International Journal of Global Economics and Management
ISSN: 3005-9690 (Print), ISSN: 3005-8090 (Online) | Volume 10, Number 3, Year 2026
DOI: https://doi.org/10.62051/ijgem.v10n3.17
Journal homepage: https://ijgem.org

A Study on the Optimization of Company K's Finished Goods Warehouse Layout Based on SLP

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ABSTRACT

With intensifying market competition and rising logistics costs, warehouse layout optimization has become a critical factor for manufacturing enterprises to improve operational efficiency. This paper takes the finished goods warehouse of Company K, a garment manufacturer, as its research subject. Addressing issues such as low operational efficiency, circuitous handling routes, and insufficient equipment utilization, the study proposes a warehouse layout optimization method that integrates System Layout Planning (SLP) with Flexsim simulation. The study first analyzed the operational processes and current status of functional zones in the finished goods warehouse through on-site research, clarifying the interrelationships between logistics and non-logistics factors. Second, the SLP method was employed to quantitatively assess the logistics intensity and non-logistics associations between functional zones, establishing a comprehensive relationship analysis model to generate two optimized layout schemes. Finally, a three-dimensional dynamic model was constructed using the Flexsim simulation platform to compare and validate the original and optimized layouts across four dimensions: handling distance, logistics throughput, equipment utilization, and operation cycle. Simulation results indicate that the optimized Scheme 2 demonstrates significant improvements over the original scheme across key metrics: total handling distance was reduced by 25.2%, outbound volume per unit time increased by 20.3%, forklift utilization decreased by 21.8%, and overall operational efficiency improved by 21.8%. This study not only provides Company K with a practical warehouse optimization solution but also offers a methodological reference for warehouse layout optimization in similar manufacturing enterprises, validating the practical value of combining SLP with discrete-event simulation in the field of facility planning.

KEYWORDS

SLP; Finished goods warehouse; Layout optimization; Simulation

1. INTRODUCTION

Against the backdrop of increasingly fierce competition in the apparel manufacturing industry, supply chain efficiency has become a key factor for enterprises to enhance market responsiveness and reduce operational costs. As the core hub connecting production and sales, the rationality of a finished goods warehouse layout directly impacts warehousing operational efficiency, logistics costs, and order delivery speed. However, warehouse management in many apparel enterprises still relies on traditional experience and lacks scientific planning methods, leading to issues such as insufficient space utilization, redundant picking paths, and low inbound and outbound efficiency. Systematic Layout Planning (SLP), as a classic facility planning method, provides a scientific basis for warehouse layout optimization by systematically analyzing the relationships between logistics and non-logistics factors. In recent years, it has been successfully applied in various industries, including apparel, electronics, and automotive.

Scholars both domestically and internationally have accumulated extensive research findings on layout issues. I. F. Febriandini et al. used the SLP method to redesign the facility layout of Biopro Cosmeceutical's corporate warehouse, effectively reducing its material handling costs. Zhang Hui et al. analyzed the characteristics of processing workshops in small and micro-enterprises using the SLP method. They then simulated the original workshop layout in Flexsim simulation software and, by integrating simulation data with the SLP method, determined the optimal workshop layout scheme [1]. Zhou Tingmei et al. addressed layout inefficiencies and congestion issues at a certain automobile manufacturer's parts distribution center. They redesigned the distribution center using the SLP method, achieving both economic and functional effectiveness, and derived the optimal layout scheme based on actual conditions [2]. Zhao Feng et al. analyzed logistics factors such as customer traffic in supermarkets and employed the System Layout Planning (SLP) method to conduct [3]. Liu Jiayin et al. proposed a new method to optimize the functional zone layout of a warehouse. Building upon traditional SLP analysis, they employed a two-stage optimization approach combining genetic algorithms and simulation methods. This method comprehensively considered computational efficiency and solution quality, avoided human interference, and balanced computational efficiency, ultimately deriving the optimal layout scheme [4]. Que L analyzed the current status of warehouse operations at JD.com's Huizhou Logistics Center and proposed corresponding optimization schemes. Finally, Flexsim software was used to simulate and evaluate the effectiveness of the warehouse operations before and after optimization. Wang H et al. utilized Flexsim and a greedy algorithm to simulate and optimize the operational processes of a medical company. They analyzed data before and after optimization to achieve lean management across the entire medical supply chain. Tao Wangze conducted on-site research at a company's warehouse and developed a layout plan based on existing warehouse data and drawings; he also used Flexsim to simulate the operation of the new plan to ensure its feasibility [5]. As can be seen, early research primarily focused on the application of SLP methods for layout optimization in warehouse workshops, but in recent years, it has gradually extended to the logistics and warehousing sector, incorporating simulation technology to verify the feasibility of solutions.However, existing research is largely concentrated on retail distribution centers or e- commerce warehouses, with relatively few case studies targeting finished goods warehouses in apparel enterprises. In particular, there is a lack of targeted analysis addressing the characteristics of multi-category, high-turnover operations. Furthermore, research on the cost-benefit ratio of SLP optimization schemes during actual operation remains insufficient, making it difficult to provide precise guidance for corporate decision-making.

Company K is a large enterprise specializing in the research, development, production, and sales of high-quality intimate apparel and related products. It owns more than 20 wholly-owned subsidiaries and over 300 branch offices, including four national high-tech enterprises. Since its establishment in 1994, Company K has undergone three strategic restructurings and has grown into an industry-leading enterprise with a workforce of nearly 10,000 employees. However, as its business continues to expand, operational pressures on its finished goods warehouse have become increasingly evident. The current warehouse layout presents issues regarding operational efficiency, circuitous routes, and forklift utilization, making it difficult to meet order demands during peak seasons.Particularly under a high-frequency, multi-batch shipping model, manual picking takes too long and error rates are rising, directly impacting customer satisfaction. Although the company has attempted to introduce an information management system, overall efficiency improvements have been limited because the physical layout of the warehouse has not been optimized simultaneously. Therefore, the company urgently needs to utilize scientific methods to systematically restructure the layout of its finished goods warehouse. This paper takes Company K's finished goods warehouse as its research subject and conducts a systematic optimization of its layout based on the SLP method. Through on-site surveys, key data such as logistics volume and operational workflows were collected. The ABC inventory classification method and EIQ analysis were used to determine the interdependence of warehouse functional zones, thereby generating an optimized layout plan. FlexSim simulation was then employed to compare pre- and post-optimization metrics such as logistics throughput and handling distances. By integrating these findings with Company K's specific circumstances, this study provides a practical layout optimization plan for Company K and offers valuable insights for the layout optimization of finished goods warehousesin similar enterprises.

