Research on Layout Planning of Logistics Park of Zhengzhou Airport

Jingwen Wu

Haaga-Helia University of Applied Sciences

Haaga-Helia Bachelor's Thesis

Degree Programme in Aviation Business

May 2023

Abstract

Author(s)
Jingwen Wu (Jenice)

Degree
Degree Programme in Aviation Business

Report/thesis title
Research on Layout Planning of Logistics Park of Zhengzhou Airport

Number of pages and appendix pages
39 + 0

This thesis aims at the operational function of Zhengzhou Airport Logistics Park and plans the internal facilities of the Airport Logistics Park. From the perspective of specialization, the author aims to create a logistics park with a reasonable spatial layout and a concentration of industrial development, which can drive the economic development of the Central Plains.

The research theme of the article is divided into two parts. First, to determine the functional areas of the planning and layout of Zhengzhou Airport Logistics Park. At first, the authors analyze the overall background of Zhengzhou Airport, and analyze the current operation status of Zhengzhou Airport in terms of its geographical location, policy background, route status and cargo capacity. After discovering the problems, the functional areas to be built in Zhengzhou Airport Logistics Park are determined with the problem-oriented approach. Second, to determine the layout planning scheme. The layout planning of Zhengzhou Airport Logistics Park is carried out by using the improved System Layout Design (SLP) method in the layout plan. The planning process analyzes various factors affecting the layout results as a whole. The logistics, non-logistics, and integrated relationships among the functional areas are analyzed. Based on the integrated relationship, we draw a location-related diagram of the functional areas, calculate the area of the functional areas, and finally determine the layout plan of the Zhengzhou Airport Logistics Park.

Keywords
Zhengzhou Airport；Logistics park；SLP

Table of contents

1 Introduction

1.1 Background

1.1.1 Research Background

With the implementation of the "One Belt, One Road" policy, China is opening its doors to the outside world more and more. To transport China's excellent products to the Eurasian economic circle, it is necessary to develop the domestic air logistics and freight business. In addition, the development of the Internet has also led to the rapid rise of e-commerce, especially the rise of cross-border e-commerce on an international scale, accompanied by the international air cargo transportation. As a result, the international air logistics industry has been developed in a spurt, which will certainly drive the large-scale development of ground infrastructure for the air logistics industry. That is, the construction of aviation logistics parks.

Air cargo is the pillar of the global supply chain. With Zhengzhou's superior geographical location and strong industrial advantages, Zhengzhou Airport was built. The air cargo logistics business at the airport is a major pillar of economic development. In the future, in order to expand the international airline cargo map and develop international aviation business, Zhengzhou Airport has to build a well-systematic ground logistics park with complete infrastructure to support the development of Zhengzhou Airport's aviation business.

According to the latest data released by the International Air Transport Association, in global air cargo transportation, air cargo revenue in 2021, $155 billion, up from $129 billion in 2020 and $101 billion in 2019. 2021 air cargo revenue accounted for more than one-third of airline revenue, more than twice as much as in 2020. 2019 global air cargo demand grows 6.9 percent from pre-epidemic levels and 18.7 percent from 2020. However, air cargo capacity (in terms of available cargo tonne kilometers (actk)) is 10.9% lower in 2021 than in 2019. Global supply chain congestion is exacerbating the inflationary environment and creating challenges for air cargo.

In contrast China is also gaining ground, with Chinese airports completing 11.994 million tons of cargo and mail throughput for the year 2022, up 3.6% from the previous year. Of these, 7.849 million tons were completed on domestic routes, up 4.6% over the previous year, including 734,000 tons on routes from the mainland to Hong Kong, Macau and

Taiwan, up 5.8% over the previous year; 4.145 million tons were completed on international routes, up 1.7% over the previous year. Among the airports, there are 49 airports with annual cargo and mail throughput above 10,000 tons, 2 more than the previous year, and the completed cargo and mail throughput accounts for 98.5% of all airports' cargo and mail throughput. From the data, it can be intuitively seen that the air logistics industry has a good development prospect under the international environment and driven by the general background of China's economic development. Accompanying the vigorous development of the aviation logistics industry is the construction of aviation logistics parks. The construction of aviation logistics park is one of the cornerstones of the development of aviation logistics industry. It is of great significance to accelerate the construction of aviation logistics park to enhance the comprehensive national power, drive the regional economic development, promote the redistribution of resources, improve the market investment environment, and realize the strategy of good and fast economic and comprehensive sustainable development. This thesis focuses on the layout planning of Zhengzhou Airport Aviation Logistics Park in the context of the project in which I participated in my internship work. After the State Council released supporting documents such as the "Central Plains Economic Zone Planning (2012 - 2020)" and "Zhengzhou Comprehensive Experimental Airport Economic Zone Development Plan (2013 - 2025)", Zhengzhou Airport Zone has become a carriage to drive the economic rise of the Central Plains Economic Zone and Henan Province with its absolute policy advantages. The document points out that Zhengzhou will strive to become a modern aviation city that is connected to the world, ecological and livable, and innovation-driven. The aviation port is one of the strategies for its development, based on Zhengzhou's local advantageous industries, the development of regional aviation economy as the leading, the Zhengzhou aviation port area to become one of the important gateways to open up the inland areas. In this context, it is necessary to build an aviation logistics park covering the Central Plains, serving the whole country, liaising with the world and having strong mobility. As for the aviation logistics parks currently in operation internationally, their main functions include: firstly, the core functions of general logistics parks, secondly, the value-added functions of air logistics cargo transit, and thirdly, the additional service functions of supporting aviation logistics parks. Among them, the aviation logistics park is still essentially a logistics park, so its core functions are the key construction planning basis, including warehousing, transit, processing, freight transport, etc. Therefore, when the aviation port builds the infrastructure of the logistics park, the planning layout should take the core functions as the leading direction to meet the needs of customers. In addition, the aviation logistics park plays an important role in optimizing the allocation of aviation resources and formulating the basic service standards of aviation logistics industry. However, due to the late start and slow development of the construction and use of aviation logistics parks in China, it leads to the lack of theoretical basis and practical experience in the construction of aviation logistics parks, plus the lack of national norms and industry standards for the construction of aviation logistics parks, which has led to many difficulties in the construction process of China's logistics aviation logistics parks in recent years, and the existence of many drawbacks in their use after completion, showing a relatively chaotic phenomenon as a whole. This has resulted in a large amount of wasted resources. In some countries where the logistics industry started earlier and the logistics is more developed, the aviation logistics industry is well developed, and accordingly the construction and use of its supporting aviation logistics parks have been quite mature. The strong transportation of international aviation logistics industry shows that as long as the aviation logistics park can get the correct and standardized layout design, it can operate efficiently with its maximum capacity, and at the same time, it can attract different advantageous industries to move in and drive the regional economic development, and also promote the development of its related industries, such as selling the local competitive products to the world.

Therefore, this thesis takes the functional requirements to be achieved by the construction of Zhengzhou Airport Logistics Park as the benchmark, designs the layout of each functional area of the Airport Logistics Park, and uses SLP to design and plan each functional area. In order to achieve the purpose of optimizing the allocation of local resources and efficient and coordinated operation of the aviation port logistics park. It also provides theoretical and application guidance for the construction of domestic aviation logistics parks in the future.

1.1.2 **Purpose and significance of the study**

Zhengzhou Airport Logistics Park, as a transportation hub in the Central Plains hinterland, plays a unique advantage and key role in ensuring the safety of goods and the smooth flow of the hub economy by virtue of air logistics under the dual background of "double cycle" and epidemic. Relying on the airport, Zhengzhou Airport Logistics Park has achieved significant results in the construction of the aviation logistics corridor by virtue of its advanced transportation advantages and perfect transportation network layout. In the face of the new economic situation and development pattern, how to properly plan its layout and ensure its efficient operation at its maximum capacity has become a new research focus.

Under the background of "One Belt and One Road" proposed by the state, road link, sea link, air link is an essential channel to promote trade and economic construction of all countries. Zhengzhou has been built as a hub city of railroad and highway transportation. Based on its inherent geographical location, the development of aviation industry has become a necessary path for Henan to rapidly realize the rise of the Central Plains. With the rapid development of Xinzheng International Airport in recent years, Zhengzhou Airport came into being. As a pillar industry for the development of aviation logistics industry, the aviation logistics park is the space form and designated area for the gathering and development of aviation logistics industry. Therefore, the planning and construction of the logistics park and the reasonable degree of the layout of each functional area are directly related to the future development of the horizontal extension of the aviation logistics industry and the operational efficiency of the logistics park, as well as trade transactions. Therefore, it is of practical significance to explore the rise of the aviation logistics industry in Central Plains and of theoretical significance to guide the construction of aviation logistics parks in the future by choosing the layout planning of Zhengzhou Airport Logistics Park as the direction of the selected topic.

