Optimization of the layout of the air logistics park in M city

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Abstract

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The continuous advancement of technology and the surge in consumer demand for time-sensitive freight transport, as well as the main functions of an air logistics park such as handling air cargo and providing a platform for related value-added services, have provided a good basis for the rapid development of air logistics. However, with the expansion of airport operations, the increase of air routes, and the adjustment of local policies, the aviation logistics park is gradually unable to meet future development needs, and problems related to the unreasonable land area of the functional area are exposed, while also facing challenges such as transformation and upgrading.

Therefore, this paper takes SL international airport logistics park in M City as the main research object and analyzes the current development of SL aviation logistics park from five aspects: Market study, Strategic positioning, Function design, Layout design, and Business plan, based on the improved MSFLB research method. It will explore how the logistics park can be developed in coordination with the airport while making full use of the existing resources to increase the added value of the logistics park and seek future development possibilities in the face of the transformation of SL International Airport's positioning.

This paper will focus on the optimization of the layout of SL International Logistics Park, which is the Layout design part of MSFLB. The original layout will be appropriately adjusted using the system layout planning method, and the improved layout plan will be obtained. After that, the layout of the park before and after optimization will be evaluated and compared, aiming to provide an effective reference for the future development of SL Logistics Park.

Keywords
Aviation logistics park、MSFLB、Layout optimization

Table of contents

1 Introduction

The upstream and downstream industry chains of the aviation industry are very extensive and closely linked. If one part of them is affected by the external environment, such as policy, economy, epidemic, etc. The related industry chains will be implicated. How to adapt to this change becomes the first task for the development of these related industry chains. In this thesis, the author chooses to take SL International Airport and SL Air Logistics Park in M city as a case study, exploring the relationship between the transformation and upgrading of airport positioning and the layout of air logistics parks.

There are several reasons for the author to choose this topic. Firstly, the author's major is aviation business and logistics management, and the subject of aviation logistics park contains the relevant knowledge of both majors, so the author wants to explore the development status of the intersection of these two majors. Secondly, since the upstream and downstream industries of aviation are closely linked, the change in the airport's positioning drives the transformation and upgrading of the aviation logistics park, and the optimization and construction of the aviation logistics park also promote the rapid development of the airport, so it is significant to explore the overall development of this subject for the aviation industry. Lastly, as a resident of M city, the development of SL international airport and SL aviation logistics park is closely related to the author and provides a reference for the author's future career choice.

1.1 Topic Background

Southwest China is geographically unique, deeply inland, and hardly connected by large rivers. The region is highly dependent on air transport, in addition to the growing demand for air cargo owning to economic development and policy support. The SL International Airport in M City is an important transportation hub connecting most parts of China and even the whole world, and the SL International Air Logistics Park is thriving and playing an important role in the development of the local airport business.

However, despite the surge in local demand, the airport is located in the heart of the city, which is more constrained. Due to the special location of SL International Airport and complex factors, it seems that there is no longer possible to expand or increase the number of routes. The local council has decided to build a second international airport in M city after deep discussions and studies. Two airports in one city will complement each other and contribute to the development of the local aviation industry. This is both an opportunity and a challenge for the existing SL International Airport. (Ji Zuo 2022,13)

In the face of the imminent transformation of SL International Airport, the aviation logistics park, which relies on SL International Airport, is also under big pressure. Reasonable optimization of the layout of the aviation logistics park can not only coordinate the transportation of goods and the deployment of facilities between the airport and the logistics park but also reduce the cost of air-ground transportation and speed up the efficiency of the entire cargo operation. And because the aviation logistics park nowadays is not only simply providing transportation and storage services for the airport, but also has the function of value-added logistics services and support functions for logistics services, such as catering, accommodation, and other logistic services, the standardized layout of the aviation logistics park can attract more investment, increase the added value of the industry and further form a complete cargo transportation chain. So how SL aviation logistics park can make reasonable adjustments to the layout of the park, fully grasp the existing advantageous resources of the park, and make the rapid transformation in the new policy environment? Increasing its own special business and improving the added value of the park is a problem that needs to be considered in future development.(Dongyu Zhang 2021, 9)

1.2 Aim of the research

The purpose of this thesis is to solve the problems that arise in the current layout of SL aviation logistics park and provide a reasonable reference layout plan for future transformation and development. It is known that the current problems in the preliminary planning of SL aviation logistics park include confusion of functional areas, duplication of cargo handling routes, and low utilization of land resources, etc. The author will analyze the current situation of the external and internal environment of the park and adopt a systematic layout planning method to refine the existing functional areas of the park and add new functional areas that meet the future development direction. A new optimized layout plan will be obtained and compared and evaluated, aiming to improve the operational efficiency of the park, reduce the basic cost of logistics operation, expand the business capacity of the park, and finally achieve the integration and optimization of the layout resources of the park.

1.3 Structure of the research

This thesis is divided into five chapters. The first chapter is a basic introduction to the content of the entire research. The background, purpose, and significance of the study will be explained. This chapter allows the reader to understand the author's starting point and the problem.

Chapter 2 starts with a description of the background, development history, and current opportunities and challenges of air logistics parks. This is followed by an in-depth review of the research on air logistics parks in four sections. They are the functional area layout, air cargo

volume forecast, factors influencing air cargo volume, and the efficiency enhancement of the park. This chapter will contain a literature review as well as the relevant theories and research methods involved, by comparing research articles on the current development status of air logistics parks in China and other countries, with emphasis on the reference to the application of methods to the optimal layout of parks.

The opening section of Chapter 3 will describe the methodology that will be covered in this research. A proper explanation of them will be given and an account of how they will be used. In this part, a frame also will be used to help the reader further understand the author's thinking. This section will mainly choose to use the five aspects of MSFLB as the chapter framework, and each of the five aspects will be further analyzed with the different research methods.

Chapter 4 applies the research methodology from the previous chapter. The results will be presented mainly in the form of graphs and charts, focusing on the comparison of the SL aviation logistics park plan before and after optimization and analyzing the improved aspects of the optimized logistics park and its feasibility.

The last chapter is an overall summary based on the results of the study. The specific content contains the prospect of the future development of SL air logistics park、self-evaluation and reflection on the author's research process.

Table 1 below shows the overlay matrix for this paper.

Table1. Overlay matrix: How to optimize the layout of SL aviation logistics park?

Research Question	Theoretical Framework(chapter)	Results
What is the status of the external environment of SL Air Logistics Park?	3.2	4.1
What is the status of the internal environment of SL Air Logistics Park?	3.3	4.2
How to determine the new functional area of SL Aviation Logistics Park?	3.4	4.3.1
How to determine the new layout map of SL Air Logistics Park?	3.5	4.3.4
SL Aviation Logistics Park future development direction possibilities?	3.6	4.5

2 Aviation Logistics Park

This chapter will begin with an explanation of the background, development history, and current opportunities and challenges of air logistics parks. After that, the chapter will be divided into four sections to elaborate on the research review of air logistics parks, including the functional area layout of the park, air cargo and mail volume forecast, factors affecting air cargo and mail volume, and the efficiency enhancement of the park.

2.1 Basic information

The deepening of global economic integration has affected almost every corner of the world. At the same time, the rise of international e-commerce has been accelerated by the update of Internet technology, which has promoted the development of the entire air logistics industry. People's increased demand for air cargo is bound to drive the development of aviation logistics ground infrastructure, which is commonly referred to as the aviation logistics park.

The aviation logistics park currently contains three main functions. The first is the core function, which is essentially the same as an ordinary logistics park, providing basic storage, loading and unloading, and transportation functions for freight. The second is the value-added function of cargo transit, providing transit services for cargo flights in operation as well as simple sorting and processing of cargo, and customs clearance for cargo owners. The third is the additional service function of the aviation logistics park, which mainly includes supporting functions such as providing information about cargo and flights and business policies.(Xiao Hu&Yuan Qian 2013, 28.)

Rational planning of the layout of the aviation logistics park has profound significance for the sustainable development of the relevant airports as well as the logistics park itself. Firstly, since the aviation logistics park provides important support for the transportation of goods at the airport, the reasonable location of the functional area is determined according to the flow of goods and the size of the flow of goods, which can reduce the number of non-essential handling of goods in the park and the distance to be carried, shorten the transportation time and improve the efficiency of handling between the airport and the aviation. Secondly, since the construction of the aviation logistics park is influenced by national policy, the functional area setting of the park is closely related to the economic development of the region and the local industrial structure. Therefore, the planning and layout of the logistics park according to the external environment can attract logistics and other related enterprises to focus on investment and enable the effective connection of upstream and downstream enterprises in the park, reduce costs, and improve organizational efficiency, while promoting the economic construction around the logistics park and increasing employment opportunities for residents, which can bring beneficial chain effects. This concept was

first proposed by Mckinley Conway in "The Airport City", which relies on the aviation resources built by the airport to form an airport economic area, thus promoting the development of the local city economy and connecting with the world. (Yang Du 2019, 22; Mckinley Conway 1970)

In addition, the construction of aviation logistics parks is often reserved for future development of open space at the beginning of construction, which is because the functional areas of aviation logistics parks are constantly adjusted in the process of development, and the types of goods circulating in different parks are not the same. Therefore, the functional areas of each aviation logistics park are not always the same. But the most basic functional areas are the logistics functional area, bonded functional area, and business functional area. The logistics area mainly includes air cargo terminals, warehousing, logistics centers, etc. Bonded functional area is a characteristic of air transportation, mainly including bonded warehouses, joint inspection buildings, and export supervision warehouses. The business function area contains a comprehensive service area and business development area. The comprehensive service area mainly provides living service facilities for the park, and the business development area mainly contains administrative office buildings and commodity exhibition halls. (Tingting Wu 2014, 23-25.)

The earliest logistics park concept arose in Japan in the 1960s. Owning to the accumulation of a large number of orders, the Japanese government, in order to better plan the functional areas of the city and alleviate traffic pressure, opened up land in the main traffic arteries of the city for the exclusive storage, transportation, and management of goods, named "Distribution Park”.(Dongkun Duan 2018, 4-5.)

In 1961, Richard MutherIII, a system engineer from the United States, used the system analysis method to determine the distribution map of each region by combining qualitative and quantitative methods. System Layout Planning (SLP) was proposed after summarizing hundreds of cases. This method can make the relationship between each functional area and each operating unit quantifiable, to better help enterprises to determine the specific location of each functional area. The appearance of the SLP method also lays a theoretical foundation for the layout planning of logistics parks.(Dongkun Duan 2018, 4-5.)

After this, more experts have improved the SLP method in the context of practical research. Lee R C and Moore J M(1967, 195-200) proposed the use of the computer as an auxiliary method that can further reduce the layout error of SLP.

The establishment of the logistics park in Bremen, Germany in 1984 laid a good foundation for the development of the planning and construction of European logistics parks as well as aviation logistics parks, and at the same time, it also means the birth of logistics parks to some degree.

After decades of development, logistics park layout planning methods have become relatively mature, and countries all over the world are constantly making efforts to improve logistics parks. In recent years, the Fraunhofer Institute for Logistics, a world-class logistics consulting and research institute, has summarized the MSFLB logistics park planning methodology based on demand-driven, competition-driven, and best-practice driven in numerous international logistics park planning projects. The MSFLB planning methodology is implemented in five steps: Market Study, Strategic Positioning, Function Design, Layout Design, and Business Plan. The planners are able to use these five major aspects as a reference, and then based on different situations combine with specific analysis in each aspect to design the entire logistics park.(Peili Wang 2015, 4; Xinfeng Deng & Xi Zhang 2010, 97-98.)