2. ANALYSIS OF THE CURRENT STATUS AND ISSUES OF COMPANY K'S FINISHED GOODS WAREHOUSE

2.1. Introduction to Company K and Its Finished Goods Warehouse

Founded in 2010, Company K is an enterprise positioned as an "Internet+Cross-Border Trade" business, with operations the two core sectors of cross-border e-commerce exports and imports. It has established offices in Shenzhen, HongKong, Guangzhou, Hangzhou, as well as in the UK, the US, Germany, and other countries and regions, with a total global warehouse area exceeding 200,000 square meters, and its business extensively covers more than 100 countries and regions worldwide. In terms of export operations, the company primarily utilizes the B2C model through over 300 established stores on well-known third-party international platforms such as eBay, Amazon, Wish, and AliExpress to sell a vast array of high-quality Chinese products directly to overseas consumers. Product categories include drone parts, electronics and components, toys, outdoor gear, tools, jewelry, and more. The market coverage spans North America, Europe, Southeast Asia, and other regions, with active expansion into emerging markets. The import business operates under thecore brand "Dolphin Supply Chain." Since its establishment in 2015, it has provided cross- border e-commerce enterprises with end-to-end services—from authentic product sourcing, overseas warehousing, and consolidated shipping to bonded warehousing—through B2B and B2B2C models. Focusing on categories such as maternal and infant products and cosmetics, the company has secured hundreds of brand authorizations from over a hundred first- and second-tier brands in Europe, the Americas, and Australia. It has partnered with more than 10,00 B2B clients, including JD.com, Vipshop, Miyi, and Xiaohongshu, processing over 200,000 orders daily, and has become a highly influential supply chain brand in the cross-border import B2B sector. As market demand continues to expand, the internal transportation efficiency of Warehouse K must be improved in tandem to meet order fulfillment requirements. Therefore, optimizing the layout of K Company's warehouse and enhancing internal operational efficiency have become critical issues that need to be addressed urgently.

This article takes a finished goods warehouse at Company K as an example. Located within the industrial park of on of Company K's manufacturing facilities, the warehouse covers a total area of approximately 13,500 square meters and is managed by the park's warehousing and logistics department, creating a spatial layout that closely integrates production and warehousing. The core operations of this finished goods warehouse revolve around both online and offline channels. On one hand, it must accurately execute the processes of picking, verifying, and shipping goods based on customer orders received from various e-commerce platforms to support the company's online retail operations; on the other hand, by monitoring real-time sales data from offline stores through the system and combining this with inventory alert mechanisms, it proactively conducts replenishment picking to ensure a stable supply of goods to retail outlets. The warehouse features a single- story flat-floor structure, with the storage area primarily divided into two functional zones: a standard storage area equipped with five-tier shelving, and an automated high-bay warehouse area. Due to the diverse range of apparel products and the massive inventory volume within the warehouse, strict zoning standards are enforced during goods intake: standardized goods whose packaging boxes do not extend more than one centimeter beyond the edges of the pallet are prioritized for allocation to the automated high-bay warehouse; conversely, irregularly shaped, oversized, or extra-long packaging boxes are uniformly stored in the flat- storage area, where manual assistance is used to meet the storage needs of goods with special shapes.

Although this zoned storage model effectively balances the efficient management of standardized goods with the provision of suitable storage space for irregularly shaped items, the zoning standards lack flexibility, making it difficult to adapt to changes in goods' shapes or short-term fluctuations in demand. Additionally, there is a disconnect in information flow and operational coordination between the automated high-bay warehouse and the manual flat-storage area, which may reduce overall warehouse efficiency.

2.2. Layout and Problem Analysis of Company K's Finished Goods Warehouse

2.2.1. Layout of Company K's Finished Goods Warehouse

Company K's finished goods warehouse is located in the northeastern part of the Jinhua plant. It is a two- story, enclosed warehouse oriented east-west, with a rectangular layout measuring 180 meters in length and 75 meters in width, covering a total area of approximately 22,000 square meters. Of this, the finished goods storage area covers approximately 13,500 square meters. The warehouse's primary functional zones are concentrated on the first floor, comprising nine areas: the receiving area, automated storage and retrieval system (AS/RS), packaging materials storage area, returns area, packaging area, temporary pallet storage area, flat-storage area, shipping area, and break room. The specific layout of the finished goods warehouse is shown in Figure 1.