(1) Practical significance. The development plan of Zhengzhou Airport Economic Comprehensive Experimental Zone is from 2013 to 2025, so now the construction and use of the aviation port are in the stage of growth period. The aviation logistics industry is the leading industry in the port area, because whether it is the landed high precision industry or manufacturing processing industry, it needs to provide transportation channels for its required resources and production products by air freight. The construction of the Zhengzhou Air Port Economic Comprehensive Experimental Zone is conducive to optimizing the layout of air cargo and enhancing the international competitiveness of China's civil aviation industry; it is conducive to promoting the development of China's air port economy and promoting industrial structure upgrading and development mode transformation; it is conducive to building an inland open highland and exploring new ways to expand openness in all aspects in the central and western regions; it is conducive to building a strategic breakthrough in the Central Plains Economic Zone and driving the new urbanization, industrialization and Agricultural modernization coordinated development. This paper is an analysis and research based on the construction data of Zhengzhou Airport Logistics Park collected on the basis of the internship. For these data, I will also

collect them through literature as well as policies issued by Henan Province, such as the Development Plan of Zhengzhou Aerodrome Economic Comprehensive Experimental Zone (2013-2025), so as to ensure the reliability as well as timeliness of the data. After that, the layout method of SLP is used to finalize the layout plan of Zhengzhou Airport Logistics Park by analyzing the logistic relationship, non-logistic relationship, and comprehensive relationship among the functional areas and drawing the functional area location related map, and by calculating the functional area. The suggestions made in this thesis are of great practical significance to the layout and construction of Zhengzhou Airport Logistics Park.

(2) Theoretical significance. At present, the planning and design of functional areas of logistics parks in China is still in the state of preliminary exploration, and the relevant theory and practice have not yet formed a system, which needs further development and application. In this thesis, from the current plan layout schemes and examples of major logistics parks, the SLP method is used for the overall layout of Zhengzhou Airport Logistics Park with respect to its functional requirements. The SLP method introduced in this paper is a quantitative-based and qualitative research method, which provides a new technical means and research perspective for the functional area layout planning of the aviation logistics park. The method applied in this paper has a good application prospect, and the method also has some reference to other logistics park layout planning. Moreover, with the lateral extension of the use of SLP method, SLP is also gradually applied to the facility planning of hospitals and logistics parks. The suggestions made in this paper provide some theoretical basis and support for domestic air port logistics parks. At the same time, through the analysis of the actual case study of this thesis, it will also provide case experience for domestic air port logistics parks.

1.2 Literature review

1.2.1 Review of foreign studies

The leading industrial development abroad has driven the planning and development of logistics parks ahead of China, especially in the US, Europe and Japan. Therefore, both construction planning, development and construction, as well as theoretical support, are of reference significance for China.

In 2016 Liliana R et al. in the article "Logistics clusters:The impact of further agglomeration,training and firm size on collaboration and value added services" mentioned that collaboration and provision of value added services are the main benefits for firms located in logistics clusters. The enhanced benefits are achieved through more explicit clustering and training opportunities within the logistics park. Furthermore, using structural equation modeling, it is further demonstrated that agglomeration positively influences collaboration as well as the sharing of transport capacity for logistics parks. In addition to this, training has a positive impact on collaboration among cluster residents, both in terms of transportation capacity sharing and resource sharing.

Nicolas R, in his article "Planning and Financing Logistics Spaces" published in 2021, proposed "logistics spaces", namely seaports, intermodal terminals, logistics parks, distribution centers and urban logistics facilities. Logistics spaces are created to connect the production of goods with consumption and recycling.

DalalclaytonB in 2013 proposed that the functional areas of the park are dynamically linked to each other. He used the SLP method to analyze logistic and non-logistic factors, using the correlation diagram method and the dynamic route layout method to calculate the area and location of each functional area, using a local logistics park for the chemical industry as an example.In 2018, Vijay argued that the layout of functional areas can only be analyzed based on the flow of goods. He used a large logistics park in India as an example to analyze the entire flow of goods in the park. Therefore, when planning the layout of the park, the process of goods circulation and the flow of goods in each functional area should be clarified first in order to be accurate.ArivalaganR et al. in 2020, elaborated the significance of bonded logistics parks, in which bonded functions play an important role in air port logistics parks. Increasing the connection between bonded functional areas and freight stations and freight villages can make them more useful. Therefore, the authors believe that the layout of the functional area of the Airport Logistics Park focuses on the layout of the bonded area, the freight station and the freight village.

1.2.2 **Review of Domestic studies**

In the study on the development mode of two-way interaction of the industrial chain of agricultural logistics park published by Hu Xiaolan in 2020, through the analysis of the connotation of the two-way interaction mode of the industrial chain of agricultural logistics park, the basic structure of the two-way interaction development mode of the industrial chain of agricultural logistics park was constructed, and the realistic path and specific form of the two-way interaction of the industrial chain of agricultural logistics park were indicated.

In 2020, Wan Cuilan studied the development strategy of RG Port Modern Logistics Park, firstly analyzed the internal and external environment of RG Port Modern Logistics Park, and found the strategic positioning and strategic business units as well as the guarantee measures. Chen Jing published the article "Research on the schedule management of intelligent transformation project of A railroad port logistics park", which argues that the key points of schedule control in the intelligent transformation of logistics park and to control them, take active measures to avoid them, and improve the ability of the logistics park to complete the project in a set time are the kind of problems to be faced by this kind of transformation project in the future. In the paper "Study on the Development Strategy of Tianjin Airport International Logistics Park" published by Wang Mengyang, the development strategy of the airport logistics park is studied by taking Tianjin Airport International Logistics Park as an example, and the key influencing factors affecting the development strategy of Tianjin Airport Logistics Park are determined by using the EFE and IEF internal and external environmental factors evaluation models, combined with the grey correlation model. The logistics efficiency of Tianjin Airport is improved and effective logistics management is achieved.

In the "Study on the Layout Planning of K City Air Logistics Park" published by Dongyu Zhang in 2022, the correlation relationship weights of SLP were improved by using AHP, and a comprehensive correlation relationship diagram was derived. Finally, the three alternatives were analyzed from six different perspectives, and the grey comprehensive evaluation method was applied to finally arrive at option 3 as the optimal option. At the same time, according to the principle of convenient and smooth operation, the road traffic in the park is set up to ensure the maximum rate of traffic in the park.

With the continuous development of science and technology, the planning and design of logistics parks have become more and more perfect and mature. Since then, several Western scholars have analyzed such cases, while domestic scholars have also studied the planning and layout of logistics parks in depth.

1.3 Research ideas

1.3.1 Research Methodology

(1) Literature analysis method. Through the study of domestic and foreign aviation logistics theory and aviation logistics park development related literature, to understand the current situation and research results of various applications of aviation logistics in airports at home and abroad, to provide basic support for the research done in this thesis.

(2) Survey and research method. In the course of the internship, we also participated in the field research and visited the existing functional areas of Zhengzhou Airport Logistics Park to understand its final construction target and construction scale.

(3) SLP method. This thesis uses the SLP method in the layout of the functional areas of Zhengzhou Airport Logistics Park, in which the logistics relationship involves quantitative analysis, the non-logistics relationship involves analysis, and finally a combination of quantitative and qualitative analysis to determine the relative positions between the functional areas.

1.3.2 Theoretical framework

The technical route of this thesis study is shown in Figure 1.