After reading a large amount of literature, it is clear to know that the planning of logistics layout nodes and the algorithm of facility layout models have been successfully researched relatively well. But the layout construction of aviation logistics parks is comparatively rare. For instance, Qiao Yuan (2011) proposed that the construction of an aviation logistics park needs to consider "airport behavior" and "non-airport behavior" when studying the construction of Changsha Airport Logistics Park. " In other words, the construction of an aviation logistics park needs to take into account various comprehensive factors and maximize its construction role based on the construction experience of general logistics parks, combined with its own development needs and external environment.

Although the outbreak of the Covid-19 pandemic had a considerable impact on air cargo, the potential of air cargo is undeniable. According to relevant data published by International Air Transport Association (IATA), global air cargo demand in February 2023 has surpassed pre-epidemic levels, table 2 below shows the year-on-year change in the air cargo market for February 2023, through which it can be observed that the air cargo volume in the Asia-Pacific region declined by 6.0% year-on-year. This is a significant improvement compared to January (down 19.0%). It has to mention here that airlines in this region are benefiting from the gradual recovery of economic activity in this region due to the reopening of China and the removal of restrictions. The 19.9% increase in available capacity in the region compared to February 2023 certainly bodes well for the development of cargo at SL International Airport. (IATA 2023)

Table 2 . Global Air Cargo Volume Change by Region in February 2023（adapted from IATA 2023)

Total Market	Global Share[1]	CTK	ACTK	CLF(%-PT)[2]	CLF(LEVEL)[3]
Asia Pacific	32.4%	-6.0%	19.9%	-12.8%	46.4%
North America	28.1%	-3.2%	2.8%	-2.5%	40.0%
Europe	21.8%	-15.3%	-1.5%	-9.4%	57.4%
Middle East	13.0%	-8.1%	9.3%	-8.4%	44.5%
Latin America	2.7%	-2.7%	27.6%	-11.2%	36.1%
Africa	2.0%	-3.4%	4.7%	-3.9%	46.8%

*1 % of industry CTKs in 2022

*2 Year-on-year change in load factor

*3 Load Factor Level

The epidemic is both a challenge and an opportunity for the aviation industry. Vaccine transportation makes the role of the aviation cold chain increasingly prominent, but with it also comes a heavy challenge, because the aviation cold chain involves too many subjects, including airlines, airports, freight forwarders, customs, and other departments, so in the process of convergence possible to break the risk of chain, affecting the quality of goods as a result. And according to statistics, about 10% of China's cold chain goods are caused by the import and export port links such as handling and loading in the airport. But at present, only a few airports such as Shanghai Pudong Airport have built professional cold chain logistics centers. The cold chain facilities in small and medium airports are seriously insufficient and fail to meet the standards, so this may be a new transformation opportunity and challenge for SL aviation logistics park.
(Zhenqiang Lin 2022, 42-43; Yingying Wang 2019, 22-25.)

Aviation logistics park relies on aircraft as the main means of transport, its biggest advantage is high timeliness, but the disadvantage is that the cost is higher than other means of transport. Therefore, in order to reduce transportation costs, customers tend to use air transportation for goods with high added value. With the progress of technology, the timeliness of sea and land transportation means is gradually improved, but air logistics has irreplaceable advantages when facing these competitors. However, according to the data, the actual time of transporting goods by

airplane is very short, but the time consumed during the process of handling goods on the ground and transferring them to the consignee at the destination can exceed the actual transportation time by several times. How to carry out reasonable planning and layout in the construction of an aviation logistics park, improve the logistics efficiency and reduce the operation cost of the park have become practical problems encountered in the development process of an aviation logistics park at present. (Tingting Wu 2014, 6-10.)

2.2 Layout of the park's functional areas

Various scholars focus on different parts of the layout of air logistics parks. Dalalclayton. B (2013, 253-255) argues that the functional areas of the park are dynamically linked to each other, and he chooses to use a local chemical factory as a case study to analyze the non-logistics and logistics factors by using the SLP layout method and uses the dynamic line layout method and the correlation diagram method to calculate the location and the related area of each functional area. Weijian Wang (2017, 51-53) argues that the core issues affecting the development of the park are the area of land scale and the number of functional areas. Arivalagan R & al.(2020, 654-657) proposed that the construction of the airport logistics area focuses on the layout of the Bonded area, cargo village, and cargo station, and that increasing the connection between these three areas can play a better role in the logistics park. Siqi Zhang & al. (2020, 20-24) proposed combining the SLP method with a computer and using computer simulation modeling, this method can be more college-saving, but it seems to be a bit poor in the dynamic flexibility of the layout.

2.3 Air cargo and mail volume forecast

The forecast data of air cargo and mail volume is the basis for the layout planning of the air logistics park. SuryaniE & al.(2012, 27-41) used the system dynamics simulation method for forecasting to balance the cargo volume by both capacity and demand factors and analyzed the expansion time of the logistics park to cope with more cargo in the park. When Han Wu (2016, 13-16) studying Chongqing Airport Logistics Park, concluded that gray theory has a greater advantage in short and medium-term Forecasting has a greater advantage, and using the improved GM (1,1) forecasting, it was found to be better than the traditional model. Chenchen Wang (2020) analyzed airport logistics, she found that using the combined forecasting method, which was able to reduce the error. She used a linear regression model and then the trend extrapolation method was used to forecast the end-coming data, after which the cargo forecast value was obtained by substituting into the linear regression model. Jingyuan Zhao & al.(2020, 100-108) used Markov chain prediction to artificially correct the gray prediction results to make up

for the shortage of traditional SLP for quantitative analysis of cargo and mail volume. This provides a new idea for the layout of logistics parks.

2.4 Factors affecting the volume of air cargo and mail

Lakew P A (2015, 134-150) took a particular air cargo volume as an example and tried to search for the multiple factors that affect air cargo volume. The results of the study showed that the concentration of secondary and tertiary sectors greatly affects the volume of air cargo, in addition to regional fiscal issues also affecting the volume of air cargo. Alexander D W and Merkert R (2020) indicated that the driver of import and export trade also affects the volume of air cargo and mail. Through the gravity model, the dynamics of cargo and mail volumes are analyzed to be equally affected by crises such as aviation issues. Therefore planners need to consider multiple influencing factors when forecasting cargo and mail volumes and plan ahead for appropriate measures. Tolcha T D & al. (2020, 86) used six countries as the research subjects and used the causality method to conclude that there is a two-way promotion with economic development.

2.5 Benefit enhancement of the park

The aviation logistics park drives the further development of the airport's economic areas. The analysis of the development background for aviation logistics parks is beneficial to help logistics parks determine the key characteristic service functions of the parks, so as to optimize and improve the layout, expand related business and improve their competitiveness. Lei Li (2017, 50-52) used SWOT analysis to study the problems of unreasonable layout, low clustering, and poor service of existing air logistics centers, and proposed that jointly improving the logistics network is conducive to the future development of the aviation logistics park. Guodong Li (2018, 85-91) studied that the coordination rate between aviation logistics and the regional economy in western China is relatively low, thus it is difficult for them to effectively play mutual roles and generate co-benefits. But it reflects that there is great room for future development. Jingjing Huang (2021, 79-81) argued that planners cannot ignore the development of regional tertiary industry and aviation logistics park's relevance. Instead, attention should be paid to the degree of linkage between air transport and other transportation modes, improving the construction of aviation logistics parks, and building a modern logistics system.

3 Conducting the study

This chapter will introduce the research methodology used in the thesis and explain it appropriately. Also, the framework of the research ideas will be provided to the reader. The author will mainly choose to use the five aspects of MSFLB as the framework and further elaborate on the five aspects in conjunction with the relevant research methods.

3.1 Research Methods

Both qualitative and quantitative research methods are important tools in the field of social science research. They can be used individually or in combination in academic research. According to the comparison and analysis of the above two research methods, the author will use a combination of the two methods for their research. The specific research methods involved will be described later. Among the common research methods of qualitative research method are data collection、literature research、 personal interview and case study, etc. Ultimately, the findings are summarized or supported by explanations in written form. Quantitative research methods tend to use mathematical and statistical tools to analyze the quantity or value of the research object, then build models or compare data and other forms, and finally obtain objective conclusions to prove the research theory in terms of data. (Gao,pham&Polio 2023, 63.)

The literature research method is based on a specific research purpose or topic. By collecting, analyzing, and studying statistical literature thus obtaining relevant information, the author will obtain authoritative certified information and relevant data through libraries, information agencies, and official websites. The data presented in the Result section of this thesis, for example, the market analysis section contains information about the development policies of SL airport in recent years, the industrial layout of M city, the level of economic development of M city, and the source of disposable income of residents, etc., collecting from the statistical bulletin of the national economic and social development of M city, and the official websites made public by the local government. The original data such as the cargo and mail volume of SL airport under the SLP research method are from the official websites of China Civil Aviation Resources Network, the Civil Aviation Administration of China, and other official websites. The proportion of cargo flow in SL air logistics park is derived by the author based on the literature research method, referring to the cargo and mail direction of other airports, combined with the research method of field investigation and visits. The author collected these data through the literature research method, organized them, and finally presented them in the form of charts and tables. Links to the relevant reference websites and literature are listed in the Reference section. The use of the literature research method will help the author to have a more comprehensive and proper understanding of the

current background and status of the development of SL Air Logistics Park in M City. (Hannah Snyder 2019, 333-339.）

The author found through compiling information that the widely used methods of functional area layout are expert analysis method, computer-aided facility layout method, and system layout planning method. The expert analysis method mainly relies on the experts' own theoretical and practical experience to conduct a comprehensive evaluation and analysis of the park and get the final layout plan, which may be more practical, but is not quite applicable to this study because it is too subjective. And the advantage of the computer-aided facility layout method is that with the development and assistance of artificial intelligence, human intervention can be effectively avoided, but the complexity of the mathematical model is extremely demanding on the researcher's professionalism and takes a relatively long time. Compared with these two methods, the author choose the last one proposed by an American scholar, the system layout planning method, which will reflect the interrelationship of operational units, where the logistic relationship will involve quantitative analysis and the non-logistic relationship will involve qualitative analysis. Finally, a combination of the two methods is used to determine the relative positions between functional areas. This method is more maturely developed and is currently the most commonly used in layouts. Most importantly, this method is also more suitable for novice scholars because it does not require as much mathematical expertise. (Hong Zhou, Jianxin Ou & Zhendao Li 2008,3314-3319; Richard Muther 1961,66-67.)

The MSFLB Planning Methodology is a demand-driven, competition-driven, and best-practice-driven logistics park planning methodology developed by the Fraunhofer Institute for Logistics in Germany after years of research and practice. This methodology is implemented in five steps: Market Study, Strategic Positioning, Function Design, Layout Design, and Business Plan. The specific content is generally adjusted by the planner according to the actual situation and then combined with the specific analysis method. This method is more complete and flexible compared with other planning methods and plays a good theoretical guidance role in the layout of logistics parks. Most scholars will consider using this method when planning the layout of logistics parks at present. (Yiwen Jin 2019, 3.)

Therefore, the author will use the MSFLB planning method as the basis of the framework to analyze five aspects of the SL airport logistics park and combine it with the specific analysis method in focused aspects. The author chose to use the PEST analysis tool in the Market Study section to evaluate the current state of the external environment of the SL Air Logistics Park. In the Strategic Positioning section, SWOT analysis will be used, and in the Layout Design section, SLP

analysis will be used. The following Chart 3 includes the details of the author's ideas by using MSFLB planning method for reference.

