education.

This study will use the spatial analysis method in GIS to analyze the unreasonableness of the existing educational resources in the study area and other allocations, and then propose a corresponding balanced optimization plan. The optimized plan not only brings a better education environment to the students, but also provides a basis for decision-making to implement the standardization of compulsory education schools and effectively narrow the gap between schools.

1.2.3 For Decision Support

The population and zoning of the three northern districts of Zhengzhou are complex, and the contradiction between the supply and demand of educational resources is more prominent, which has a certain degree of research representativeness.

This study taking the junior high schools in the three northern districts of Zhengzhou as the research object, it conducts a comprehensive and in-depth discussion and analysis on the balanced development and layout adjustment of education. It explores whether there are problems in the balanced development of education in the

three northern districts of Zhengzhou, such as long-distance education, unbalanced distribution of educational resources between urban and rural areas, and excessive school classes. It provides decision support for the balanced development and spatial layout adjustment of education in the three northern districts of Zhengzhou.

This research explores how to achieve a balanced education service, provides a reference and basis for quantitative evaluation of educational balance and layout adjustment, and proposes a layout optimization adjustment plan based on GIS technology and methods, which can provide a reference for the decision-making of the the three northern districts of Zhengzhou government and education authorities.

1.3 Aim of Study

The purpose of this research is to design the assessment indicators to evaluate the balance between education situation in the three northern districts of Zhengzhou by studying the spatial characteristics of factors that affect the education balance, and to propose improvements to optimize the education balance in the area through spatial analysis techniques.

1.4 Research Question

(1) What is the current situation of education resource balance in the three northern districts of Zhengzhou?

(2) How to optimize the current educational resources allocation in Zhengzhou to improve the balance of educational resources allocation in this region?

1.5 Research Objective

To achieve the aim of this study, 3 objectives has been developed;

（1）To identify the problem in evaluating education in Zhengzhou City.

Collect information on the layout and basic situation of Zhengzhou schools, the state of government investment and government input, teacher allocation information and population distribution information. And establish a database, and discuss the problems existing in the education of Zhengzhou.

（2）To evaluate the education balance in Zhengzhou City using GIS.

Design and establish an education balance evaluation system. Establish an index system from three dimensions: balanced educational opportunities, balanced resource allocation, and balanced educational quality. The study will analyze the level of education balance in Zhengzhou based on GIS technology.

（3）To give suggestions on optimizing and adjusting the layout of education resources in Zhengzhou.

According to the evaluation results of the education balance evaluation system, suggestions are made for the optimization and adjustment of the school layout and resource allocation in Zhengzhou.