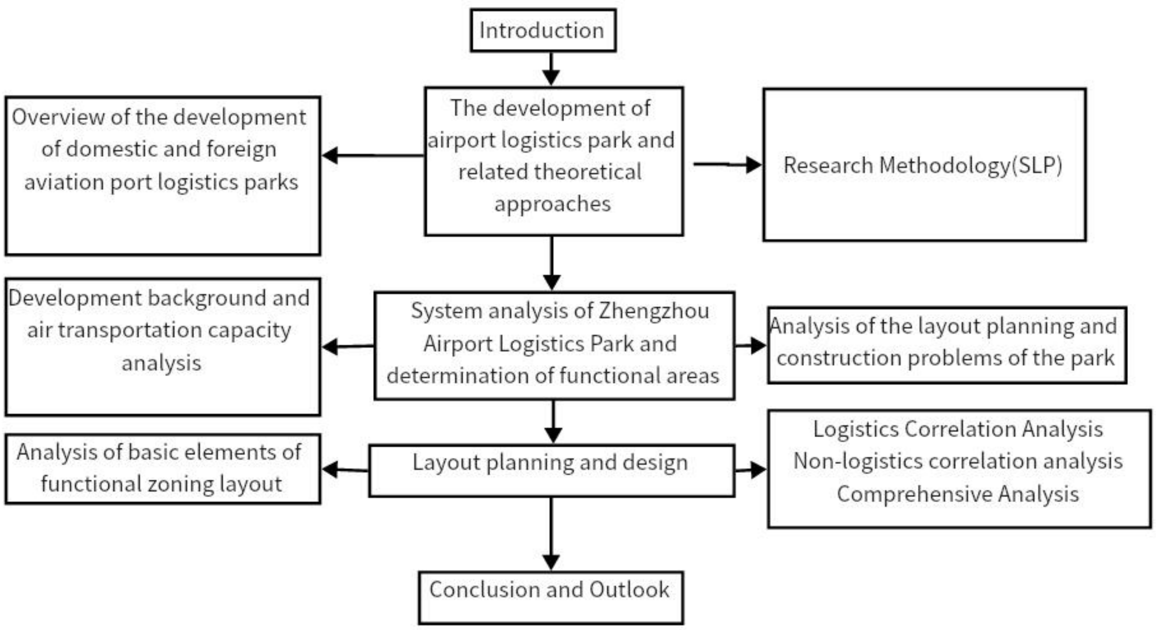

Figure 1. Technical route

2 Airport logistics park and SLP method

2.1 Airport Logistics Park Overview

When it comes to the concept and development of the aviation port logistics park, the first thing that should be focused on is the development of the logistics park. In 2022, China Federation of Logistics and Purchasing, China Society of Logistics released the Sixth National Logistics Park (Base) Survey Report, which pointed out that the basic conditions required for the construction of logistics parks are as follows:

- Have a designated logistics base. Among the enterprises (units) involved in logistics parks, logistics hubs, logistics bases, logistics centers, highway ports, railroad ports, logistics ports, waterless ports, etc.
- provisions require logistics parks to cover an area of 150 acres (0.1 square kilometers) and above, and have land procedures issued by government departments.
- Park has a number of enterprises stationed in the park, to provide social logistics services. Entities planning, building and operating the logistics park, and entities landing in the logistics park are included in the scope of the survey.

As the aviation logistics park is developed on the basis of the general logistics park. Therefore, the aviation logistics park also has the above basic characteristics, but differs from the ordinary logistics park in terms of infrastructure.

2.1.1 **Development of the International Airport Logistics Park**

Airport logistics parks, also known as airport logistics parks, first emerged with the development of the "airside economy". The term "airside economy" was first introduced by McKinleyConway in "TheAirportCity". With the rapid development of economic globalization, the natural advantages of air cargo airports have been rapidly highlighted, and the development of the regional economy has been rapidly promoted. The "airside economy" refers to the airport infrastructure construction as the core, relying on the airport to build up the aviation resources, the formation of airside economic region. Exporting local special economic products to the outside world and introducing high value-added products to the outside world. Promote the local economy to go global and connect to the world. This is the most direct and effective economic development carrier is to rely on the development of the air cargo industry to drive economic development. Data show that entering the 21st century, although in the freight industry as a whole, air cargo accounted for only 2% of the global freight volume, but its transport products, mostly high value-added products, so the total value of transported goods more than 40% of the total global trade freight. In the context of globalization of international trade, the overall trend of international air cargo transportation is increasing year by year. The following chart, shows the year-on-year data of the air cargo market in March 2023 and the comparison with the same period in 2019.

Table 1. Air cargo market overview - March 2023

Air cargo market overview - March 2023

	World share [1]	March 2023 (% year-on-year)				March 2023 (% ch vs the same month in 2019)			
		CTK	ACTK	CLF (%-pt)[2]	CLF (level)[3]	CTK	ACTK	CLF (%-pt)[2]	CLF (level)[3]
TOTAL MARKET	***100.0%***	**-7.7%**	**9.9%**	**-8.8%**	**46.2%**	**-8.1%**	**-1.0%**	**-2.2%**	**46.2%**
International	*86.8%*	-8.1%	8.3%	-9.5%	53.1%	-9.0%	-4.9%	-0.8%	53.1%

[1]% of industry CTKs in 2022 [2]Change in load factor [3]Load factor level

2.1.2 **Development of China's aviation port logistics park**

As China continues to open up to the outside world and speed up the construction of free trade zones around the country. The domestic aviation port logistics park also gets rapid development. From the statistical information of China's civil aviation data, China's civil transport airports will complete 14.531 million tons of cargo and mail throughput in 2022, down 18.5% from the previous year, recovering to 85.0% in 2019.

2.2 System Layout Design Method - SLP

2.2.1 **Overview of SLP**

Systematic Layout Planning (SLP) was proposed by Richard Muther in 1961, and SLP is a well-known method for facility planning and layout in enterprises. With the improvement of the theory and the development of science, the application of SLP has been extended horizontally. Richard Muther first proposed SLP in the field of plant design. Product P, output Q, production route R, auxiliary departments S and production time T are given as basic elements, which are the starting point for planning the layout of a plant. Product P and production Q are the main considerations. The required operating units are determined according to the type of products to be produced and the volume of products to be produced. Finally, the layout plan will be set based on the logistics and non-logistics relationships to determine where they are to be located.

2.2.2 **Implementation steps of SLP**

The layout planning of logistics park is similar to the facility layout of factory, but different. The layout planning in a logistics park is for functional areas. In the logistics relationship is reflected as the route and sequence of logistics operations, while the size of the output reflects the type of production. The work volume between functional areas in logistics parks reflects the intensity of logistics operations between each functional area, the route of logistics operations, the length of time, and the direct reflection of the intensity of operations on the layout is in the layout of functional areas. The setting of each workstation should be based on 5 basic elements, and 5 basic elements should also be referred to in the setting of functional areas in logistics parks. It is necessary to consider the logistics object P, material flow Q, logistics operation route R, auxiliary department S in the park, and logistics operation time T. Among them, logistics object P and material flow Q are the most important factors to be considered in the layout planning of logistics park.

2.2.3 **Feasibility of SLP application in logistics park layout**

The planning and layout of logistics park using SLP method mainly includes the arrangement of logistics operation area, the arrangement of auxiliary logistics operation area and the placement of the revised planning area. This paper is applied to the planning of the aviation port logistics park, based on the application of SLP in the layout of plant facilities, but different.

3 Analysis of the current situation of the internal layout of Zhengzhou Airport Logistics Park

3.1 Zhengzhou Airport Logistics Park Development Background

In order to strengthen the construction of logistics infrastructure, promote the development of large logistics enterprises, promote the construction of Zhengzhou central logistics hub and key projects, and promote Zhengzhou as an international aviation logistics center, the Henan government formally adopted the application for the construction of Zhengzhou Airport in October 2007, proposing the vigorous development of modern logistics industry. The Henan government set up a management committee in 2011 to ensure the standard operation of the construction of the aviation port and free trade zone. In November 2012, the State Council of the People's Republic of China approved the "Central Plains Economic Zone Planning", proposing the construction of Zhengzhou Airport Economic Comprehensive Experimental Zone with Zhengzhou Airport as the main body, relying on a comprehensive transportation hub and developing air cargo as a breakthrough. On January 10, 2014, the People's Government of Henan Province approved the Conceptual Master Plan of Zhengzhou Aerodrome Economic Comprehensive Experimental Zone (2013-2040), which is the first aerodrome economic development pilot zone in China. By the end of 2022, the total number of market entities in Zhengzhou Airport exceeded 60,000, 9.3 times that of 2012; the annual business income of the above-standard service industry reached 34 billion yuan, and the annual sales of the above-standard trade enterprises exceeded 150 billion yuan. 2022, the regional gross domestic product (GDP) of Zhengzhou Airport completed 120.8 billion yuan, 5.9 times that of 2012.

3.2 Analysis of the air transport capacity of Zhengzhou air port

Zhengzhou Airport Economic Comprehensive Experimental Zone is based on Zhengzhou Xinzheng International Airport for the development of aviation logistics, the development of the airport experimental zone development planning, one of its main objectives is committed to the Zhengzhou Airport Economic Comprehensive Experimental Zone into an international aviation logistics center, the rapid development of the airport in recent years has driven the development of the experimental zone aviation logistics industry.