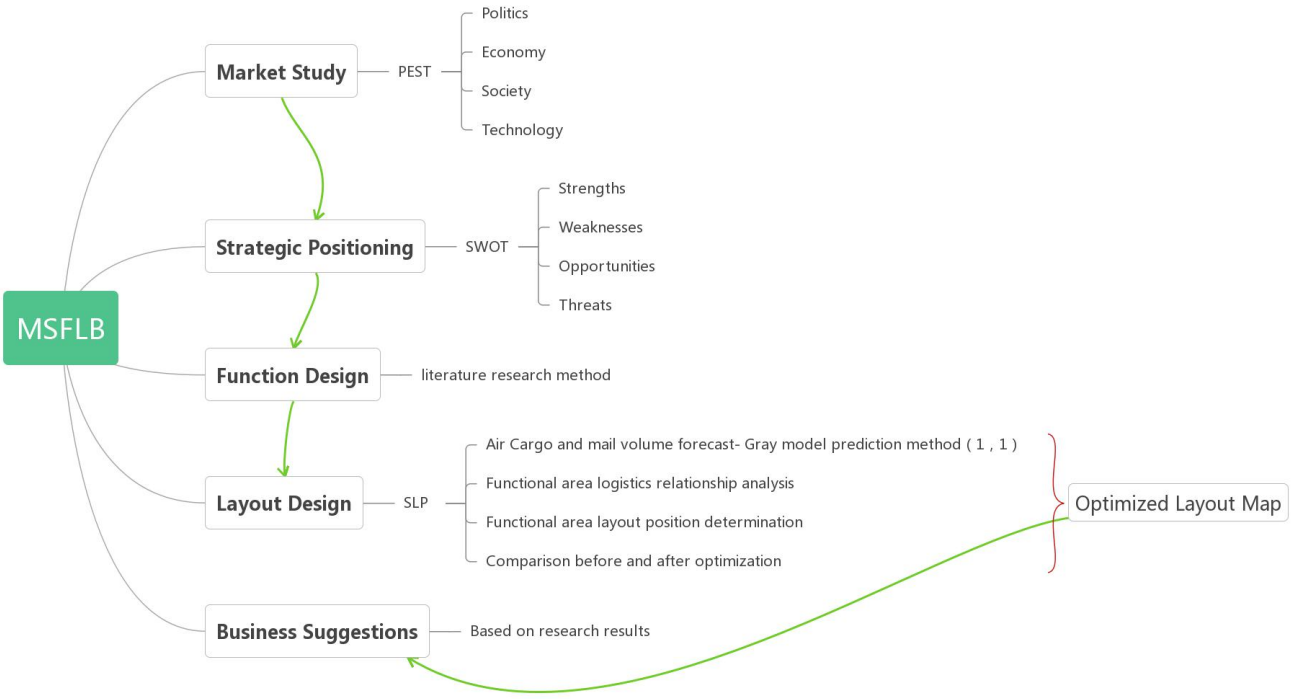


Chart 3. The framework of the author's research ideas

3.2 Market Study

PEST analysis is a basic tool for strategic external environment analysis, which grasps the macro environment in general from four aspects: political, economic, social, and technological. Choosing this macro analysis tool can help the author better understand the current situation of SL aviation logistics park's environment as well as the changing trends, and evaluate the impact of these factors on the strategic objectives and strategy formulation of the enterprise, which is helpful for aviation logistics park take advantage of favorable opportunities and avoid threats and unfavorable factors in advance. ((Nandonde& Felix Adamu 2019, 54–61.)

The author will use the PEST analysis tool in this phase of the analysis Market Study. The local government policies that have an impact on SL airport will be analyzed. The relevant information

and data are obtained from authoritative official websites and data, and the author will integrate and summarize them. The industrial layout, economic development level, and disposable income of residents in M city will be analyzed respectively. The social aspects will be analyzed in terms of the values, purchasing habits, and consumption structure of the residents in M City. Technological aspects will be analyzed by the author in terms of the development of advanced technologies related to air cargo, etc. The results of the above analysis are mainly presented in the form of tables and line graphs, and the PEST analysis can reflect the future development environment of SL Air logistics park and provide directional suggestions for the later transformation and upgrading.

3.3 Strategic Positioning

SWOT analysis is in some ways an intra-firm analysis. This approach combines the theories of resource and capability scholars. It has a significantly structured and systematic character, analyzing the resources and capabilities within the company in four aspects: strengths, weaknesses, opportunities, and challenges. The advantage of this approach is that it considers the problem comprehensively and has systemic thinking. The author will analyze the four aspects of SL Air Logistics Park and explore the current strengths and weaknesses of the park. Through this approach, appropriate action plan recommendations are given to obtain alternative countermeasures for the future development of the SL Air Logistics Park. (Andrews 1987)

The SWOT analysis tool will be used in this stage to explore the current strengths, weaknesses, opportunities, and threats of the park from four aspects. This method can help the author deeply understand the current development of SL Air Logistics Park. For example, what is the park doing well at present? What will help the park to transform and upgrade in the future? What aspects of the park's design are still not good enough? What possible opportunities can be used to fully exploit their role? The author will use the results of the SWOT analysis to give corresponding action plan recommendations and obtain alternative countermeasures for the future development of the SL Air Logistics Park. The purpose is to help SL Air Logistics Park to expand its advantages and avoid its weaknesses, so as to transform and upgrade the functional positioning of the park in the future.

3.4 Function Design

In this section, the author will adjust and add functional areas to the park based on the existing layout of SL Aviation Logistics Park, combined with the results of the previous PEST and SWOT analyses, and determine the types of optimized functional areas of the park because of the shortcomings of the current layout and the possibilities of the future development direction of the park. The adjustment and addition of functional areas of the park are based on the development

status of SL aviation logistics park and reference to the optimization cases of other aviation logistics parks. Trying to meet the needs of the future development of SL aviation logistics park，which is based on the future development objectives of the park.

3.5 Layout Planning

The system Layout Planning method contains five basic elements: P, Q, R, S, T. P represents logistics objects, such as goods flowing in the park, and the specific types of goods are mainly classified according to the positioning of the park, such as flowers, electronic products, fresh, pharmaceutical products, etc. Q represents material flow, which means how many goods are transported in the park. R represents the handling route of logistics, when the goods enter the park, they will be transported to different functional areas according to different demands, for example, some goods need to be split and assembled; some goods will be directly stored in the warehouse or need to be processed for value-added services; Some other goods will be transported to the trade display area for exhibition, etc. S represents the auxiliary sector, which usually has no actual flow of goods, but provides services for various logistics activities in the park and indirectly affects the flow speed and efficiency of goods. T stands for logistics technology, which is a general term for the theories and facilities used in the park, and this is also usually considered a non-logistics relationship. (Richard Muther 1961,66-67.)

The gray prediction model(1,1) method is a common method used by scholars in cargo and mail volume forecasting. The gray prediction method can take into account a variety of factors and accurately reflect the relationship between each factor and the target, and this model is often used together with related software, so this method is simple and easy to operate for scholars. The author will use the historical cargo and mail volumes collected from SL airports as the base data and bring them into the gray model prediction software to obtain the predicted values, which are used as the base data reference for layout optimization.(Sifeng Liu 2004, 501-508; Dongdong Din& Xuegang Shi 2015,2.)

The SLP planning method is divided into four main steps. The first is to forecast the future cargo and mail volume of SL Air Logistics Park. In this part, after comparing different forecasting methods and analyzing according to the actual situation, the author chooses to use a gray forecasting model(1,1) to obtain the future cargo and mail volume of SL International Logistics Park using software analysis of historical data in recent years, which is the most common method used in layout planning and has the smallest forecasting gap. Secondly, the logistics and non-logistics relationship between functional areas of SL air logistics park is analyzed according to the future forecasted cargo and mail volume. The third is the comprehensive correlation analysis of cargo in

the logistics park, this step can derive the closeness of the connection between each functional area of cargo in the air logistics park and provide data support for drawing the optimized layout map later. The last step is to determine the relative location and specific area of functional areas, which is also known as Function design in MSFLB planning method. As the author's data sources in this section on functional areas are unofficial. Therefore, this part of calculating the area will be omitted and replaced by a comparative evaluation of the logistics park before and after optimization. The existing functional areas of SL Aviation Logistics Park will be retained and then adjusted or added to meet future development needs as much as possible. (Richard Muther 1961,66-67; Li Ma & Jian Mao 2021, 141-145.)

3.6 Business Suggestions

This part is mainly based on all the previous relevant references and the research results obtained by using the research tools as a summary, and since this part is not the focus of this paper, only relevant suggestions are briefly drawn here for the future business development direction of the SL aviation logistics park for reference.

4 Results

The chapter will apply the research methodology from the previous chapter. The results will be presented mainly in the form of graphs and charts, The author will analyze the SL Aviation Logistics Park externally and internally, followed by the optimization of the park layout using the Slp method, and compare and evaluate the layout maps before and after the optimization. The data sources and data usage process for this section are shown in the following table 4.

Table 4. Data sources and data usage process

Data	Data Sources	Data usage process
PEST Analysis	Civil aviation resources network 2023. 2022 National Civil Transport AirportProduction Statistics Bulletin: http://news.carnoc.com/list/601/601495.html Chengdu Daily News 2023. Statistical Bulletin of National Economic and So-cial Development of Chengdu City in 2022: http://www.pidu.gov.cn/pidu/c125560/2023-03/27/content_c1940f6e8af44af4bec5a70306952e12.shtml Chenchen Wang. 2020. Research on Functional Positioning of Chengdu T-win Airports Based one Field Theory:https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202002&filename=1020041483.nh Jingjing Huang. 2021. Analysis of the impact of aviation logistics onregionaleconomic development one by one, taking Zhengzhou Air-port as an example Mouth. Mall Modernization:https://kns.cnki.net/kcms2/article/abstract?v=1UV6lUEUW669ZjsOzr7KtbQRMyme18wVdGiPdwWTRHoyg-CGkrI_nCB-7YuVo0y5H_pgPBGyuMfH7gyy8NLUZUk_SlIKR3X4Obg45VCa6Qee_F6jsTBI1bomLaCAiLBODr6HjkeYWP8=&uniplatform=NZKPT&language=CHS	The author collected and summarized the economic, social, and technological development of the SL Air Logistics Park in M through the policies issued by the local government website of M, and public websites. Relevant analyses of SL airports by previous scholars were also referred to. Extracting the information that is beneficial to the future development of SL Air Logistics Park. And the data was finally organized in a tabular format.
SWOT Analysis	Yang Du. 2019. Research on the Development Strategy of Shuangliu Airliner Economic Area under the Dual Airport Model:https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202001&filename=1020716816.nh Ji Zuo. 2022. Study on the development strategy of Chen	The author collected and extracted internal competitive advantages beneficial to the future development of SL Air Logistics Park by analyzing the internal analysis of SL Airport by other scholars and the current situation of airside