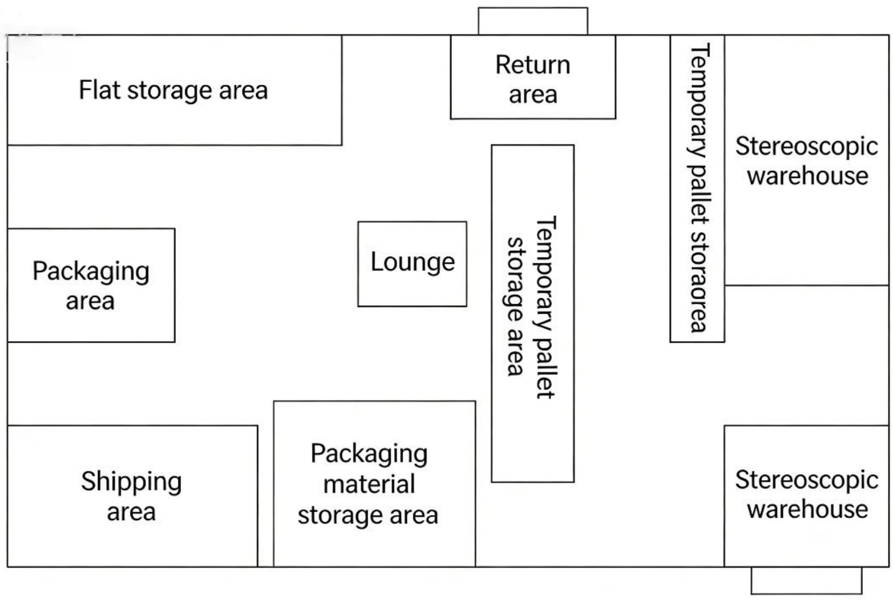

Figure 1. Initial Layout of Company K's Finished Goods Warehouse

Different functional zones have distinct responsibilities, with their specific functions outlined in Table 1.

Table 1. Functional Area Responsibilities

Name	Function
Flat-Packed Storage Area	Storage of irregularly shaped, extra-wide, or e xtra-long
non-standard packaging boxes Returns Area	Temporary storage of returned goods
Packaging Materials Storage Area	Storage of various materials used for
packaging goods Automated Storage and Retrieval System (AS/RS)	Storage area for standardized goods with regular shapes
Break room	Finished Goods Warehouse Staff break area
Packaging Area	Packing goods ordered by customers
Temporary storage area for pallets	Storage of various types of pallets
Inbound Area	Unloading and temporary storage of goods delivered by suppliers; goods are put into inventory after passing inspection
Outbound Area	Temporary storage of goods ordered by customers and from various stores

2.2.2. Analysis of Layout Issues in Company K's Finished Goods Warehouse

(1) Low Operational Efficiency

Currently, the layout of the finished goods warehouse lacks scientific planning. Under the current layout, the distance between the Inbound Area and the automated storage and retrieval system (AS/RS) and the flat-storage areas is too long, resulting in poor operational flow. After goods arrive at the Inbound Area, they require multiple forklift transfers and handling before reaching the storage areas, adding unnecessary movement steps within the warehouse. The packaging area and packaging material storage area are scattered across different parts of the warehouse and are obstructed by the temporary pallet storage area in between. When packaging operations require retrieving goods from the storage area, staff must frequently detour back and forth between distant zones, thereby slowing down the overall workflow. The temporary pallet storage area is not closely integrated with the storage and picking processes. This makes it difficult to promptly match available pallets when shelving goods, and picking operations also require extra time to locate suitable pallets, furtherr reducing the efficiency of goods receiving and shipping. The traffic flow in the shipping area intersects with that of the storage and packing areas. During peakorder shipping periods,material handling vehicle sand personnel interfere with the flow of people and goods involved in storage, picking, and packing operations, causing congestion in the shipping area and slowing down the handover and dispatch of goods. Overall, the current layout fails to establish an efficient closed-loop workflow following the "receiving-storage-picking-packing-shipping" process. The spatial connections between stages are awkward, and functional coordination is insufficient. Deficiencies in the spatial layout result in additional time consumption and interference across all processes, ultimately hindering improvements in the finished goods warehouse's operational efficiency.

(2) Circumventing Work Routes

The current layout of the finished goods warehouse suffers from circuitous operational routes in multiple stages. First, although the receiving area is adjacent to the automated storage and retrieval system (AS/RS), the flat-storage area is located diagonally across from the receiving area. After goods are temporarily stored in the AS/RS from the receiving area, if they need to be transferred to the flat-storage area, they must detour around the temporary pallet storage area and the packaging material storage area, crossing through the center of the warehouse, which significantly increases unnecessary travel distance;Second, the returns area is located on the north side of the warehouse. After processing returns, goods must be re-stocked, requiring a trip across the packaging materials storage area and the temporary pallet storage area to reach the south side, and then transported from the receiving area to the storage area—effectively doubling the distance traveled; Third, the packaging materials storage area is separated from the packaging zone. When retrieving materials for packaging, staff must transport them from the center of the warehouse to the opposite end, which is not only time-consuming and labor-intensive but also adds unnecessary movement; Fourth, although the shipping area is adjacent to the ground-level storage zone, its pathways intersect with those of the automated storage and retrieval system (AS/RS) and the packaging area. After picking, goods are sent to the shipping area, where efficiency is easily compromised by path congestion or detours.

(3) High Forklift Idle Time

Company K's finished goods warehouse is equipped with six forklifts for transporting goods. Due to the nature of the apparel industry, logistics operations are subject to uncertainty, with the arrival times of freight vehicles being randomly distributed, making it difficult to predict daily arrival times; furthermore, outbound operations rely on the warehouse management system to receive customer ordersand store restocking instructions before picking and shipping can begin. To enable simultaneous in-warehouse and out-of-warehouse operations and ensure overall efficiency in goods receipt and dispatch, Company K adopted a simple equipment resource allocation strategy: dividing the six forklifts into two equal groups, with three groups assigned to inbound operations outside the warehouse and three groups to outbound operations inside the warehouse. However, the diversity of styles and packaging formats for finished apparel inherently increases the complexity of route planning for goods handling. When peak operational periods overlap, forklifts handling inbound operations outside the warehouse in the unloading area and those handling outbound operations inside the warehouse in the picking aisles and shipping preparation areas are prone to conflicting movement paths.This leads to situations such as idle waiting and unnecessary detours for forklifts, resulting in a significant increase in the proportion of empty-load operations. The equipment utilization efficiency that Company K originally hoped to improve through the parallel operation model has, instead, resulted in a decrease in overall forklift operational efficiency due to the irrational planning of operational routes, thereby negatively impacting the efficiency of goods receiving and shipping operations.