Along with the continuous improvement of all aspects of the aviation airport, infrastructure and service levels continue to optimize, coupled with good prospects for economic development in recent years, the development trend of Zhengzhou's aviation logistics industry has also shown a strong trend. The total throughput is rising rapidly, of which, in 2021, the region's gross domestic product grew from 20.6 billion yuan in 2012 to 117.3 billion yuan, with an average annual growth rate of 15.3%; up 12.1% year-on-year. Zhengzhou is the central city of China, and its cargo volume jumped from 151,000 tons in 2012 to over 700,000 tons in 2021, successfully ranking among the top 40 global cargo airports. The total value of foreign trade imports and exports grew from 175.9 billion yuan to 524.6 billion yuan, with an average annual growth rate of 12.6%; a year-on-year increase of 17.9%, accounting for 64% of the province and 89% of the city. The growth rate of major economic indicators is basically about twice the average growth rate of the province. 2022 Zhengzhou Xinzheng Airport completed passenger throughput of 9,221,674 passengers, compared with the same period in 2021, a decrease of 9,733,233 passengers, down 51.3%. 2022 Zhengzhou Xinzheng Airport passenger throughput growth rate ranked 24th in the country, down 10 places compared with the growth rate ranking in 2021. The cargo and mail throughput of Zhengzhou Xinzheng Airport in 2022 was 624,654.08 tons, a decrease of 80,094.82 tons or 11.4% compared with the same period in 2021, and the growth rate of cargo and mail throughput of Zhengzhou Xinzheng Airport in 2022 ranked 6th in China, which remained the same compared with the growth rate in 2021.

3.3 Analysis of Planning and Layout Problems of Zhengzhou Airport Logistics Park

First of all, in logistics and transportation, there are a lot of cross traffic and reverse logistics between operation areas, and the material flow is large and prone to congestion. This makes the logistics cost higher and the production efficiency lower.

Secondly, the location of the operation area is unreasonable, the distance is far, the distance of material transportation is long, and the handling process is cross and roundabout.

Finally, the space utilization rate of production center I is low, which wastes the available space. This is not conducive to the production company to increase equipment and improve production capacity.

4 Functional Area Layout Planning of Zhengzhou Airport Logistics Park Based on SLP Method

4.1 Use of SLP logistics park functional area layout scheme design

4.1.1 Determination of planning functional areas

The airport is divided into 7 operational units, which are air cargo area, international transit and distribution area, bonded warehouse area, value-added circulation and processing area, international procurement and trade area, comprehensive supporting area, information service area, etc. The name, code and function of each operation unit are shown in the table below.

Table 2. Operation unit and code introduction table

Code	Operating unit
1	Airport Cargo Area
2	International Transit and Distribution Zone
3	Bonded Warehouse Zone
4	Circulation Value-added Processing Zone
5	International Procurement and Trade Zone
6	Comprehensive Support Zone
7	Information Service Zone

(1) Airport Cargo Area

This is an area to be built based on Xinzheng Airport. All goods entering the port area will be unloaded, yarded, stacked and finally entered into various functional areas of the port area. Therefore, this area provides functions such as receiving, shipping, handling and temporary storage for the import and export cargo of Xinzheng Airport. This includes the public cargo terminal built by the airport, as well as various airline base cargo terminals, and cargo handling platforms, customs acceptance and other areas are in the planning of the airport cargo area.

(2) International transit and distribution area

The aviation port logistics park can naturally go international based on its own conditions and advantages. Some of the goods in long-distance transportation may need transit points, and some goods may need transit stations to sort, allocate and distribute goods to different countries and regions, which requires the construction of international transit and distribution zones in the aviation port logistics park.

(3) Bonded Storage Area
This is mainly for customs import and export goods to provide bonded services, which involves bonded warehouses, checkpoints, carabiners and other equipment composition.

(4) Circulation value-added processing area
Many goods entering the port area need to be separated and sorted, graded and classified, combined and packaged, measured and weighed, coded and filmed, and repackaged, etc. Therefore, it is necessary to design the value-added circulation processing area according to the functional requirements at this time.

(5) International procurement trade zone
This area is mainly for the international freight goods in and out of the air port to carry out services.

(6) Comprehensive supporting area
In the logistics park, there is not only the flow of goods to and from the park, but also the need to provide basic livelihood protection for the customers and staff in the port area. Therefore, the comprehensive support area is actually a living area, including accommodation, stores, hospitals, parking lots, etc.

(7) Information service area
In order to make Zhengzhou Airport Logistics Park a famous cargo port at home and abroad, it is necessary to have strong information service as a guarantee. This includes the information of each warehouse logistics, freight flight information, customs clearance inquiry, inspection inquiry, customs clearance operation and the centralized analysis and notification of weather conditions and surrounding traffic information, which has an important role in the normal operation of the port area.

These seven functional areas are the basis of the layout planning of Zhengzhou Airport Logistics Park and are also an important part of its infrastructure construction. The so-called layout planning of the aviation port logistics park is to arrange these functional areas in suitable locations to maximize the functions to be achieved through qualitative and quantitative analysis of the logistics influencing factors in the port area.

4.1.2 **Analysis of the basic elements of the layout**

With the functional area layout of SLP method, the following five factors are considered P (product, material or service), Q (quantity or output), R (production route or process flow), S (auxiliary service department), T (time or schedule), which correspond to the factors considered in the construction planning of Zhengzhou Airport Logistics Park are also from these aspects. So the basic elements of layout planning are as follows.

(1) Logistics object (P)
In the planning process of Zhengzhou Airport Logistics Park, the logistics object is the goods imported and exported from the logistics park. The types of incoming and outgoing goods mainly include electronic products, textiles and raw materials, transportation equipment, department stores and homes, equipment and instruments, food, beverage and tobacco, metal products and other plastic products, rubber products, wood products, etc.

(2) Cargo flow (Q)
Based on the author's internship and the data provided by the company, the cargo throughput of Zhengzhou air port for the next six years was obtained. Based on this, the following design of SLP functional area system arrangement is carried out.

(3) Logistics process (R)
After the field investigation and data collection, it is found that the goods purchased and distributed from home and abroad will be processed in the following five ways after entering Zhengzhou Airport Logistics Park.
①International and domestic goods that need to be delivered in time are split and assembled in the park and then transferred to other destination ports inside and outside the country.
②The goods to be delivered according to the specified date will be deposited in the warehouse and arranged to be assembled and shipped after the delivery date.
③After comprehensive processing treatment and simple value-added processing of imported goods, they are distributed to domestic and overseas.
④For goods for trading purposes, samples are displayed in the trade logistics area, and if a deal is made, the goods are picked up from the warehouse for distribution.

(4) Auxiliary service sector (S)
The auxiliary departments of Zhengzhou Airport Logistics Park are mainly contained in the comprehensive supporting area and the information service area of the Airport Logistics Park. Their existence is to serve the various logistics activities in the logistics park. Therefore, more consideration can be given to non-logistics relations in the layout planning.

(5) Logistics technology (T)
This is an item that is difficult to be reflected in the planning of SLP applied to logistics parks. These facilities exist in all aspects of the port logistics park, all for the purpose of realizing efficient and convenient transportation of goods in the aviation port logistics park, and the non-logistics relationship is also mainly considered in the layout.

4.1.3 **Analysis of logistics relevance**

The analysis of the logistics relationship between functional areas in Zhengzhou Airport Logistics Park is carried out in three steps in turn, such as determining the flow of materials between functional areas in the future Zhengzhou Airport Logistics Park, determining the grade of logistics intensity between functional areas and drawing a correlation diagram of the grade of logistics relationship between functional areas.
The logistics status of each operation unit is an important factor in the arrangement of facilities. Quantifying the relationship between operation units, by confirming the material flow of each operation unit, is an important basis for avoiding cross and circuitous logistics routes and reducing logistics costs. Using graphical tools operation unit distance from to table, product and logistics volume from to table, product and logistics intensity from to table, etc. to analyze this air port, determine the importance of each operation unit in the production plant and the level of logistics intensity between them, and provide help to optimize the plant layout.

(1) Material flow between functional areas
This step is to calculate the logistics flow between each functional area of Zhengzhou Airport Logistics Park to determine the logistics relationship between them.
Through statistical analysis of the daily flow of incoming goods in AZ Airport Logistics Park, it is found that the flow of goods in the park is approximately as follows:
① All the goods come to the air port cargo area first, 48% of the goods go directly to the international transit and distribution area, 20% go directly to the bonded storage area,

then 16% go to the value-added circulation and processing area, and about 14% flow to the international procurement and trade area.

②Bonded warehouse area of the goods every day and then 78% of the amount of the day into the international transit and distribution area, and 20% into the international procurement and trade area.

③ Circulation value-added processing zone every day and then 56% of the same day into the international transit distribution area, 20% into the bonded warehousing area, the international procurement trade area has 78% into the international transit distribution area.