	gd-u Shuangliu Airport under"One city and two airports" :https://kns.cnki.net/kcms2/article/abstract?v=1UV6lUEUW65baYzlWnyz8ac9n6sASmxR9juqJRWZDz__rH05RNOMkYxzxZllAe4YshE3W4m6FZ3TOEOHWuyAgUjYIYeU2iJ0mARAxtIlx1J4AaoNi4SY9WG4LRQIT3HFkZ6mFkQ13WI=&uniplatform=NZKPT&language=CHS Lin Zhenqiang. 2022. Current situation and trends in the development of cold chain logistics parks in China. Logistics Technology and Applications. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=WLJY2022S2020&DbName=CJFQ2022	economic development of SL Airport. The data is then summarized by combining personal views finally presented in the form of a table.
SLP Method	Civil aviation resources network 2023. 2022 National Civil Transport Airport Production Statistics Bulletin: http://news.carnoc.com/list/601/601495.html Civil Aviation Administration of China.Source of cargo and mail data :http://www.caac.gov.cn/INDEX/ Chengdu Daily News 2023. Statistical Bulletin of National Economic and S-ocial Development of Chengdu City in 2022: http://www.pidu.gov.cn/pidu/c125560/2023-03/27/content_c1940f6e8af44af4bec5a70306952e12.shtml Chengdu Aviation Logistic zone 2021: https://www.renrendoc.com/paper/180103420.html Dongyu Zhang. 2021. Study on the layout planning of aviation logistics par-k in K city: https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202201&filename=1022455949.nh Dongkun Duan. 2018. Study on the layout planning of Zhengzhou aviation port logistics park: https://kns.cnki.net/kcms2/article/abstract?v=1UV6lUEUW64mAQzLfnBPwGV2fZoe9EVRso4kuzAfbzwfFj1gfi02oG5oZFW5vUFBLFhI2wyXXRg4j2Bp79o8QQtxCniQLCsH8IbEo7vK9YHNeLy6Qt-8BUFA-i19WwgDF7tvXZsoYaU=&uniplatform=NZKPT&language=CHS	The author collected data from the official website of M city in recent years, presented the obtained data in graphs, and substituted these data into the GM prediction model to get the forecast cargo and mail volume of aviation in the next five years. Then, based on the cargo flow ratio of other Chinese air logistics parks combined with the field survey of SL air logistics park to obtain the cargo flow ratio between the functional areas of SL air logistics park. By substituting the obtained forecast data into the ratio of each functional area, the daily cargo flow and flow direction of each functional area are obtained and the relevant graphs are obtained. Then the non-logistics relationship between each functional area is drawn, and finally the comprehensive logistics relationship of functional areas is scored and ranked, and the layout is arranged in order according to the score from highest to lowest, and the layout diagram after the optimized layout is drawn. The original layout diagram was adapted from Google Maps and related PowerPoint materials.

4.1 External Environment Analysis

Politics：

2019, The Sichuan Provincial Government and the Civil Aviation Administration jointly signed the "Deepening Cooperation Agreement on Promoting the High-Quality Development of Sichuan Civil Aviation Industry", "Chengdu International Aviation Hub Strategic Plan", "Chengdu New Airport Transfer and Operation and "Two Fields in One" Time Resource Allocation Plan", a series of policies to further divide the work between the two airports in M city. SL International Airport retains international cargo routes and supports the development of its air cargo business.

2021, CPC Central Committee and State Council Outline of the Construction Plan of Chengdu-Chongqing Regional Twin-City Economic Circle Investing in building an integrated comprehensive transportation system in Chengdu and Chongqing, building an international aviation gateway hub, and implementing SL airport expansion and renovation.

Economy：

The economic aspect will be analyzed from the industrial distribution of M, Gross production and growth rate of M, and the disposable income of M residents which will be shown in Table 5、Chart 6, and Chart 7 below respectively.

Table 5. Current industrial distribution of M City in billion yuan（National Economic and Social Development Statistics Bulletin 2022）

Index	2022（Billion Yuan）	Compared with 2021
Gross Regional Product	20817.5	2.8%
Primary Industry	588.4	3.8%
Secondary Industry	6404.1	5.55%
Tertiary Industry	13825.0	1.5%

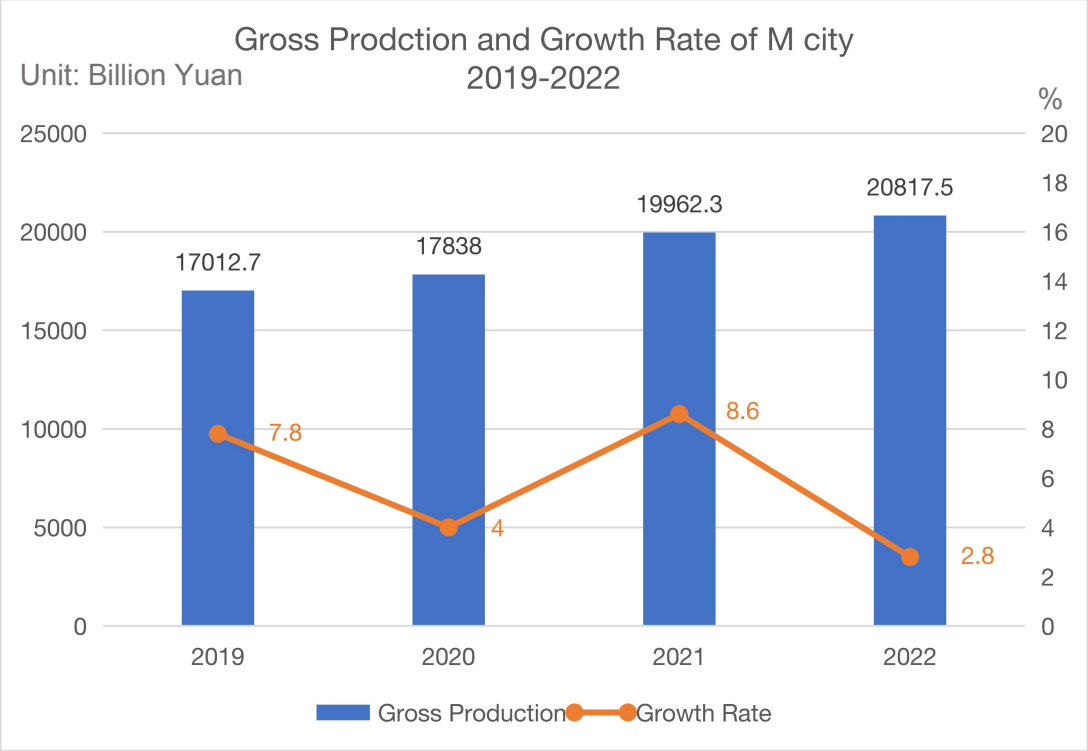


Chart 6. Grass Production and growth rate of M City from 2019 to 2022 in Billion Yuan (National Economic and Social Development Statistics Bulletin 2022）

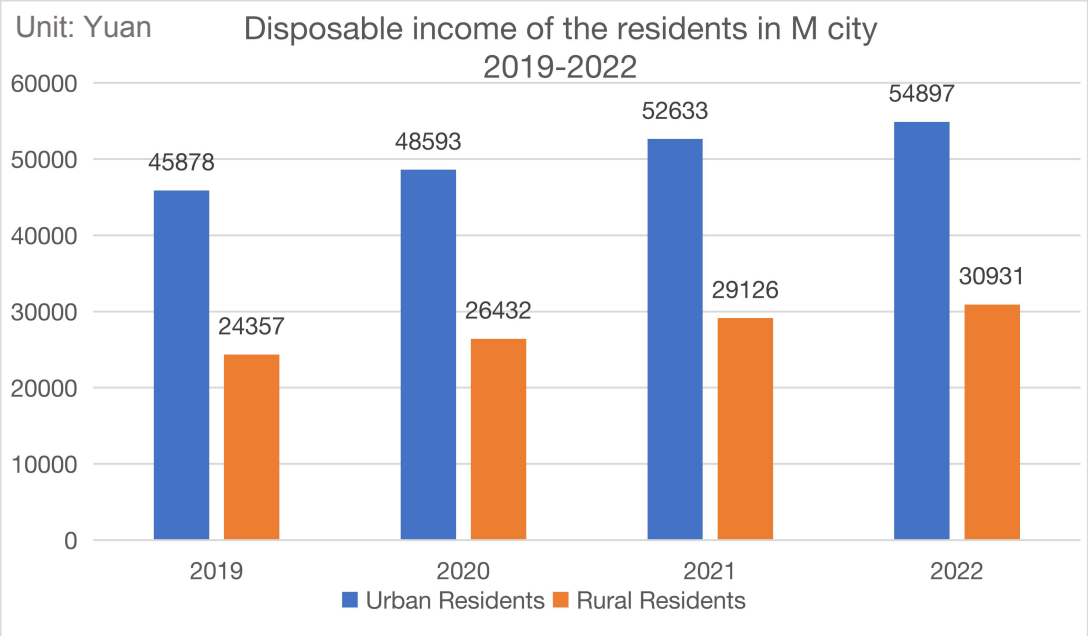


Chart 7. Disposable income of the residents in M City (National Economic and Social Development Statistics Bulletin 2022）

Society：

M is the provincial city of Sichuan province and also a famous leisure and tourism city in China. The interweaving of multiple political, economic, and cultural aspects in the past pushed this city to become highly inclusive. According to the data, M city's GDP accounts for one-third of the total province, the residents' consumption cost is relatively low, while the disposable capital is relatively abundant, so the residents' consumption potential is large. At the same time, due to the slow pace of enjoying life's consumption concept is deeply rooted in the people of M city, most of the citizens are emotional consumers, belonging to the impulse consumption mode, and the residents here prefer to entertain than to save all their money. Therefore, consumer spending in M is bigger than in other similar cities, and the marketing environment is quite famous in China.

Chart 8 below shows the consumption structure of urban residents in M City in 2022.

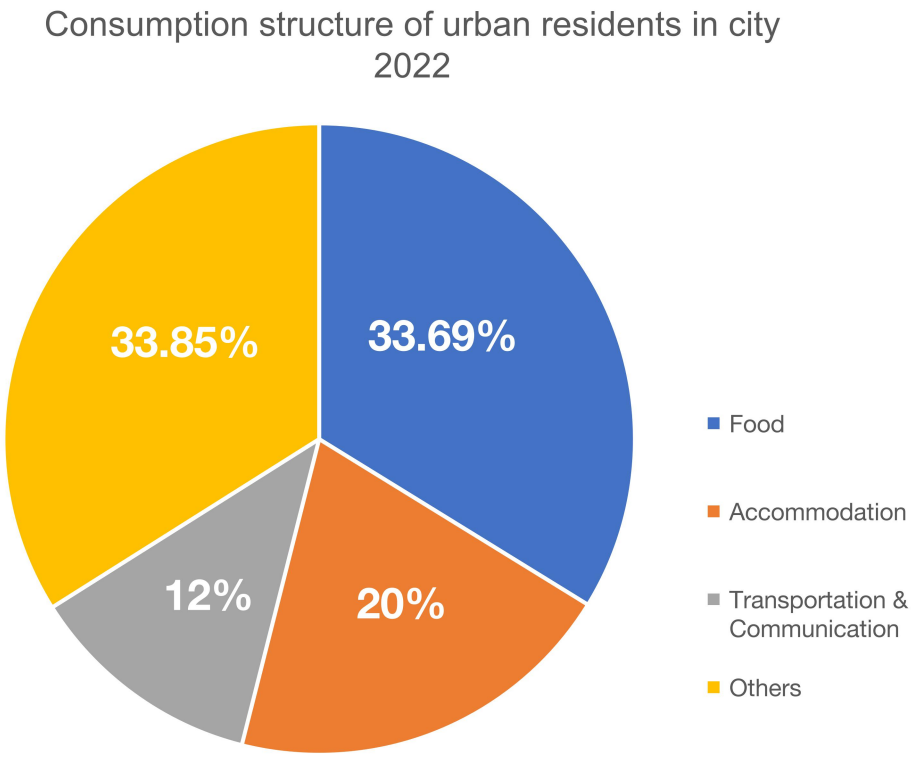


Chart 8. Consumption structure of urban residents in M City（adapted from State Statistics Bureau 2022）

Technology:

The development of cross-border e-commerce has provided important support for the air cargo business, and the mature development of various websites and software has provided great convenience for customers, while the further standardization of freight forwarders has greatly increased the capacity of the air cargo business. For airline companies, the development of big data has also helped them to quickly and accurately target and market to potential customers.