3. ANALYSIS DESIGN OF THE LAYOUT OPTIMIZATION PLAN FOR COMPANY K'S FINISHED GOODS WAREHOUSE

3.1. Functional Relationship Analysis

3.1.1. Logistics Relationship Analysis

Analyzing the logistics intensity between different functional zones in the finished goods warehouse is a core task in the SLP process; at the same time, logistics intensity serves as a key reference indicator in the floor plan optimization process [6].In this paper, based on the different functional zones within the finished goods warehouse, each zone isnumbered sequentially from1to6 in the order of receiving area, automated storage and retrieval system (AS/RS) area, flat-storage area, packaging area, returns area, and shipping area. Using the logistics volume between each functional zone and the movement distances between them, obtained from a field survey at Company K, the product of these values is calculated to derive the logistics intensity between each pair of zones, as shown in Table 2.

Table 2. Economic Data Statistics

Functional Zone	1	2	3	4	5	6
1		595056	244464	4788		
2					132030	
3					236448	
4						
5						368478
6						

Using the SLP method for analysis, the logistics intensity levels between functional zones in the finished goods warehouse are classified into five grades—A, E, I, O, and U—in descending order of intensity. The logistics intensity classification table is shown in Table 3.

Table 3. Logistics Intensity Classification Table

Symbol	Logistics Intensity Grade	Proportion of Logistics Volume (%)	Grade Value
A	Extremely High Logistics Intensity	40	4
E	Very high logistics intensity	30	3
I	Moderate logistics intensity	20	2
O	Moderate logistics intensity	10	1
U	Negligible handling	0	0

Based on the logistics intensity classification table,ananalysisandsummarywere conductedby combining the logistics volume intensity between the various functional zonesofthe finished goods warehouse. Thisyieldedtheproportion of logistics intensity between each functional zone, resulting in the logistics intensity analysis table shown in Table 4.

Table 4. Logistics Intensity Classification Table

Functional Area	Logistics Volume	Transportation Distance	Logistics Intensity	Intensity Grade
1-2	3234	184	595056	A
1-3	2778	88	244464	I
1-4	38	126	4788	U
2-5	2934	45	132030	O
3-5	2463	96	236448	I
5-6	5397	124	368478	E

Based on the logistics intensity between functional areas shown in Table 4, the logistics relationship map is shown in Figure 2

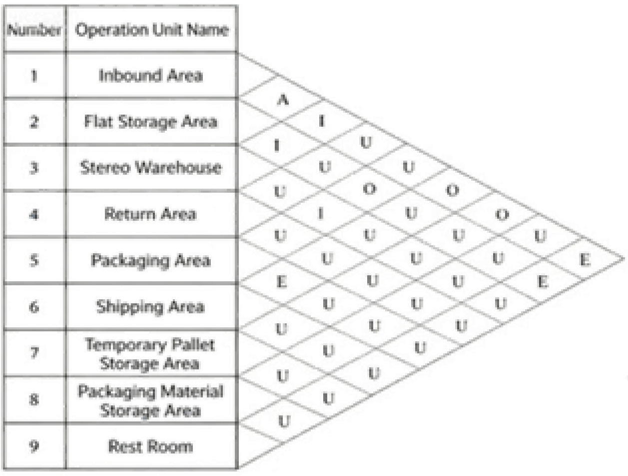

Figure 2. Crossref Logo

3.1.2. Analysis of Non-Logistics Relationships

Non-logistics relationships between functional areas generally include the continuity of operational processes, the closeness of personnel interactions, equipment, safety of the work environment, convenience of supervision and management, and accurate information transmission. These factors cannot be overlooked in the analysis process [7]. This paper analyzes the characteristics of operations and layout in Company K's finished goods warehouse and derives the table of non-logistics relationship influencing factors shown below.

Table 5. Table of Non-Logistics Relationship Influencing Factors

No.	Factors Influencing Non-LogisticalRelationships	No.	Non-Logistics RelationshipInfluence Factor
1	Continuity of Operations	4	Workplace Safety
2	Level of Interaction Among Staff	5	Ease of Supervision and
3	Relevance of equipment	6	Management Accurate Transmission of Information

The classification of non-logistics relationship closeness shares similar characteristics with that of logistics relationship strength, generally divided into six levels: AE, I, O, U, and X. Analysis of Company K's finished goods warehouse reveals its non-logistics relationship strength levels as shown in Table 6.

Table 6. Table of Non-Logistics Relationship Influencing Factors

No.	Non-Logistics Grade	Score	Percentage
A	Absolutely Critical	4	2%–5%
E	Very	3	3%–10%
I	important Fairly	2	5%–15%
O	important Moderately	1	15%–30%
U	Important No effect	0	45%–80%
X	Negative significance	-1	As needed

By analyzing the factors influencing non-logistical relationships in Table 5, this paper evaluates the non-logistical relationships between functional zones within Company K's finished goods warehouse. Using the criteria in Table 6, these relationships are further classified by strength, and a diagram illustrating the non- logistical connections between functional zones is presented in Figure 3, and plotted a diagram of thenon-logistical relationships between the various functional zones, as shown in Figure 3.

Figure 3. Crossref Logo

3.1.3. Comprehensive Relationship Analysis

When conducting comprehensive analysis, it is essential to consider the relative importance of logistics-related and non-logistics relationships. Based on the actual conditions of Company K's finished product warehouse, this study concludes that logistics relationships hold greater significance compared to non-logistics relationships, thus establishing a weighting ratio of 2:1 between them [8]. The hierarchical levels A-X for logistics and non-logistics relationships are quantified sequentially from 4 to-1. The comprehensive relationship importance between two operational units is then calculated using the formula $SR_{ij}=bMR_{ij}+dNR_{ij}$, where SR_{ij} represents the comprehensive relationship score, MR_{ij} denotes the logistics interaction level score between functional zones, and NR_{ij} indicates the non-logistics interaction level score. Finally, relevant data for logistics and non-logistics relationships are categorized into six relationship levels: A, E, I, O, U, and X, with comprehensive relationship intensity levels presented in Table 7.