These data above have the reliability about the annual air cargo diversion of Xinzheng Airport based on the research during the internship and provided by the internship company. Using the cargo volume of a year, on average to each day, the flow of cargo volume between the functional areas of the logistics park can be roughly calculated, as shown in the following Table 2 Logistics flow from to table. Since Zhengzhou Airport Logistics Park is planned with an eye on future use, we have selected the predicted freight demand of Zhengzhou Airport Logistics Park in 2028, 2343559 tons, as the basis data for quantitative analysis of layout planning. Then the average daily volume is
2343559 / 365 = 6420.71 (tons)

Table 3. Logistics flow between functional areas from to table (tons)

to / from	Airport Cargo Area	Internat-ional transit distribution area	Bonded Storage Area	Circulation value-added processing zone	Internat-ional Procure-ment Trade Zone	Comp-rehensive Suppo-rt Area	Informa-tion Service Area
Airport Cargo Area		3081.94	1284.14	1027.31	898.90	0	0
International transit distribution area	0		1001.63	575.29	701.14	0	0
Bonded Storage Area	0	1001.63		205.46	256.83	0	0

Circulation value-added processing zone	0	575.29	205.46		0	0	0
International Procurement Trade Zone	0	701.14	256.83	0		0	0
Comprehensive Support Area	0	0	0	0	0		0
Information Service Area	0	0	0	0	0	0	

(2) Determination of logistics intensity levels between functional areas

There are five grades of logistics intensity: A, E, I, O and U. The different levels are determined according to the size of different logistics route ratio or the size of the proportion of material flow undertaken.

Table 4. AEIOU Grade Classification Table

Logistics strength level	Symbols	Route ratio（%）	Percentage of material flow（%）
Ultra-high logistic strength	A	10	40
Extra high logistic strength	E	20	30
Greater logistical intensity	I	30	20
General physical strength	O	40	10
Handling can be ignored	U		

From the table, the number of operating units of each logistics strength level in this production center can be pushed out.

According to the push work unit pairs, combined with the logistics strength from to table to work unit pairs for logistics intensity level division, draw the logistics intensity situation summary table, as shown in the following table.

Table 5. Logistics intensity summary table

No.	Operating unit for	Logistics strength	Logistics strength level	Percentage of physical flow
1	1-2	3081.94	A	34.12%
2	1-3	1284.14	E	14.22%
3	1-4	1027.31	E	11.37%
4	1-5	898.9	I	9.95%
5	2-3	1001.63	E	11.09%
6	2-4	575.29	O	6.37%
7	2-5	701.14	I	7.76%
8	3-4	205.46	O	2.27%
9	3-5	256.83	O	2.84%

(3) Draw the logistics relationship between each functional area and the hierarchical correlation map

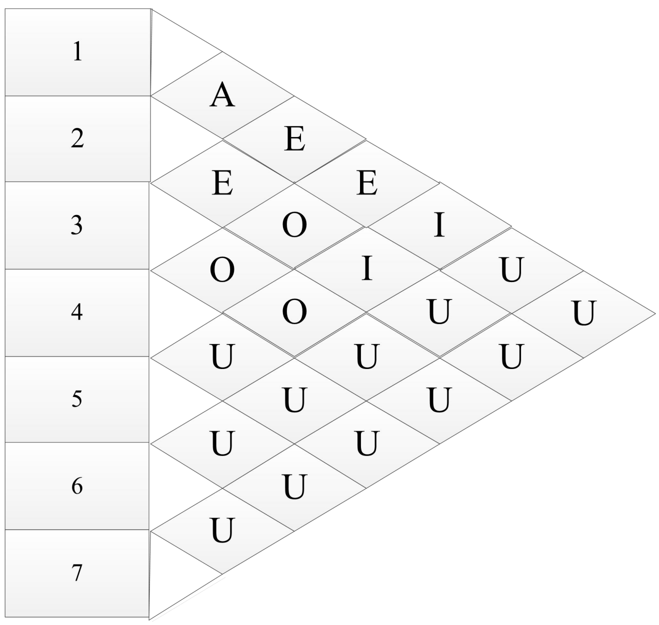

Figure 2. Logistics strength related graph

4.1.4 **Analysis of non-logistical correlations**

In facility layout and design, there are other links between operating units than through logistics. For example, the connection of management services, auxiliary services, and other activities. The degree of closeness between these work units is their non-logistics relationship.

Based on the characteristics of the products and production lines in this production center, the non-logistics relationship between each operation unit is established by combining the factors of closeness of interrelationship and the ratio of interrelationship levels of operation units. The non-logistics relationship of the production center is divided into A, E, I, O, and U respectively.

Table 6. Table of factors of closeness

No.	Reasons
1	Process flow of the process
2	Production Services
3	Material handling, Logistics
4	Easy supervision and management
5	Vibration, noise, smoke and dust, flammable and explosive hazardous materials

Table 7. Operating unit non-logistics relationship level share table

Symbols	Meaning	Instructions	Percentage（%）
A	Absolutely Important		2-5
E	Specially Important		3-10
I	Important		5-15
O	Generally close		10-25
U	Unimportant		45-80
Z	Negative closeness	Do not wish to approach	Depends on the situation

Table 8.

Symbols	Operation	Reasons
A	1-2/2-3	1 2 3
E	1-3/1-7/2-5/5-7	1 3
I	1-4/2-7/3-4/5-6	1
O	1-5/1-6/2-4/3-5/3-7/4-7	
U		
X	6-7	5

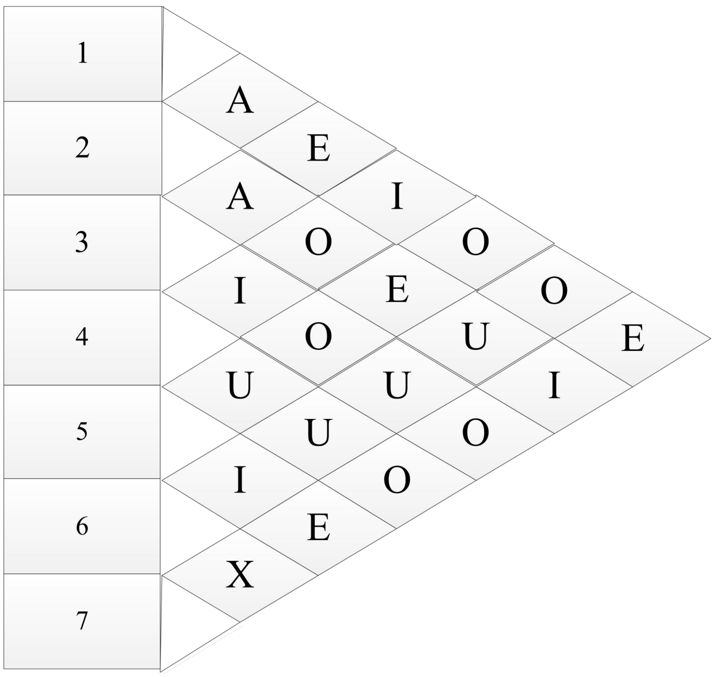

Figure 2. Non-logistics relationship chart

4.1.5 **Analysis of integrated relationships**

According to the focus of the layout objectives on logistics and non-logistics relationships, the logistics and non-logistics relationships are quantified and weighted according to the focus for comprehensive analysis.

(1) Determination of weighting value

The size of the weighted value reflects the focus of the factors considered in the layout of the plant, after investigation, the production center focuses more on the logistics relationship, and the ratio of logistics relationship to non-logistics relationship is set as m:n=2:1 in this paper.

(2) Calculation of integrated interrelationships

① Quantify the relationship levels, A = 4, E = 3, I = 2, O = I, U = 0, and Z = -1.

② Weighted summation. Let an operation unit be i and another operation unit be j. The quantified value of logistics relationship level of two operation units is J_{ij} and the quantified value of non-logistics level is H_{ij}, then the quantified value of comprehensive mutual relationship between two operation units (O_{ij}) is: $O_{ij}=m \cdot J_{ij}+n \cdot H_{ij}$.

③ Comprehensive relationship level division. According to O_{ij} value, set the O_{ij} value range to divide A, E, I, O, U, Z levels.

Table 9. Initial integrated interrelationship level

A pair of operating units	Relationship Secret Level				Integrated Relationships	
	Logistics Relationships Weighted value：2		Non-logistics relationships Weighted value：1			
	Grade	Score	Grade	Score	Score	Grade
1-2	A	4	A	4	12	A
1-3	E	3	E	3	9	E

1-4	E	3	I	2	8	I
1-5	I	2	O	1	5	I
1-6	U	0	O	1	1	U
1-7	U	0	E	3	3	O
2-3	E	3	A	4	10	E
2-4	O	1	O	1	3	O
2-5	I	2	E	3	7	I
2-6	U	0	U	0	0	U
2-7	U	0	I	2	2	O
3-4	O	1	I	2	4	O
3-5	O	1	O	1	3	O
3-6	U	0	U	0	0	U
3-7	U	0	O	1	1	U
4-5	U	0	U	0	0	U
4-6	U	0	U	0	0	U
4-7	U	0	O	1	1	U
5-6	U	0	I	2	2	O
5-7	U	0	E	3	3	O
6-7	U	0	X	-1	-1	X

(3) Determine integrated interrelationships

Based on the initial integrated relationship grade, the percentage of each score band is calculated by score, as shown in Table 9. Also, according to Table 10, the current operating units are flexibly adjusted for the grade share by reference to the integrated relationship share.