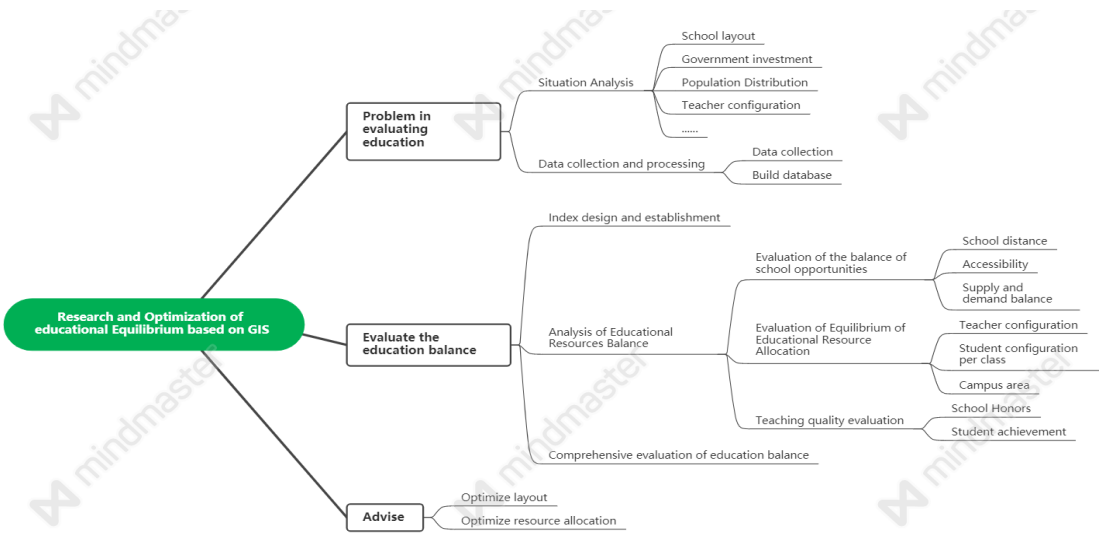

Figure 1.1 The article Outlines

1.6 Scope

Zhengzhou is located in the north of central Henan Province, downstream of the Yellow River. It has jurisdiction over 6 municipal districts (Zhongyuan District, Erqi District, Jinshui District, Zhengdong New District, Huiji District, Guancheng District), and 5 county-level cities (Xingyang City, Dengfeng City, Gongyi City, Xinzheng City, Xinmi City) and one county (Zhongmu County), with a total area of 7,567.18 square kilometers. In 2019, the city's permanent population was 10.352 million.

Figure 1.2 Administrative divisions of Zhengzhou

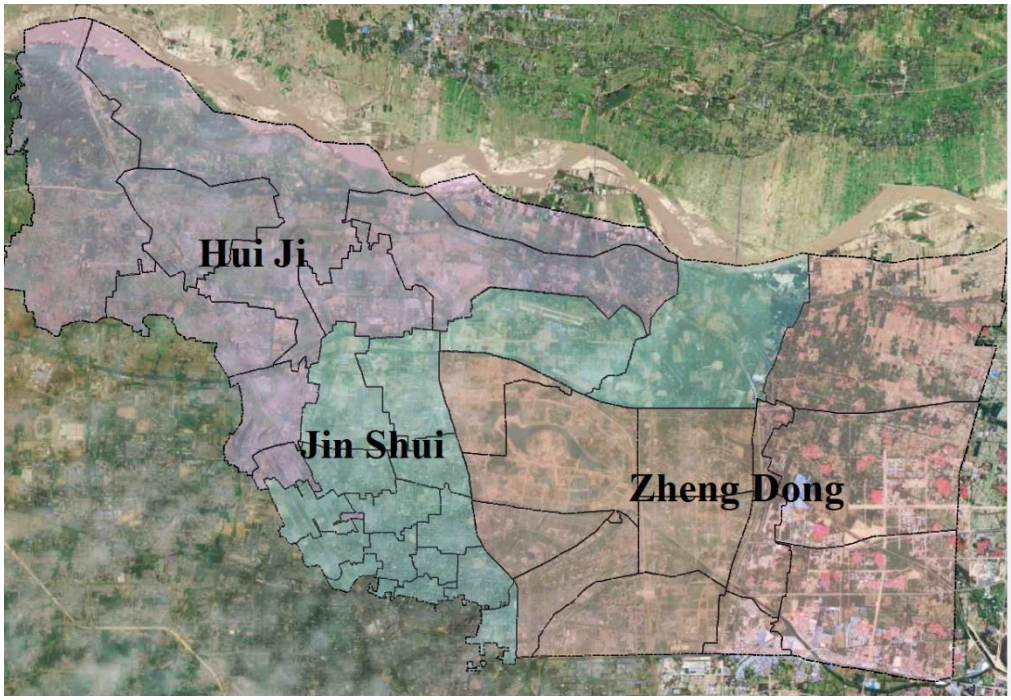

Figure 1.3 Administrative divisions of the three northern districts of Zhengzhou

The three northern districts are located in the northern part of Zhengzhou City, namely Huiji District, Jinshui District and Zhengdong District. The permanent population of the three districts is 2.385 million (311,000 in Huiji District, 1.333 million in Jinshui District, and 741,000 in Zhengdong District). There are 37 sub-

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