Table 7. Comprehensive Relationship Strength Rating Table

Intensity Level	Symbol	Value
Absolutely Necessary Proximity	A	9–12
Very important, close	E	6–8
Important, approaching	I	2–5
Generally Important Proximity	O	1
Not important, close	U	0
Do not want to get close	X	-1

Based on the calculated comprehensive relationship scores between each functional area, the level of closeness of their comprehensive relationships is determined, and finally, a comprehensive relationship diagram of the functional areas within Company K's finished goods warehouse is generated, as shown in Figure 4.

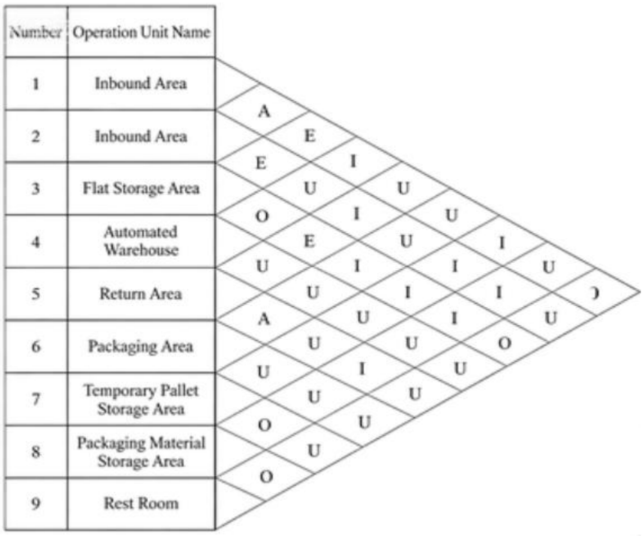

Figure 4. Comprehensive Relationship Diagram

3.1.4. Functional Area Location Diagram

First, calculate the comprehensive proximity score for each functional area. For functional areas with equivalent relationship levels, priority should be given to those with higher proximity scores [9]. During mapping, note that grades A and E indicate high inter-area proximity, requiring them to be plotted first. Next, apply the same method to delineate the I proximity level. Finally, determine the O proximity level based on the number of operational units between them and the complexity of line connections. The quantity of lines can represent proximity intensity—more lines signify closer relationships, while fewer indicate weaker connections. The resulting position correlation map for functional areas in the finished warehouse is shown in Figure 5.

Table 8. Comprehensive Proximity Score Table for Functional Zones

Functional Area	1	2	3	4	5	6	7	8	9
1		A-4	E-3	I-2	U	U	I-2	U	I-2
2	A-4		U	U	I-2	U	I-2	I-2	U
3	E-3	U		0-1	E-3	I-2	I-2	I-2	U
4	I-2	U	O-1		U	U	U	U	U
5	U	I-2	E-3	U		A-4	U	I-2	U
6	U	U	I-2	U	A-4		U	U	U
7	I-2	I-2	I-2	U	U	U		U	U
8	U	I-2	I-2	U	I-2	U	U		U
9	I-2	U	U	U	U	U	U	U	
Overall Proximity	13	10	13	3	11	6	6	6	2

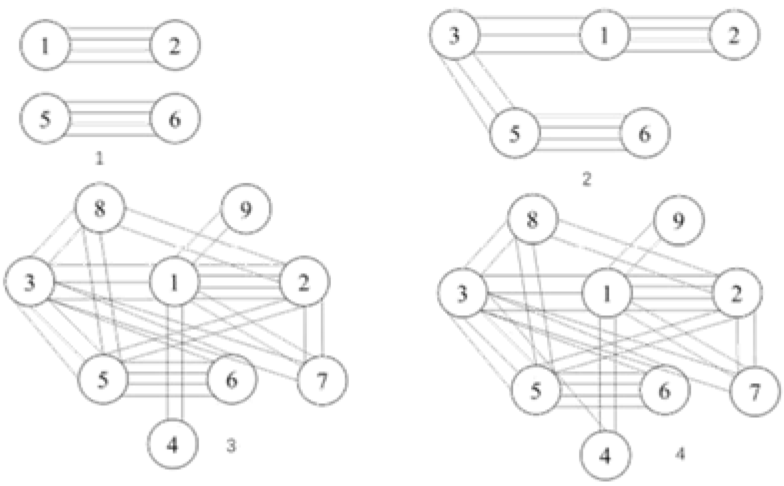

Figure 5. Position-related diagram

3.2. Functional Relationship Analysis

Based on the systematic analysis of Company K's finished goods warehouse using the SLP method described above, a series of steps—including defining work units, analyzing interrelationships, and plotting a location correlation diagram—ultimately resulted in two feasible layout optimization schemes, providing a concrete direction for the layout planning and adjustment of the finished goods warehouse.

Solution 1: The scorecard analysis reveals that both the automated warehouse and shipping zone exhibit the highest comprehensive proximity scores, indicating their pivotal role in operational workflows. Spatially, these areas are surrounded by high-interconnection zones. For instance, establishing a temporary pallet storage area adjacent to the warehouse aligns with the A-4 relationship, while the shipping zone neighbors packaging and material storage areas corresponding to E-3 and I-2 relationships, ensuring seamless packaging-shipping coordination. The inbound and return zones, with lower proximity scores, are strategically positioned at peripheral locations to minimize interference with core operational zones. This approach optimizes workflow efficiency and spatial utilization by strategically positioning functionally interconnected areas based on relationship strength. The layout of Solution 1 is illustrated in Figure 6.