Table 10. Comprehensive relationship level percentage table

Total Score	Relationship Secret Level
11-12	A
9-10	E

6-8	I
5-2	O
0	U
-1	X

Table 11. Reference table for the classification of the secret level of comprehensive relations

Relationship Secret Level	Symbol	Logarithmic ratio of operating units（%）
Absolutely Necessary Proximity	A	4.76
Specially important to approach	E	9.52
Important	I	14.29
General	O	33.33
Unimportant	U	33.33
Do not want to be close	Z	4.76

In this way, the integrated logistics correlation diagram is derived.

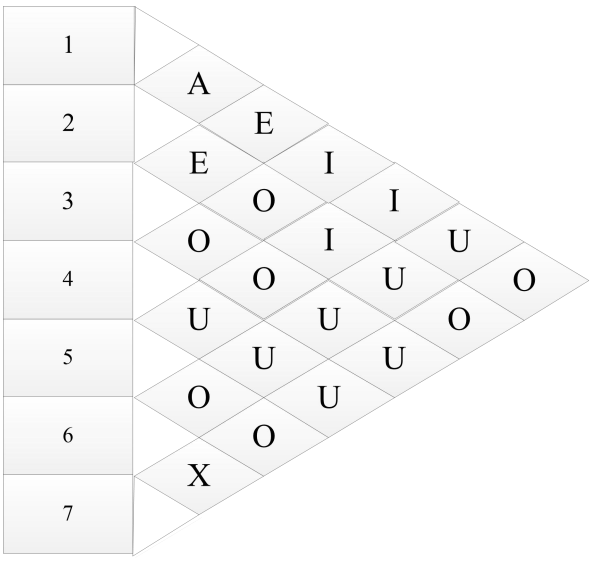

Figure 3. Comprehensive relationship chart

4.2 Interior layout plan of Zhengzhou Airport Logistics Park

Excellent facility layout can take into account the logistics relationship and non-logistics relationship between the operating units and facilities departments as much as possible to reduce logistics costs, strengthen the connection between different production links, thus improving the operational efficiency of the production system and reducing material handling costs. After analyzing the unreasonable arrangement between airports, the distance between each operation unit is relatively far, and there is a cross-logistics phenomenon, so the facility arrangement of the production center is optimized and improved.

4.2.1 Determination of the initial optimization plan

The initial optimization plan is formed by quantifying the comprehensive interrelationship level between each unit and determining the comprehensive proximity of each operation unit.

4.2.2 Determine the integrated proximity of work units

Quantify the integrated relationships by row or column accumulation. After that, the ranking is done according to the accumulated values, and the table of the integrated proximity of the operating units is formed.

Table 12. Comprehensive proximity ranking table

Functional area code	1	2	3	4	5	6	7
1		A	E	I	I	U	O
2	A		E	O	I	U	O
3	E	E		O	O	U	U
4	I	O	O		U	U	U
5	I	I	O	U		O	O
6	U	U	U	U	O		X
7	O	O	U	U	O	X	
Overall score	12	11	8	4	7	0	2
Sort	1	2	3	5	4	7	6

4.2.3 **Determine the location of the operating unit related to the map**

Table 13. Operating unit relationship level representation table

Grade	Coefficient value	Number of lines	Relationship Secret Level
A	4		Absolutely Important
E	3		Specially Important
I	2		Important
O	1		Generally
U	0		Unimportant
X	-1		Unwanted

The grade is divided into line numbers to obtain the location-related map.

(1) First, the layout is carried out for the comprehensive relationship rank of A.

First, the layout is carried out according to the functional unit with integrated sorting of 1, and the functional unit with which the unit relationship level is A is found. According to the above table, the unit with integrated sorting of 1 is code 1, and the functional unit with unit relationship level of A is code 2, for which the layout is carried out.

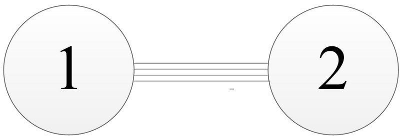

Figure 4. Operating unit location related map

(2) First of all, the layout is carried out for the integrated relationship level of E.

First, we select functional units for layout in accordance with the integrated ranking, and find out the functional units with which the unit relationship level is E. According to the above table, we can see that the functional units with the unit relationship level E are 1-3, 2-3. Therefore, the layout is carried out.

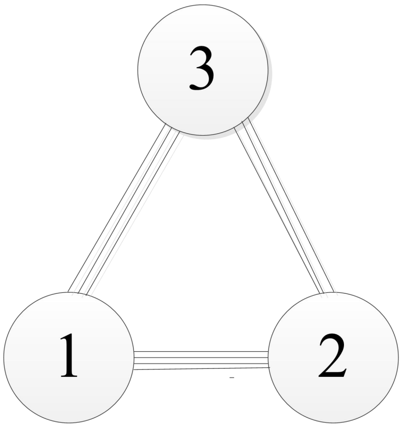

Figure 5. Operating unit location related map

(3) Layout for the integrated relationship level I.

Select functional units for layout in accordance with the integrated ranking, and find the functional units with the unit relationship level of I. According to the above table, the functional units with unit relationship level I are 1-4\2-5\1-5.

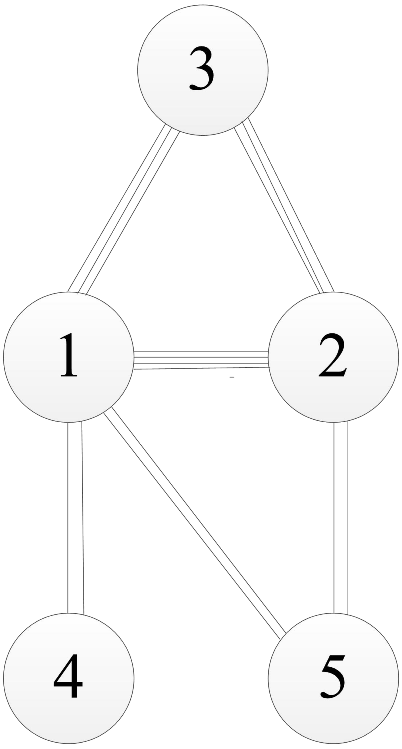

Figure 6. Operating unit location related map

(4) Layout for the integrated relationship level of O.

Select functional units for layout in accordance with the integrated ranking, and find the functional units with the unit relationship level of O. According to the above table, the functional units with unit relationship level O are 3-4/1-7/2-4/3-5/5-7/2-7/5-6 for the layout.

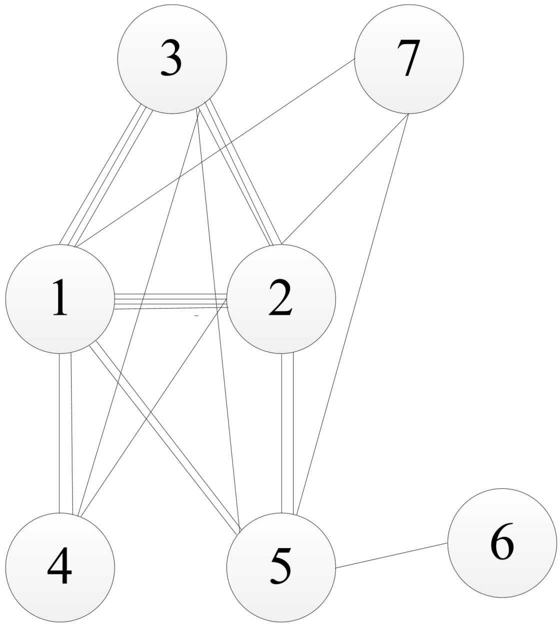

Figure 7. Operating unit location related map

(5) Layout for the integrated relationship level X.

Select functional units for layout in accordance with the integrated ranking, and find the functional units with the unit relationship level of X. According to the above table, we can see that the functional units with unit relationship level X are 6-7.