The epidemic has accelerated the digital transformation of air cargo, and the demand for cold chain transportation in air cargo has increased greatly. At present, China's air cargo industry gradually shows the trend of extending upstream and downstream of the industry chain, information development and increasing cooperation with the express industry, and the use of Internet of Things technology will become an inevitable part of the international development of China's air cargo. Referring to information technology such as barcodes, databases, and enterprise resource planning in foreign airports, continuously improving the information system of air logistics and combining it with a modern business model is the main direction of the future development of air cargo in China.

The emergence of new technologies will also change the business model of air logistics, such as the optimization of the cargo airline network, the gradual implementation of new hybrid, electric aircraft, and biofuel aircraft technology will greatly affect the development of air cargo, thus affecting the operation of air logistics parks. At the same time integrated airports and professional cargo airports related to the automation and intelligence of the equipment requirements are gradually increasing, not only the requirements of professional equipment is higher, but the layout of the air logistics park of the functional area, the degree of three-dimensional requirements are also higher. Because this is closely related to the operating costs.

As can be seen from the PEST analysis, the future external environment of SL international airport and SL aviation logistics park is optimistic, first is the policy leadership of national transportation and the deepening reform of the Chengdu-Chongqing economic circle, the second is that although the negative impact of the epidemic on the economy is heavy, China's current economic growth rate still maintains positive growth, the local economy of M city shows a rising trend in consumption, and people's consumption concept is avant-garde, which provides a favorable economic guarantee for SL international airport and aviation logistics park. Lastly, the technical development of air cargo has laid a good foundation for the transformation and upgrading of the SL air logistics park, and the development demand for air cold chain cargo may become the main development business direction of SL air logistics park in the future.

4.2 Internal Environment Analysis

The SWOT analysis tool will be used in this part which can be seen in Table 9.

Table 9. SWOT Analysis of SL Air Logistics Park

	Internal Factors	
	Strengths	**Weakness**
External Factors	1. Mature development and relatively complete infrastructure support in the logistics park. 2. Close to the city center, adjacent to the highway and railroad station. Multi-linkage distribution is convenient. 3. Numerous industrial parks around, strong upstream and downstream industrial base.	1. The development area of the park is limited and the expansion capacity is restricted. 2. Irrational layout of the park and blurred boundaries of functional areas. 3. Low utilization rate of park resources and duplication of logistics transportation routes.
Opportunities	**SO**	**WO**
1. Local policy support, the park introduced a series of preferential policies to attract all kinds of enterprises to the park. 2. High potential for future market demand for air cargo after the epidemic. 3. The implementation of the strategy of two airports in one city	1. Grasp relevant policies, make good use of resources, and attract potential investment enterprises 2. Strengthen the cooperation of multimodal transportation to achieve a win-win situation. 3. Utilize the existing resources around to achieve the integration of multiple industries	1. Determine the future business development potential and direction of the park. 2. Rationalize and optimize the current functional area of the aviation logistics park.
Threats	**ST**	**WT**
1. Intense competition in the air transportation market 2. Influence of other competitors 3. New airports have some degree of influence	1. Making good use of the advantages of the existing park's supporting facilities. 2. Find the future business development positioning of the park and form its own characteristics.	1. Optimize the existing layout of the logistics park and determine the future development direction. 2. Synergistic development with the new airport.

Through the analysis of external opportunities and threats and internal strengths and weaknesses of SL Air Logistics Park. It can be clearly understood that currently SL airport is the most well-equipped airport in western China in terms of hardware facilities and has a larger scale of international routes and good development prospects compared with other airports. Therefore, under the adjustment of local policies and the development strategy “ Two airports in one city," the development direction of SL International Airport is mainly to retain international air cargo routes and vigorously develop the air cargo business for future transformation and upgrading. Meanwhile, the logistics infrastructure in SL air logistics park and the supporting industries around the park are relatively mature, which provides a good guarantee for the future development of SL air logistics park. Through relevant information inquiry and collation, SL Aviation Logistics Park hopes to realize comprehensive development of SL area with the transformation of SL International Airport, introduce top international logistics integrators, and make intelligent transformation of existing warehouses. To create intelligent international logistics distribution warehouses and international transit warehouses to improve the efficiency of air cargo distribution. The cold chain transportation of air logistics during the epidemic brought development opportunities for SL International Airport and provided new ideas for the transformation and development of SL Air Logistics Park in the future.

However, due to the limitation of the current park area plus the possibility of changes in the development of the cargo business in the future, the author will use the SLP method next part to add a new cold chain cargo transportation business in SL Air Logistics Park as a hypothesis, which provides layout suggestions for the future development and transformation.

4.3 Application of System Layout Planning

4.3.1 Function Design

The functional area of the existing air logistics park in SL is relatively complete, but the subdivision of functional areas is still slightly unsatisfactory, so the author added the express cargo handling area, cold chain storage area, distribution processing area, and parking area on this basis to further refine the functional areas while adding the cold chain storage area to provide good basic support for the transformation of the air logistics park in the future.

The function of the Shipment processing area is that the air express cargo will be transported to the splitting area for sorting by professionals using trailers and other means of transportation upon arrival, then sent to the warehouse by the transportation belt, and finally transported out of the express cargo handling area through scanning machines and customs inspection. Therefore, the

customs inspection area will be adjusted in combination and arranged in the Shipment Processing area.

The purpose of the new Distribution and Processing area is to strengthen the connection between upstream and downstream enterprises in the park, improve the form of product transportation and create conditions for improving logistics efficiency, and its main function is the operation area responsible for undertaking the production and processing business of air cargo.

The new cold storage area is mainly responsible for the cold chain storage link in the airline cold chain logistics. It provides temporary storage service before the cargo is put on the plane, and because of the special cargo, the flow speed is also higher compared to other functional areas. This new functional area can help SL Air Logistics Park accelerate the establishment of a global biomedical supply chain system. Take advantage of the 5 designated regulatory sites for chilled aquatic products, fruits, meat, etc. to develop port trade.

Lastly, the parking area will be adjusted. At present, there is no separate parking area in SL Aviation Logistics Park, which leads to confusion about functional areas in the park, so the author will provide separate parking lots for cargo vehicles and employees in the logistics park.

4.3.2 Forecast of Cargo and mail volume

Using gray Model(1,1) to Predict future cargo and mail volume needs 4 elements, which will be shown below differently, Chart 10 SL International Cargo and Mail Throughput、Chart 11 Total GDP Value in M city、Chart 12 Gdp per capita in M city and Chart 13 Number of aircraft Landings and Take off at SL International Airport.

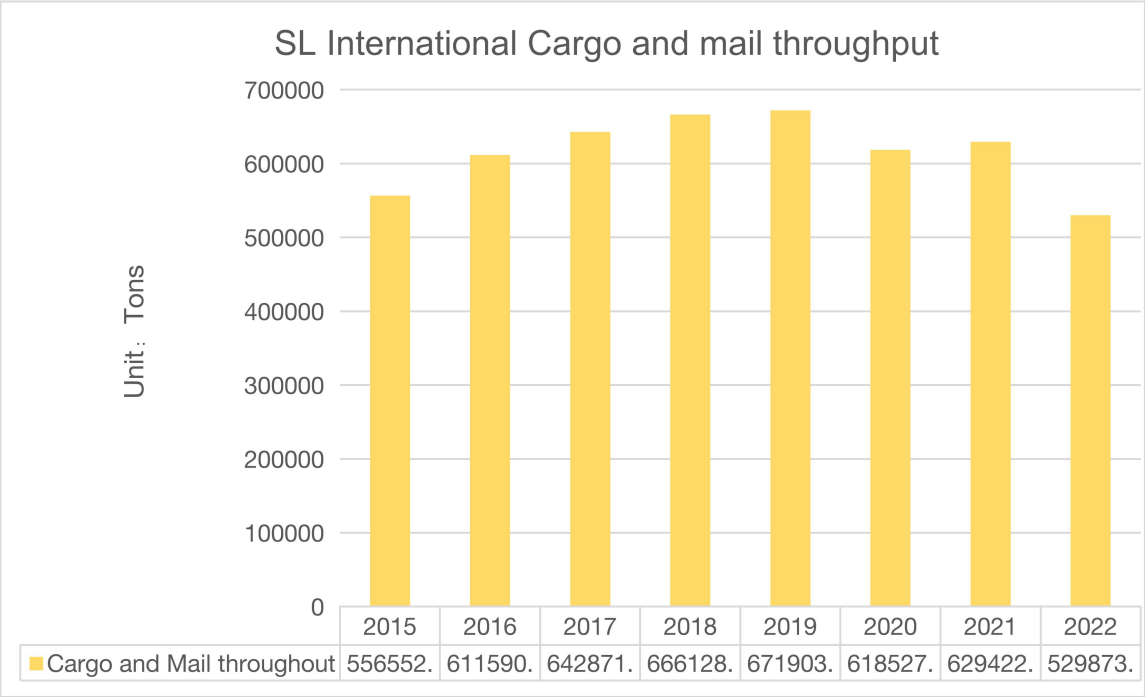


Chart 10. SL International Cargo and Mail Throughput (CAAC 2022)

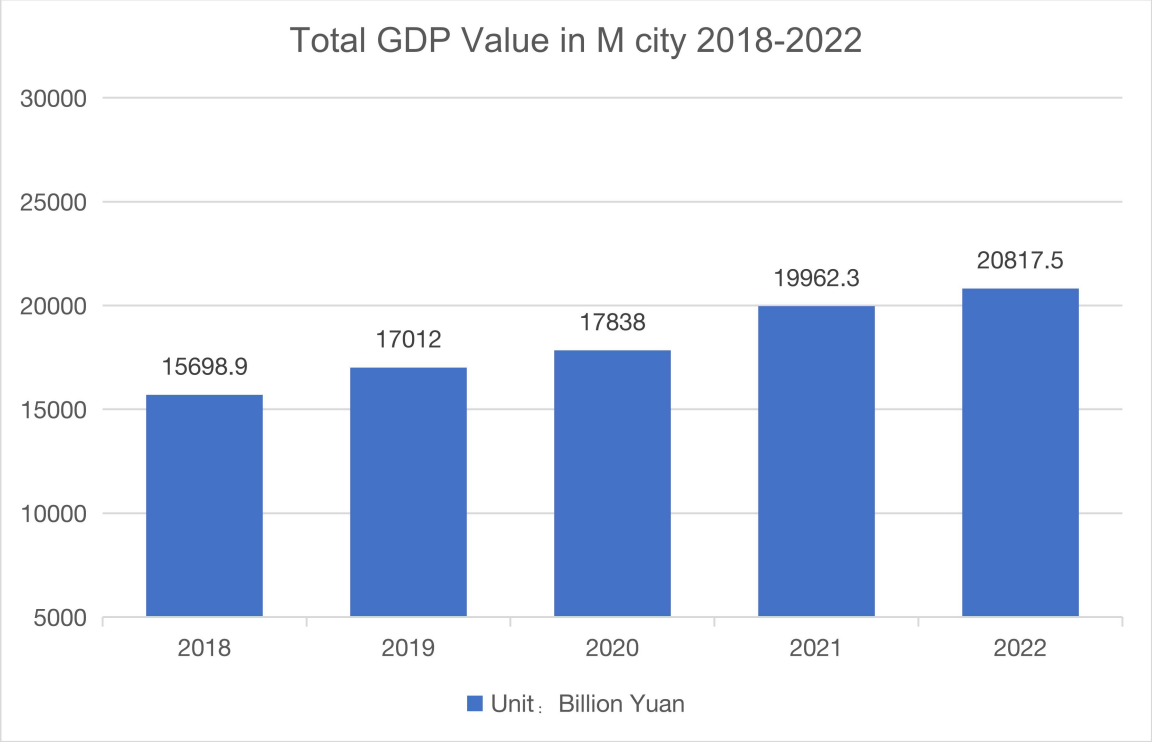


Chart 11. Total GDP Value in M city from 2018 to 2022 (adapted from National Economic and Social Development Statistics 2022）