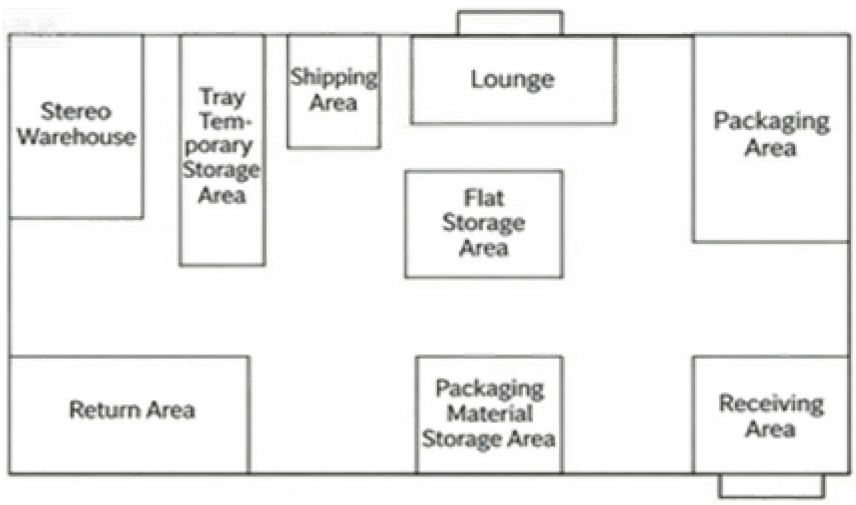

Figure 6. Optimized Scheme 1

Solution 2: Given the critical operational interdependence between the automated warehouse and shipping zone with high integration compatibility, they are strategically positioned at the warehouse's upper level to establish a "storage-shipping" core framework ensuring smooth workflow continuity.

The pallet temporary storage area is closely integrated with the automated warehouse through adjacent layout design, facilitating rapid material turnover. Packaging and shipping zones demonstrate strong operational correlation, with the packaging area's proximity enabling efficient pre-shipping packaging operations. Packaging material storage requires seamless workflow coordination with packaging zones, necessitating adjacent placement for rapid material supply. Return and inbound areas, exhibiting weaker cross-functional relevance, are strategically located at peripheral zones to avoid disrupting core processes. Staff rest areas are designed with employee needs in mind, positioned in quiet locations that do not interfere with primary operations.

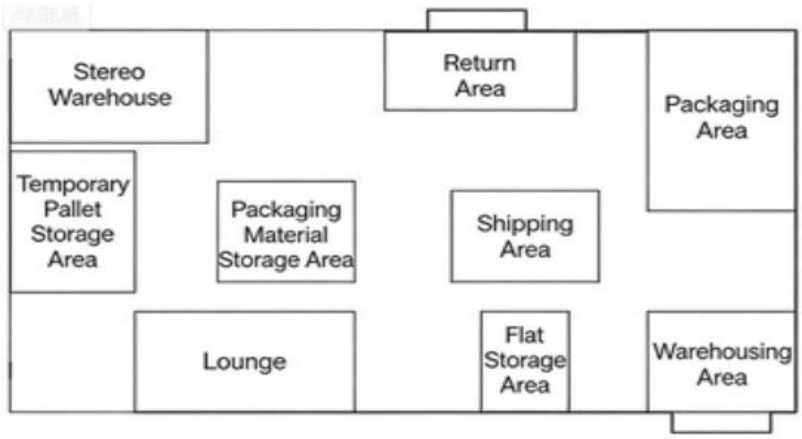

Figure 7. Optimization Scheme 2

4. ANALYSIS DESIGN OF THE LAYOUT OPTIMIZATION PLAN FOR COMPANY K'S FINISHED GOODS WAREHOUSE

In the preceding study, the functional zoning of Company K's finished goods warehouse was redesigned using the SLP method, resulting in two improved layout schemes. However, whether these adjusted layout plans can effectively enhance warehouse operational efficiency and align with the company's long-term development needs still requires in-depth analysis and verification. Before implementing the new layout schemes, it is essential to conduct a scientific screening and evaluation of the optimized designs in light of Company K's actual conditions to avoid resource wastage and inefficient logistics routes. Furthermore, while the SLP method achieves spatial optimization of operational units, it does not address the rationality of equipment configuration within each unit. Therefore, this chapter focuses on utilizing the Flexsim simulation platform to transform the theoretical model into a functional digital model. By comparing the operational performance of different layout schemes, we will verify the practical value of the optimized design, comprehensively evaluate the feasibility and scientific validity of each scheme, and ultimately determine the most efficient warehouse layout as the implementation plan.

After simulatingtheoriginalplan alongside Plan1andPlan2, the results wereoutput, comparing thethreeplansacross four aspects: handling distance, logistics volume, forklift operating status, and runtime. Based on these comparison results, this paper will conduct a comprehensive analysis to select the optimal plan.

4.1. Analysis of Simulation Model Results

4.1.1. Handling Distance

The primary objective of optimizing the finished goods warehouse layout is to minimize the total handling path length throughout the entire process—from receiving and storage to picking and shipping—by rationally planning the positioning of warehouse zones and aisle design. This reduces unnecessary detours and repetitive handling, thereby lowering time consumption, labor, and equipment costs during the handling process and improving overall warehouse operational efficiency. A comparison of the simulation results shows that the handling distances for both optimized schemes are shorter than that of the original scheme.

Table 9. Comparison of Handling Distances

Operational Direction	Distance in OriginalScheme	Distance of Scheme 1	Distance for Plan 2
1-2	148	415	415
1-3	443	111	111
1–4	100	114	120
2–5	117	91	100
3–5	70	177	181
5–6	243	206	147
Total	1,121	1,114	1,074

4.1.2. Handling Volume

To evaluate layout rationality, the logistics throughput at the finished product warehouse exit was adopted as the core evaluation metric, as this data directly reflects the overall operational efficiency of the warehousing system. This study established a 6,000-second operational duration as the data collection interval. Through simulation runs comparing the original layout scheme with two optimized alternatives under identical conditions, the results demonstrated: the original layout achieved an average hourly outbound volume of 39.5 hundred pieces; Optimization Scheme 1 increased throughput to 41.5 hundred pieces, representing a 5% improvement over the original scheme; Optimization Scheme 2 reached 47.5 hundred pieces, achieving a 20% efficiency enhancement with the most significant improvement observed.