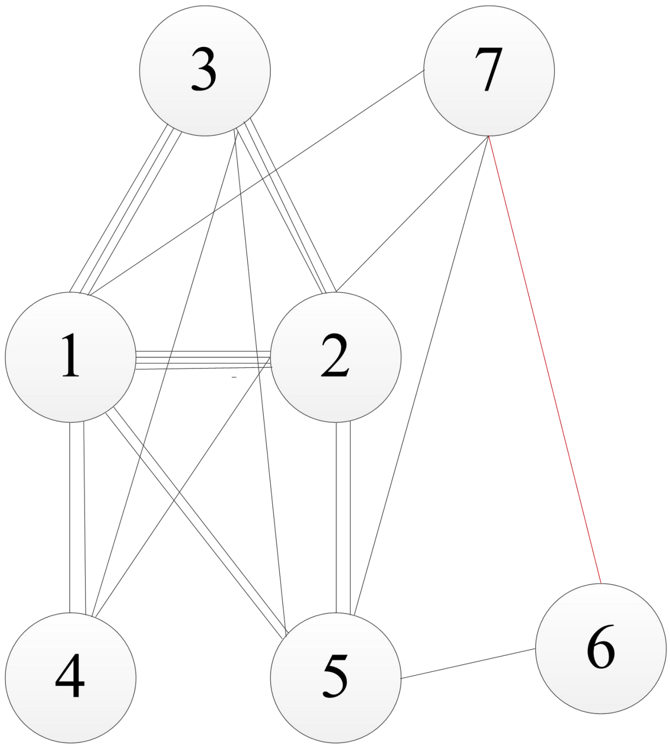

Figure 8. Operating unit location related map

4.2.4 **Calculation of the area of each functional area**

The aviation port is divided into 7 operational units. The code, name and area of each operation unit are shown in the table below.

Table 14. Operating unit area introduction table

Code	Operating unit	Sizes (m^2)
1	Airport Cargo Area	1284144
2	International Transit and Distribution Zone	540288.86
3	Bonded Warehouse Zone	296790.48
4	Circulation Value-added Processing Zone	732264.37
5	International Procurement and Trade Zone	200000
6	Comprehensive Support Zone	200000
7	Information Service Zone	60000

(1) $S_1 = \frac{Q_1 * T_1 * \alpha}{\beta * t}$ =1284144 m^2

S_1 represents the area required for the air port cargo area.

Q_1 is selected as the average daily volume of cargo demand forecast for 2028 AZ air port logistics park is taken as 6420.71 tons.

T_1 is expected to take 5 hours for one air cargo cargo operation, which is converted here to days 5/24 days.

α is the air cargo loading and unloading cargo for one flight covers an area of about 200 m^2.

β is the area utilization factor, generally take 20%-60%, this paper takes 50%.

t is the working time of a working day, about 10 hours, converted into days, 10 / 24 days.

(2)S2 $= \frac{Q_2 * T_2 * \gamma}{\beta * t}$ =540288.86 m^2

S_2 is the area of the international transit distribution area.

Q_2 is the daily volume of goods handled in the international transit and distribution area is taken as 5360 tons.

T_2 is taken as 7 days here.

y is generally taken as 1.5-3m^2. Because it is air cargo, it will not be stacked extra high, so 3m^2 is taken in this paper.

β is the area utilization factor, generally take 20%-60%. In this paper, we take 50%.

t is the working time of a working day, about 10 hours, converted into a day, 10/24 days.

(3)S3 $= \frac{Q_3 * T_3 * \delta}{\beta * L_3 * \varepsilon * X_3}$ =296790.48 m^2

S_3 is the area of the bonded storage area.

Q_3 is the goods in and out of the bonded.

T_3 is 180 days. This is because goods in bonded storage areas are available for long-term storage.

δ represents the warehousing factor, which is the warehousing rate, usually around 80%. This paper takes 0.9.

β is the area utilization factor, generally taken 20%-60%. This paper takes 0.5.

L_3 is the number of stacking layers. In the freight warehouse, this value is generally between 2.5-4. This paper takes 3 layers.

ε is the imbalance coefficient. Mainly refers to the uncontrollable factors in the logistics park, resulting in unbalanced operation of each functional area, generally take 0.5-0.8. This paper takes 0.5.

X_3 is about 1.5-3t/m2 according to the general warehouse information. 2t/m2 is taken in this paper.

(4)$S4 = \frac{Q_4 * T_4 * \delta * \mu}{W_4 * t_4}$ =732264.37 m^2

S_4 is the area of circulation value-added processing area.

Q_4 is the sum of incoming and outgoing goods of 1,808.06 tons.

μ is the proportion of goods that need to be circulated and processed when entering the value-added circulation processing area. Entering this functional area, generally need to be reprocessed, this paper takes 0.9.

δ is 5.

T_4 is the processing time required for goods of one route, which is about 30 days.

W_4 is the volume of goods processed per unit area, generally taking the value of 0.8-lt/m^2. 0.8 is taken in this paper.

t is the daily working time, about 10 hours, converted into days, 10/24 days.

(5)S5 =H5*d5=200000 m^2

S_5 is the area of the international sourcing trade area.

H_5 is the number of merchant customers accommodated in the international sourcing trade area. This paper takes 200.

D_5 is the area required for each merchant customer. In this paper, we take 1000m^2.

(6)S6 =H6*d6=200000 m^2

S_6 is the area required for the integrated support area.

H_6 is the average number of personnel in the supporting service area per unit of time. Today, there are about 10,000 people serving various logistics operations in the park, plus the industrial park staff.

D_6 is the area of the supporting service area occupied by personnel per person, which is about 20ｍ2.

(7)S7= 60000 m^2

This represents the area needed for the information service area, which will be adjusted according to the expansion of Zhengzhou Airport in the future.

4.2.5 **Result-Determine the optimization scheme diagram of SLP**

Table 15. SLP optimization scheme (area table of functional areas)

Code	Operating unit	Sizes (m^2)		Length (m^2)	Width (m^2)
1	Airport Cargo Area	1284144		1284.144	1000
2	International Transit and Distribution Zone	540288.86		1080.578	500
3	Bonded Warehouse Zone	296790.48		989.3016	300
4	Circulation Value-added Processing Zone	732264.37		1464.529	500
5	International Procurement and Trade Zone	200000		666.6667	300
6	Comprehensive Support Zone	200000		666.6667	300
7	Information Service Zone	60000		300	200
Total	Zhengzhou Airport Logistics Park	6000000		3000	2000

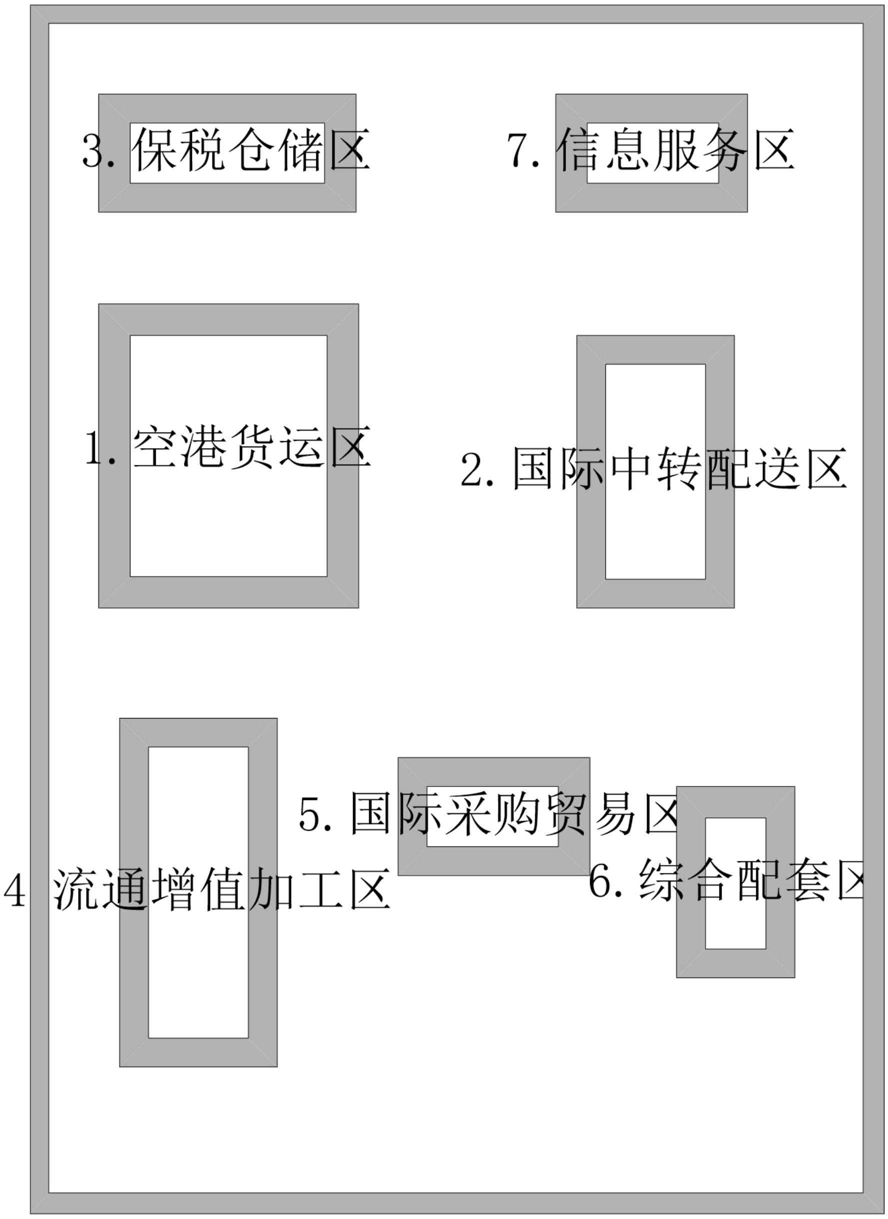

Figure 9. SLP optimization program diagram

5 Conclusion

In this thesis, after referring to the construction planning experience of many logistics parks at home and abroad, the SLP method is proposed to plan Zhengzhou Airport Logistics Park based on the development requirements of Zhengzhou Airport Logistics Park. After an in-depth analysis of the development background of Zhengzhou Airport, the functional objectives to be achieved by the layout planning are analyzed and the functional areas required for the park are designed. Finally, the final planning map of Zhengzhou Airport Logistics Park was obtained by analyzing according to the SLP method. The results derived from this method have strong practicality and sustainability, and are useful for the future construction planning of the logistics park. The planning and construction of the logistics park of Zhengzhou Airport will have a key role in its later operation and also play an important role in promoting the regional economic development.