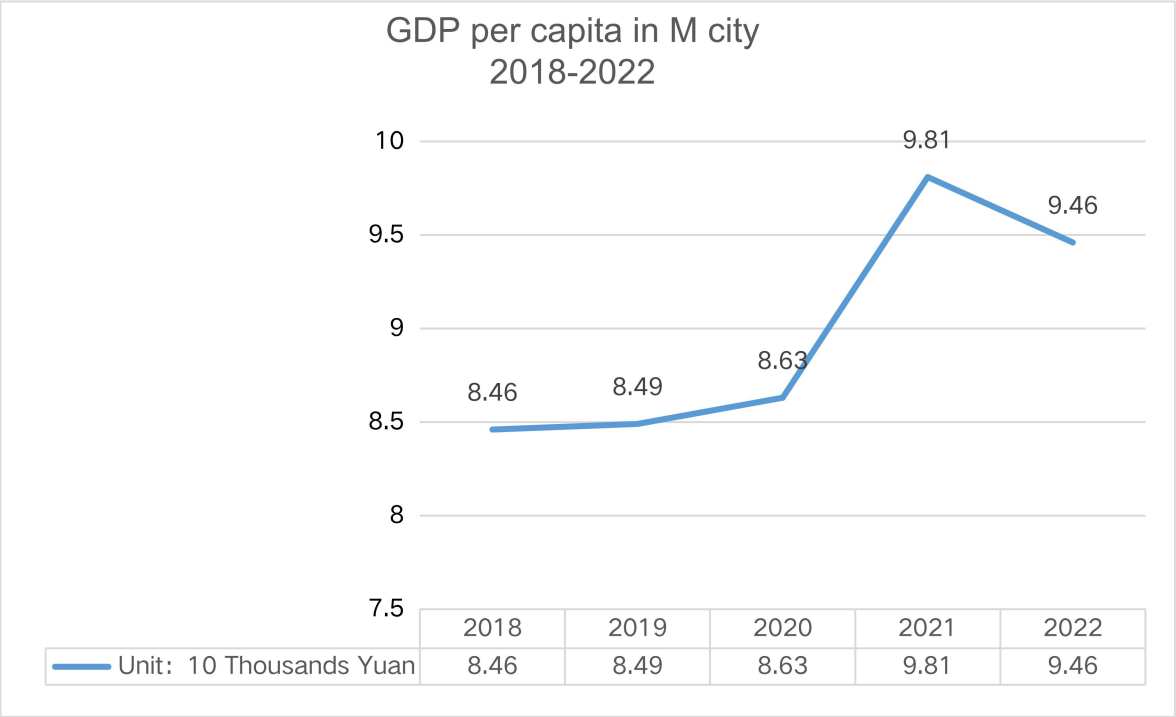


Chart 12: Gdp per capita in M city 2018-2022, Data from National Economic and Social Development Statistics Bulletin）

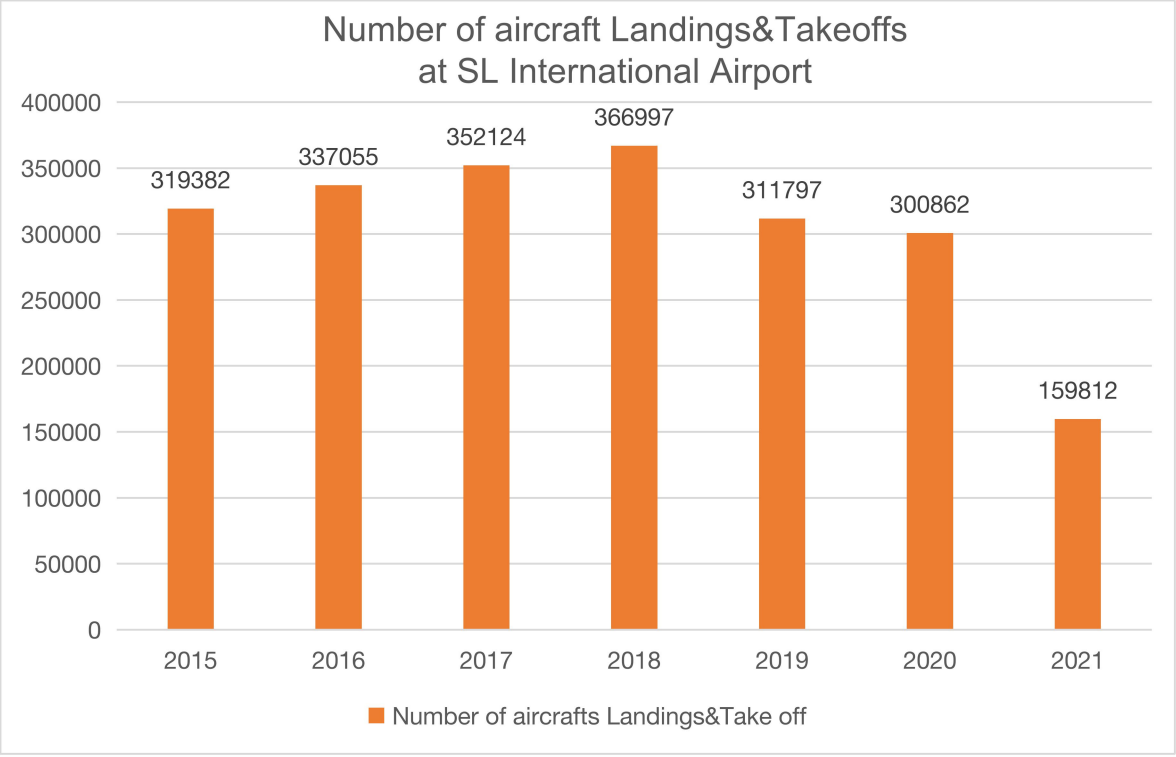


Chart 13. Number of aircraft Landings&Take off at SL International Airport (CAAC 2022)

Then GM(1,1) model is established by the above four elements, and the original data are transformed into a first-order cumulative generating series to estimate the linear trend by solving the differential equation. Since the specific calculation process is omitted with the help of relevant gray forecasting software, only code examples are shown below:

```python
import pygray

# Convert normalized data to a list

gdp = [100, 108.25, 113.6]

per_capita_gdp = [100, 105.26, 107.24]

takeoff_landing = [100, 108.71, 114.82]

air_mail_throughput = [100, 91.73, 115.51]

# Use the GM(1,1) model to build and forecast cargo and mail volumes for the next five years

model = pygray.GM()

model.fit(air_mail_throughput)

prediction = model.predict(steps=5)

prediction = [round(x * 629422.2 * 0.01, 2) for x in prediction]

# Output prediction results

print("The predicted value of cargo and mail volume for the next five years is:", prediction)
```

According to the above code, the forecasted value of cargo and mail volume for the next five years will be shown below in Table 14.

Table 14. Forecast Cargo and Mail Throughput in SL International Airport

Year	2023	2024	2025	2026	2027
Forecasted Cargo and Mail throughput (Unit: million tons)	53.83	54.13	55.87	57.44	58.47

Based on the results of the gray forecast method, it can be concluded that the cargo and mail volume of SL International Airport will maintain a relatively stable growth with little change in the next five years, partly because of the slow recovery of the epidemic, and partly because the second airport of M City will be officially opened in 2021, so the flights of SL International Airport are diverted and may not be able to return to the pre-epidemic data in a short time.

Therefore, in this paper, the forecasted total cargo and mail volume of 584,700 tons in 2027 will be selected as the basic reference data for the optimal layout of the SL air logistics park. According to 365 days a year, the average daily cargo and mail handling capacity is about 1602 tons. Cold chain cargo forecast is assumed to be 5% of the total daily forecast cargo volume. The following table 15 shows the composition of international and domestic cargo and mail volume of SL airport in recent years, the average ratio of these three years is 47%, but due to the adjustment of local policies, SL airport will focus on developing international cargo routes in the future, so here the forecast ratio of international and domestic cargo and mail in 2027 is according to 6:4. 351,000 tons of international cargo and mail volume and 234,000 tons of domestic cargo and mail volume.

Table15. SL International Airport International Domestic Air Cargo Ratio in 3 years (adapted from CAAC 2022)

Year	Cargo and mail throughput (unit: 10,000 tons)	Domestic	International	International ratio
2020	61	28	32.3	53%
2021	62.94	31.94	30.38	48%
2022	53.1	31	22.1	41%

4.3.3 Functional area logistics relationship analysis

In this section, the author will show the logistics flow from to table, logistics intensity map, non-logistics interrelationship, and final optimized layout map of each functional area by drawing relevant charts based on the basic data obtained from the gray forecast above.

(1) Analysis of logistics interrelationships in functional areas of SL Aviation Logistics Park:

First of all, according to the analysis, the flow of goods in the park is found to be about the following:

International goods of which 48% of the goods flow into the International Cargo area, 20% into the Bonded area, then 12% into the Distribution and processing area, 8% into the shipment processing area, and finally 10% into the International Sourcing Display area; Domestic goods of which 54% into the Domestic Cargo area, 24% into the Distribution and Processing area, and 20% into the Shipment Processing area. 100% of the cold chain goods enter the Shipment Processing area after inspection.

Then about 76% of the goods in the Bonded area enter the international Cargo area, and 22% enter the international display area. After inspection, 95% of cold chain goods from Shipment Processing enter the cold storage area.

Finally, 54% of the international goods in the Distribution and Processing area enter the International Sourcing Display area and 22% of the goods flow into the Bonded area; 56% of the goods in the Distribution and Processing flow into the domestic freight area and 76% of the goods in the international display area flow back to the International Sourcing Display area.

According to the above goods flow direction to draw the SL aviation logistics park functional area between the logistics flow, as shown in Table 16 below and a reference table of functional areas represented by each serial number is attached in appendices.

Table16. Logistics Flows Between Functional Areas From Table To in Tons

From \ To	1	2	3	4	5	6	7	8
1		0	192.24	115.34	76.9	96.12	0	0
2			0	371.66	256.32	0	0	0
3	146.1	0		25.37	0	42.3	0	0
4	62.28	0	25.37		0	0	0	0
5	0	0	0	0		0	80.1	0
6	32.15	0	0	0	0		0	0
7	0	0	0	0	76.1	0		0
8	0	0	0	0	0	0	0	

According to Table 17, the size of the flow of each functional area between logistics parks is divided into logistics intensity levels, from A to O, a total of five levels, where A represents the

largest proportion of goods in the park and the strongest logistics intensity, and E, I and O account for the largest proportion and intensity in decreasing order. As shown in Table 18.