4.1.3. Forklift Operation Status

(1) Forklift Travel Distance

To further validate layout optimization effectiveness, this study conducted comprehensive simulations of inbound and outbound operations, focusing on comparative analysis of operational distance differences between the original layout and two optimized solutions. Data reveals that under the initial layout, forklifts accumulated 8.9 kilometers of total travel distance with an average daily operation mileage of 4.1 kilometers. After reconfiguration, the first optimized solution reduced total transportation distance to 7.2 kilometers and decreased daily travel distance to 3.6 kilometers. The second optimized solution demonstrated superior performance, achieving only 6.0 kilometers in cumulative transport distance while maintaining average daily operation mileage at 3.0 kilometers. These results indicate that optimized layouts effectively minimize unnecessary equipment movement, significantly reduce path redundancy during operations, and substantially enhance overall warehouse system efficiency. Notably, the second optimized solution exhibited distinct advantages in shortening transportation distances.

(2) Forklift Operating Status

During the finished goods outbound process, different categories of goods need tobe transported from designated functional zones to the outbound buffer area. By monitoring forklift operational status and idle time, the rationality of logistics routes can be assessed. This study simulated the complete outbound operation process through simulation modeling. Figure 8 illustrates the forklift utilization efficiency under the three layout schemes, where t_0 represents the utilization rate of the original layout, and t_1 and t_2 correspond to the two optimized schemes, respectively. Analysis indicates that, given the same workload, lower forklift utilization implies longer equipment idle time, while higher utilization margins reflect superior transportation efficiency. By comparing the operational performance of the models across the three different layout schemes, data analysis of forklift utilization reveals that the original layout scheme has a forklift utilization rate of 99.3%, while Scheme 1 has a utilization rate of 88.6%. Solution 2's forklift utilization rate was 77.5%. The forklift utilization rates of the two new layouts were lower than that of the original layout, resulting in improved operational performance of the finished goods warehouse.

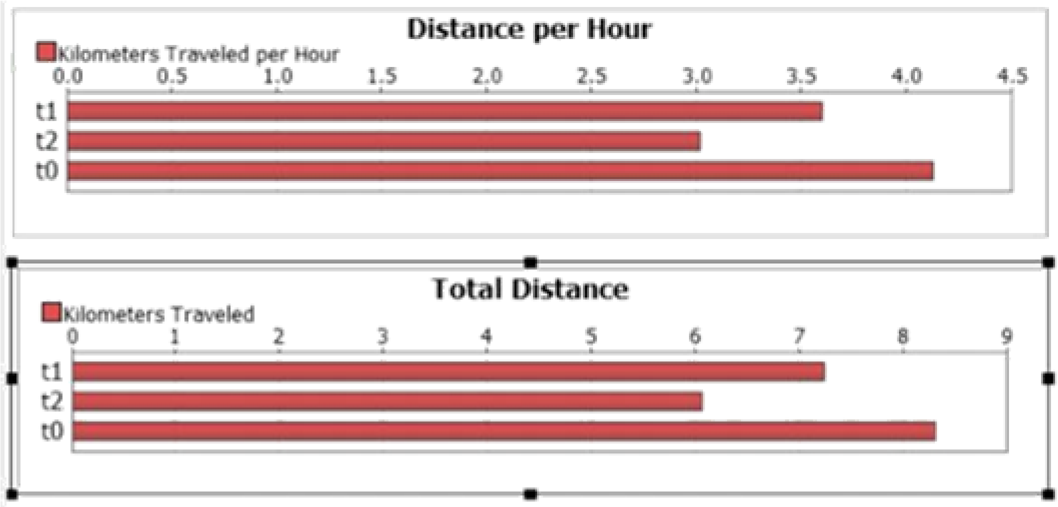

Figure 8. Statistics on Forklift Transport Distances

4.1.4. Operating Time

This study selected a 5-day logistics cycle as the analysis sample. Based on preliminary logistics volume calculation data, the simulation model accurately replicated the actual operational flow of the finished goods warehouse and the initial positions of each functional zone. To scientifically evaluate the effectiveness of the layout optimization, this paper conducted complete inbound and outbound operation simulations under the original layout and the two improved schemes, using the same cargo throughput, and recorded the operation duration for each scheme. The simulation results show that the original layout required 7,252.1 seconds to complete the operations, while the optimized Scheme 1 took 6,465.4 seconds, and Scheme 2 completed the same workload in just 5,670.2 seconds to complete the same workload. A comparison of the data indicates that the redesigned warehouse configuration significantly the operation cycle, with Scheme 2 demonstrating the most notable improvement in operational efficiency, saving 21.8% of the operation time compared to the original layout. This result fully validatesthe positive impact of layout optimization on enhancingwarehouse operational efficiency.

4.2. Determining the Final Soluion

Through simulation experiments on the original layout, Scheme 1, and Scheme 2, and by organizing and tabulating the resulting data, a systematic comparative analysis was conducted across four aspects: handling distance, logistics volume, equipment utilization, and finished goods warehouse operating time. The results indicate that both optimized schemes significantly outperform the original layout in all metrics, demonstrating that the optimized schemes can effectively improve the operational efficiency of the finished goods warehouse. This also validates the rationality and effectiveness of the layout improvement method proposed in this paper, which combines the SLP method with Flexsim simulation software. Further comparison revealed that Scheme 2 outperformed Scheme 1 across all performance metrics, demonstrating particularly clear advantages in handling distance and equipment utilization. Based on these findings, Scheme 2 was ultimately selected as the optimal layout for Company K's finished goods warehouse.