References

The Central Plains Economic Zone Plan (2012 - 2020) issued by the State Council of China.

Development Plan of Zhengzhou Aeroport Economic Comprehensive Experimental Zone (2013 -2025) issued by the State Council of China.

China's Sixth National Logistics Park (Base) Survey Report. Accessed: China Logistics Association.

Henan Provincial People's Government Releases the Conceptual Master Plan of Zhengzhou Airport Economic Comprehensive Experimental Zone (2013-2040). Accessed: February 2016.

Feng Shi, Fan Guojun.(2022).Layout planning analysis of cold chain backbone network logistics park based on provincial level. China Logistics & Purchasing(15),109-112. doi:10.16079/j.cnki.issn1671-6663.2022.15.041.

Zhang Haitao, Wang Jiaxin & Zhai Changqing.(2022).Analysis of the Planning and Layout Patterns of Agricultural Products Wholesale Markets in Large and Medium-Sized Cities: The Comprehensive Agricultural Products Wholesale Market in Neijiang and the Agricultural Products Logistics Park in Yan'an as Examples. Urban Architecture Space(S1),54-57.

Ye Xiarong.(2022).Layout Optimization of NC Airport Logistics Park Based on SLP and TOPSIS-Grey Correlation Degree Evaluation (Master's Thesis, Nanchang University).https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202301&filename=1022662888.nh

Jiang Yiting.(2021).Research on the planning and layout of logistics park based on demand-oriented. Residential & Real Estate(31),121-123.

Liu Geou.(2021).SLP-based optimization study on the layout of fragmented express zone in Sha Ling Railway Logistics Park. Architecture & Budget(01),56-58. doi:10.13993/j.cnki.jzyys.2021.01.018.

Liu Junjie.(2019).Hunan Jinxia Grain Logistics Park Functional Area Layout Planning Study (Master's Thesis, Changsha University of Technology).https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202102&filename=1021046565.nh

Guo Feiyu.(2019).Study on the functional area layout of Jinan Logistics Park of Company S based on improved SLP (Master's Thesis, Beijing Jiaotong University).https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202001&filename=1019189857.nh

Zhou Huixiu.(2019).Exploring the layout planning and design of a home building materials logistics park. Value Engineering(14),65-67. doi:10.14018/j.cnki.cn13-1085/n.2019.14.016.

Jiang Zhengdong.(2018).Zhuzhou Railway Integrated Logistics Park Freight Demand and Layout Plan Study. Railway Freight (07),25-29. doi:10.16669/j.cnki.issn.1004-2024.2018.07.06.

Hu Aiguo.(2018).Empirical study of logistics park layout (Master's Thesis, Guangdong University of Technology).https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD201802&filename=1018866146.nh

Han Zhi.(2018).Exploring the planning layout of an aquatic product cold chain logistics park in Zhoushan. Journal of Zhejiang Ocean University(Natural Science Edition)(01),81-86.

Cai Jiakun.(2017).SLP-based optimization study on the layout of fragmented express zone in Sha Ling Railway Logistics Park (Master's Thesis, Tohoku University).https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202201&filename=1020150623.nh

Li Jingwen.(2017).Modeling and Implementation of Spatial Layout of Beijing-Tianjin-Hebei Steel Logistics Park. Journal of Beijing University of Technology (Social Science Edition)(03),1-7+22.

Chen Junsheng.(2017).Study on the development strategy of Shenzhen International South China Logistics Park (Master's Thesis, Xiamen University). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD201902&filename=1017107263.nh

Xiao Beishui.(2016). Study on the plan layout planning of logistics park based on SLP method (Master's Thesis, Shenzhen University).https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD201701&filename=1016763978.nh

Li Mengjia.(2015). Hunan High Star Steel Logistics Park Plan Layout and Traffic Organization Study (Master's Thesis, Changsha University of Technology).https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD201701&filename=1016262294.nh

Li Hong.(2015). Linyi Railway Logistics Park Planning Site Selection and Layout Study. Railway Freight (02),7-10+5.

Gao Jun.(2014). The current stage of China's steel logistics park construction necessity and layout of the discussion. Logistics Engineering and Management (09),4-6.

Xie Di.(2014). Thinking about the necessity and layout of steel logistics park construction. Metallurgical Economics and Management (03),30-32.

Liu Shifeng.(2014). A study on the macro layout of the main operation area of agricultural and sideline products logistics park (Master's Thesis, Shanghai Jiao Tong University).https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD201502&filename=1015033587.nh

Juan Wang,Ya Fan Li & Guang Hua.(2014).Research on Problems of Logistics Park Layout Optimization Based on Low-Carbon Concept. Advanced Materials Research(962-965). doi:10.4028/www.scientific.net/AMR.962-965.1654.

Yang Qianqian & Qin Lu.(2021).Steel logistics park layout based on market basket analysis and accessibility. MATEC Web of Conferences. doi:10.1051/MATECCONF/202133609022.

Liliana Rivera， YossiSheffi， Desirée Knoppen。Logistics clusters: The impact of further agglomeration, training and firm size on collaboration and value added services [J]. Science Direct, 2016.

Planning and Financing Logistics Spaces [J]. Science Direct, 2021.

Dalalclayton B . Tuming green the strategic way The role and potential of strategic environmental assessment in securing a green economy [J]. Applied Mechanics & Materials, 2013, 253-255(1):1553-1557

Vijay Joshi. An Analytical Study of Logistics Process at Logistics Park India Pvt. Ltd. Nagpu [J]. Asian Jourmal of Management, 2018, 9(1)

Alexander D W，Merkert R . Applications of gravity models to evaluate and forecast US international air freight markets post-GFC [J]. Transport Policy, 2020.

Hong-ying SHAN1,Li-bin ZHANG2,Yu-ping TANG1,Xiao ZHOU1 1 School of Mechanical Science and Engineering,Jilin University,Changchun,China 2 Department of Vehicle Operation Engineering,Jilin University,Changchun,China. Simulation Research of Warehousing Logistics Layout based on Tabu Algorithm[A]. Industrial Engineering Branch of Chinese Mechanical Engineering Society, IEEE Beijing Branch.Proceedings of 2011 IEEE the 18th International Conference on Industrial Engineering and Engineering Management(Volume 3)[C]. Industrial Engineering Branch of Chinese Mechanical Engineering Society, IEEE Beijing Branch:Industrial Engineering Branch of Chinese Mechanical Engineering Society,2011:342-345.

SHUAI Bin1, WANG Yu1 ,and LI Jing1, College of Traffic and Transportation, Southwest Jiaotong University, Chengdu 610031, China). CITY LOGISTICS LAYOUT PLAN BASED ON ROUGH SET THEORY[A]. China Communication and Transportation Association、American Society of Civil Engineers、ASCE Transportation and Development Institute、Mao Yisheng Science and Technology Education Fund. Proceedings of the First International Conference on Transportation Engineering (Volume I) [C].China Communication and Transportation Association、American Society of Civil Engineers、 ASCE Transportation and Development Institute、Mao Yisheng Science and Technology Education Fund: Southwest Jiaotong University School of Transportation,2007:3611-3616.

Huiying Zhang. Research on Logistics Supply Chain Management in the Process of Online Sales of E-commerce Agricultural Products[A]. Wuhan Zhicheng Times Cultural Development Co., Ltd..Proceedings of 4th International Conference on Business, Economics, Management Science (BEMS 2022)[C].Wuhan Zhicheng Times Cultural Development Co., Ltd.: Wuhan Zhicheng Times Culture Development Co.,2022:50-56.