Table17. Classification Table of Logistics Intensity

Functional area	The volume of material flow (tons)	Share of material	Strength Level
1——2		More than 20%	A
1——3		10%-20%	E
.....		5%-10%	I
.....		Less than 5%	O
.....		Negligible	U

The intensity level and logistics size among the functional areas of SL aviation logistics park are divided according to Table 17, as shown in Table 18.

Table18. Classification of Logistics Intensity Between Functional Area

Functional area flow direction	**The volume of material flow**	**Ratio(%)**	**Strength Level**
1➡3	192.24	12%	E
1➡5	115.34	7%	I
1➡4	256.32	15%	E
1➡6	96.12	5.70%	I
2➡5	371.66	22%	A
2➡4	256.32	15%	E
3➡1	146.1	8.70%	I
3➡6	42.3	2.50%	O
5➡6	62.28	3.70%	O
5➡3	25.37	1.50%	U
6➡1	32.15	1.90%	U
4➡7	76.1	4.60%	O

The final functional area intensity correlation Diagram 19 of the logistics park is drawn according to Table 18 which is as follows:

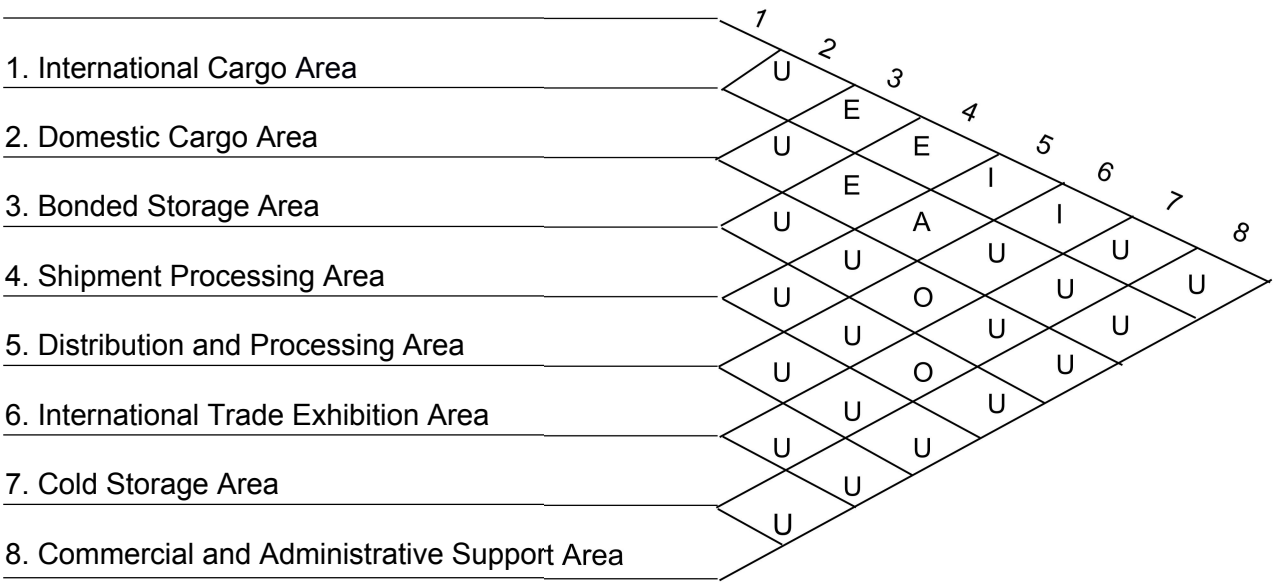


Diagram 19.Correlation Diagram of Logistic Strength in Logistics Park Planning Function area

(2) Analysis of non-logistics relationship in SL aviation logistics park functional area:

In the SLP method, non-logistic relationships are also important factors to be considered in the layout, for example, the environmental factors of the park can also affect the efficiency of freight handling. Therefore, the layout needs to determine the closeness between functional areas based on their logistic relevance, operational similarity, supervision and management, and other factors. The six aspects in Table 20 below are usually used as a reference for non-logistic relationships:

Table 20.Factors affecting the non-logistic relationship in functional areas

No.	Non-logistics relationship reasons
1	Logistics-related, continuity
2	The similarity of logistics operations
3	Frequency of logistics operations
4	Logistics handling
5	Supervision, management convenience
6	Environmental impact of noise, garbage, dust, etc.

Table 21.Classification of closeness between operating units

Mutual relationship closeness level symbol	Level Symbol Description	Score	Ratio
A	Important	4	2~5
E	Especially Important	3	3~10
I	Important	2	5~15
O	General	1	10~25
U	Unimportant	0	45~80
X	No approach	-1	\

Comprehensive mapping of non-logistics relationships for SL Aerophysical Park functional areas based on Tables 20 and 21, which can be seen from Diagram 22.

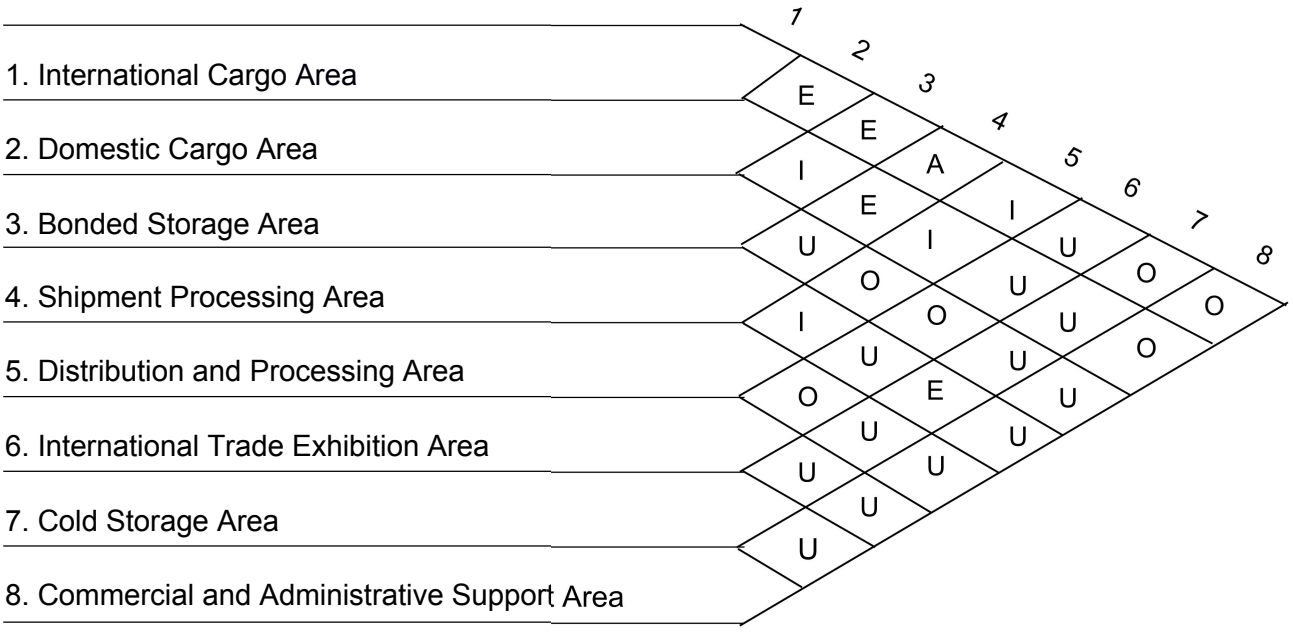


Diagram 22. Functional Area Non-Logistics Strength Correlation Diagram

(3) Analysis of Functional area comprehensive correlation:

The functional area logistics relationship intensity level of SL aviation logistics park is quantified from A, E, I, O, and U to 4, 3, 2, 1, 0, and -1 by five scoring levels. The following Table 23 SL aviation logistics park functional area comprehensive relationship value is obtained by comprehensive consideration and calculation.

Table 23. SL aviation logistics park functional area comprehensive relationship value

Functional area	Activity Relationship Score		Comprehensive relationship score	Functional area	Activity Relationship Score		Functional area
Flow direction	Logistics Relationship	Non-Logistics Relationship		Flow direction	Logistics Relationship	Non-Logistics Relationship	Flow direction
1——2	0	3	1.2	3——5	0	1	0.4
1——3	3	3	2.7	3——6	1	1	1
1——4	3	4	3.6	3——7	0	0	0
1——5	2	2	2	3——8	0	0	0
1——6	2	1	1.6	4——5	0	2	1
1——7	0	1	0.4	4——6	0	3	1.2
1——8	0	1	0.4	4——7	3	3	2.7
2——3	0	1	0.4	4——8	0	0	0
2——4	3	3	2.7	5——6	0	1	0.4
2——5	4	2	2.7	5——7	0	0	0
2——6	0	0	0	5——8	0	0	0
2——7	0	1	0.4	6——7	0	0	0
2——8	0	1	0.4	6——8	0	0	0
3——4	0	0	0	7——8	0	0	0

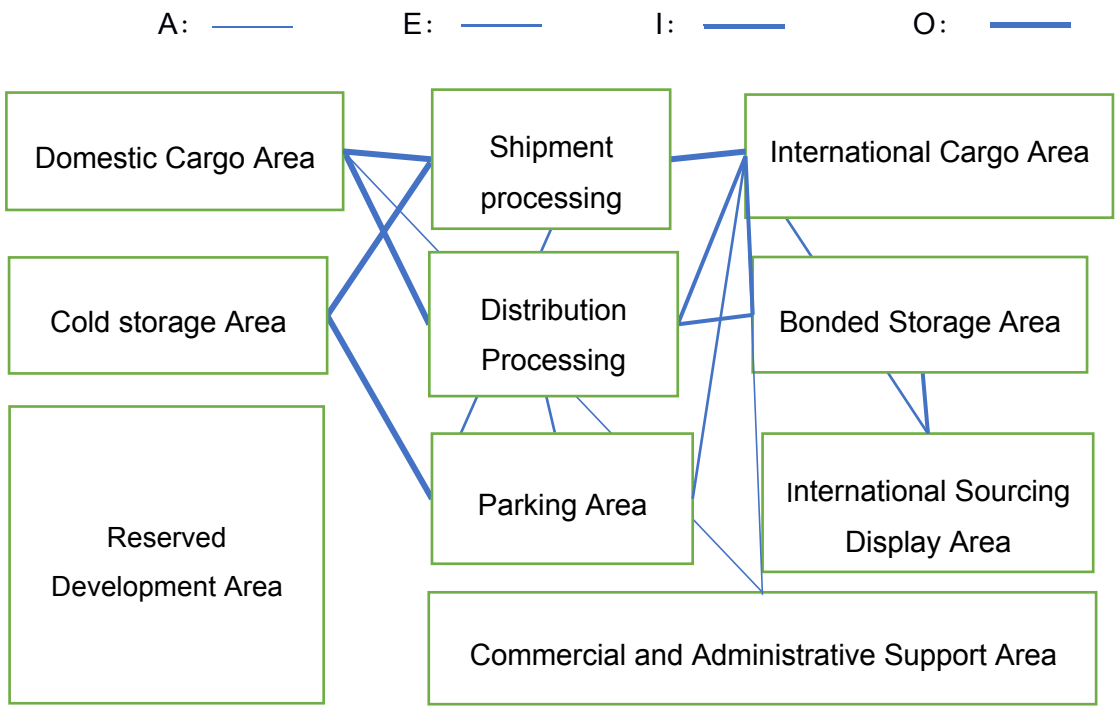
4.3.4 Functional area layout position determination