Table 10. Comparison of Simulation Output Data

Item Comparison	Original Scheme	Solution 1	Solution 2
Goods Handling Distance (meters)	1121	1114	1074
6,000 Shipments per second (hundreds of items)	39.5	41.5	47.5
Total distance traveled by forklifts (kilometers)	8.9	7.2	6
Average daily transport distance per forklift (kilometers)	4.1	3.6	3
Time for a complete warehouse entry/exit operation (seconds)	7252.1	6465.4	5,670.2

5. CONCLUSION

A rational system layout planning not only ensures normal production operations for enterprises but also significantly enhances warehouse operational efficiency. Taking Company K's finished goods warehouse as the research subject, this study employs System Layout Planning (SLP) methodology for theoretical layout optimization and validates the optimized solutions using FlexSim simulation software. During the research process, two theoretical optimization schemes were first designed based on SLP methods, followed by simulation runs of the original layout and two optimized schemes through the FlexSim platform. To ensure experimental accuracy, all simulation parameters remained consistent except for layout configurations. Comparative analysis of four key indicators—handling distance, logistics volume, equipment operational status, and running time—revealed the following conclusions: While both Scheme 1 and Scheme 2 outperformed the original layout in total handling distance, unit time output, forklift transportation distance, and running time, Scheme 2 demonstrated superior performance. Specifically, Scheme 2 reduced total handling distance by 25 meters compared to Scheme 1, increased unit time output by 14.5%, decreased total forklift transportation distance by 1.2 kilometers, and saved 795.2 seconds in operational time. These data conclusively demonstrate Scheme 2's significant advantages in improving warehouse operational efficiency. Therefore, based on comprehensive evaluation of all metrics, this study ultimately identifies Scheme 2 as the optimal layout solution.

REFERENCES

[1] Zhang Hui, Li Chengsong, Li Yulin, Li Xiyang, Ma Xinchun. Optimization study on machining workshop facility layout based on SLP method and Flexsim simulation [J]. Modern Manufacturing Engineering, Vol. 2016, No. 05, pp. 63-68, 2016. https://link.cnki.net/doi/10.16731/j.cnki.1671-3133.2016.05.014

[2] Zhou Tingmei, Wang Lei, Mo Yimin, Zhang Feng, Wang Wanfu. Layout optimization of OEM parts distribution centers based on SLP method [J]. Logistics Technology, Vol. 36, No. 02, pp. 142-145+177, 2017. https://kns.cnki.net/kcms2/article/abstract?v=JGGnQT2jy0KItN6mtkmU6WT35nRHXMQ6aCnb18kZYjhUEkFXvJY3B7cbjZiX5I7lV4bqIRgw-jwaXvhemEMF-5XgPqGio--UMLWrrgQ_liI0Q2EFAKzY4pzbT9Cx2Kc-vmSqBkgDg89iRTd4cq8BY89c3LLbjfH4g1N2u_3W8LxGNCwbIdKlP2ECe50VlXnF&uniplatform=NZKPT&language=CHS

[3] Zhao F, Wang Z. Application research of improved SLP and AHP methods in supermarket layout design [J]. Logistics Technology, Vol. 41, No. 09, pp. 13-17, 2018. https://doi.org/10.13714/j.cnki.1002-3100.2018.09.004

[4] Liu Jiayin, Shi Tao, Zhang Nan, Zhang Kun, Zhao Gang. Warehouse layout optimization based on genetic algorithm and simulation technology [J]. Computer & Digital Engineering, Vol. 47, No. 04, pp. 833-837, 2019. https://kns.cnki.net/kcms2/article/abstract?v=JGGnQT2jy0LCvUdAzDkMc3i5kfRugOeJZFH5rO--bp5ZbdVkOjg6_KRXmVkhCz8T8Uec-0z3LY2lgUz11pzkTC0_oZBWvBEuOb6vwboSaM3zq9MyGW5jxXE4RW1PlDACIXqylxt0q2Mi1tXP2iLnLRLJ69xMpdgq5TKKNz7hmnoo7epuWSSKWg==&uniplatform=NZKPT&language=CHS

[5] Tao Wangze. A Warehouse Layout Planning Based on Intelligent Logistics Perspective [J]. Logistics Technology, Vol. 40, No. 07, pp. 78-81, 2021. https://kns.cnki.net/kcms2/article/abstract?v=JGGnQT2jy0JMPAmBcoQliNizAXVPNcGn25YaCDzumXdiY_b2_dv-

4x40wq1HLGT3qeYOrvxc3gUDMoOwrltNRmBarck2JdSUZzzTn2ccl_v3l_hCx_J1y5FxMw4N41NiWjV79gKN-o11ytpInxf6exv32j5ofXtxNFccw7X1Wf7MSv_sNSlD2w==&uniplatform=NZKPT&language=CHS

[6] Wang Hanxin, Zhang Yajie. Layout optimization of M warehouse based on SLP [J]. Logistics Technology, Vol. 48, No. 13, pp. 146-149, 2025. https://doi.org/10.13714/j.cnki.1002-3100.2025.13.033

[7] Sun Hongran. Layout optimization of ingredient supply chain distribution centers based on improved SLP method: A case study of H Ingredient Supply Chain Company's distribution center [J]. Journal of Suzhou Vocational University, Vol. 36, No. 02, pp. 60-69, 2025. https://doi.org/10.16219/j.cnki.szxbzk.2025.02.011

[8] Shi Hao. Optimization design method for functional zone layout of greening expo exhibition park based on SLP [J]. Forestry Survey and Planning, Vol. 50, No. 02, pp. 195-200, 2025. https://kns.cnki.net/kcms2/article/abstract?v=JGGnQT2jy0Kc1M2nMjGa0B1KTToX9iJ9ZaeNArb8pJJ_sxC6880NajsW454iy_wkIp0XYCHOGfvqaTsa80Qg7BNqcJ6sWW6jbPu_RNyPHzbVym4DThzkbQFrwGpb6SppNbxaAK2qku0NFgLrvAxg47Un9Dczq_fuG9UBmJx_0itB0KZzNLb4BA==&uniplatform=NZKPT&language=CHS

[9] Zhang Junling, Zhang Enhui. Study on Functional Area Layout Planning of R Station Railway Logistics Center Based on SLP [J]. Journal of Shaoxing University, Vol. 45, No. 02, pp. 111-120, 2025. https://doi.org/10.16169/j.issn.1008-293x.2025.02.012