According to the layout planning principles and the above functional area logistics and non-logistics relationships and comprehensive logistics relationship analysis diagram, the order of functional area drawing is obtained, as shown in Table 24 below:

Table 24. Functional area mapping sequence

	1	2	3	4	5	6	7	8
1		I/2	A/4	E/3	E/4	I/2	E/3	O/1
2	I/2		E/3	E/3	E/4	U/0	O/1	O/1
3	A/4	E/3		I/2	O/1	E/3	U/0	U/0
4	E/3	A/4	E/3		I/2	O/1	I/2	U/0
5	E/3	E/3	U/1	E/3		U/0	A/4	U/0
6	I/2	I/2	I/2	O/1	U/0		U/0	O/1
7	E/3	I/2	I/2	U/0	E/3	U/0		X/-1
8	O/1	U/0	U/0	U/0	U/0	U/0	X/-1	
Accumulated points	18	16	15	12	14	6	9	2
Planning Sequence	1	2	3	5	4	7	6	8

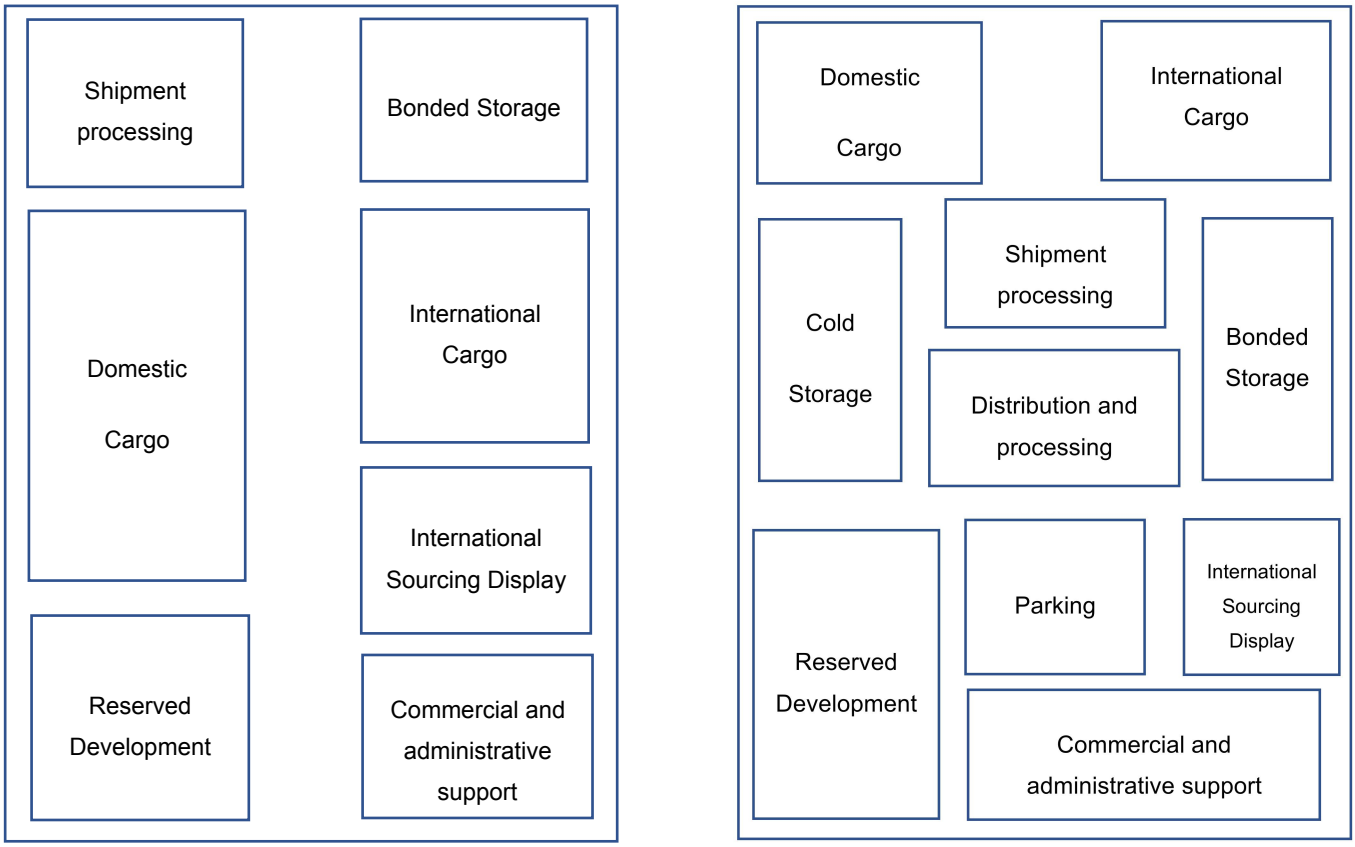
Then the layout location is roughly planned: As shown in map 25 below: (the thicker the connection line means the stronger the logistics intensity and the closer the functional areas come and go)



Map 25. SL aviation logistics park preliminary layout map location determined

4.4 Comparison before and after optimization

According to map 25, Then map 26 contrasts of SL Logistics Park layout before and after optimized as below.



Map26. SL Air Logistics Park layout contrast before and after optimization (Layout map before optimization adapted from Google map and details added in appendix)

The following improvements can be seen through the optimization of the layout of SL Air Logistics Park:

The Shipment Processing area is moved to the middle of the domestic cargo area and international cargo area, which better shortens the distance to the international cargo area and speeds up the efficiency of international cargo processing, Unnecessary detours in cargo transportation paths are avoided in this way. At the same time customs inspection work will also be carried out in this functional area.

The Bonded area is moved to the bottom of the international cargo area and directly enters the Bonded area after customs inspection in the Shipment Processing area, which reduces the

logistics moving distance compared with the pre-optimization, As the circulation between the International Sourcing Display center and the Bonded area is more frequent, so the International Sourcing Display center is adjusted to the bottom part of the Bonded area, and the circulation of goods between these two functional areas is more convenient.

To cater to the transformation and upgrading of SL Aviation Logistics Park, a new Distribution and Processing area for goods has been added. This initiative enables SL Air Logistics Park to carry out the extension of upstream and downstream logistics-related activities, where different types of subjects can provide value-added logistics activities, such as freight forwarders, logistics companies, etc. The addition of this functional area is conducive to enhancing the added value of goods and increasing the competitiveness and operating profit of the park.

The parking area is divided from the commercial supporting area. Before optimization, the parking area was included in the commercial supporting center, which would confuse the park's function, and at the same time, due to the operation and stopping of operation vehicles, the sound and dust pollution and other problems are more obvious, which is not conducive to the development of the commercial supporting area, so a separate parking area is set up here.

The new cold storage area is adjacent to the reserved development land, according to the future transformation direction of SL airport, it is known that SL airport is particularly outstanding in cold chain cargo transportation during the epidemic, and at the same time, due to the mature supporting commercial support around SL aviation logistics park, the future SL aviation logistics park will tend to develop aviation logistics cold chain cargo in the future, so the author refers to the relevant information of Shanghai Pudong airport cold storage. The author has added a new cold storage area adjacent to the reserved development area, which can be appropriately adjusted in the area according to the growth of business in the future.

4.5 Future business development possibilities for SL Air Logistics Park

Since the focus of this thesis is to optimize the layout of SL Air Logistics Park, so the author only suggests the future business development direction based on the previous analysis of the external and internal environment of SL Air Logistics Park.

According to the SWOT and PEST analysis, SL Air Logistics Park will support more airlines to put more all-cargo planes in SL International Airport in the future and innovate the business of "conversion of passenger planes to cargo planes", so this provides a good basis for the development of value-added business in SL Air Logistics Park. In addition, there is a strong market demand for cold chain air transportation in China, especially the surge in demand for vaccine

transportation during the epidemic. However, the overall aviation cold chain development in China is not perfect, so taking advantage of the new opportunity of air cargo transportation is an important opportunity for SL air logistics park to face transformation and upgrading. At the same time, SL comprehensive free trade area has been developing very well, and the biomedical cold chain is a very airworthy aviation product. If the cold storage in SL air logistics park is established successfully in the future, the future business of the park can focus on developing hub-type cold chain cargo transportation projects, which will highlight the characteristics of SL air logistics park, improve the competitiveness of the park business and create good social and economic benefits.

5 Discussion

The last chapter includes two parts, the author's expectation of the future development of SL Air Logistics Park and what she has learned during this research, and the aspects that can be further improved in future study.

5.1 Conclusion

This thesis takes SL Aviation Logistics Park as an example, based on the analysis of its current external development environment and internal strengths and weaknesses, under the development background of "one city, two airports" in M city and the adjustment of the government's positioning of SL International Airport, the layout of SL Aviation Logistics Park is optimized and adjusted to meet the transformation and development while developing its own core competitive business. core competitive business.

Through market analysis, it is known that SL International Airport will mainly develop cargo routes and domestic routes in the future, so this is undoubtedly a good development condition for the business development of SL Aviation Logistics Park. Therefore, the author combined the environment of SL aviation logistics park and the current layout of the aviation logistics park in the early stage for optimization and improvement. The SLP method is used to predict the future cargo and mail volume by using gray prediction software, and the daily cargo flow and direction of the park are analyzed with the cargo and mail volume as the basic data of the park, and the layout is rearranged according to the data. The author refines the confusion of the original functional areas and adds a cold storage area and a distribution processing area after comparing the current development of China's air logistics parks and the cold chain transportation in Shanghai Pudong Airport, and provide layout suggestions for future business development of SL air logistics park.

After the layout optimization, the functional areas of SL Aviation Logistics Park are more refined, and the connection of goods between each function is smoother and more efficient. At the same time, the new functional areas provide a favorable guarantee for increasing the added value of the park. The construction of hub-type cold chain warehousing and the vigorous development of cold chain cargo transportation can enable SL aviation logistics park to form its own characteristic competitiveness based on the transformation it is facing, and at the same time create good social and economic benefits and drive the simultaneous development of the surrounding upstream and downstream industries.

5.2 Own Learning

The author has gained a lot through this thesis project. One is the ability to discriminate between various information. The author repeatedly ensures that the information she obtains and the search channels are official and authoritative based on her access to a large amount of information and data. Secondly, she has enhanced her logical ability to make repeated deliberations and revisions in the written narrative. Thirdly, personal learning ability is also enhanced, such as the professional methods required in this thesis, which the author spent a lot of time studying and researching.

It is hoped that the research in this thesis can help provide a useful reference for the future development direction and layout optimization of SL air logistics park. Due to the limited ability of the author, there are still some aspects that can be improved better, such as the complexity of the SLP method and the actual operation of the park may not be the same. Since logistics park is a large category, the author needs to consider very carefully, only considering the design of the functional areas is not enough, the roads、waters、and other complex situations also need to be included in the park planning, which is also insufficient of this paper. And the author suggested the direction of optimizing the layout based on the environmental analysis, which is somewhat subjective. In the future, the author will continue to explore the field of aviation business as well as logistics management. Continuously improve her personal learning ability.

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Appendices

Appendix 1. Map of SL Air Logistics Park layout before optimization from Google Map.

Appendix 2. Reference table of the functional area represented by the serial number.

Serial No.	Functional Area
1	International Cargo Area
2	Domestic Cargo Area
3	Bonded Storage Area
4	Shipment Processing Area
5	Distribution and Processing Area
6	International Trade Exhibition Area
7	Cold Storage Area
8	Commercial and Administrative Support Area