

Chapter 2

Research on Logistics Center Layout Based on SLP

Yannan Liu and Qilan Zhao

Abstract Systematic layout planning (SLP) has been widely applied to the production system, but not to the service system. Combined with the goals, influencing factors, and conditions of logistics center layout, this paper probes into the application of SLP to the layout of the rapidly increasing logistics centers in large- and medium-sized cities in recent years. According to the logistics relationship and non-logistics relationship between work units in the logistics center, the author decides the position of work units and maps out the initial position relationship chart. Through further amendments and adjustment based on the move line and other factors, the author gets the feasible layout plan. Finally, this paper uses a medicine logistics center in Jiangsu Province as an example to design, analyze, and evaluate for the purpose of providing some theoretical basis and method for reference in the service system layout.

Keywords SLP · Logistics center · Layout · Design

2.1 Introduction

Since entering the twenty-first century, the logistic industry in China has been rapidly growing up and the number of logistics centers has increased dramatically. Many large- and medium-sized cities across the country are planning to set up logistics centers. Logistics center is a comprehensive, regional concentration of large quantities of materials, and it is an intermediary between production and marketing enterprises, integrating commodity flow, logistics, information flow, and cash flow [1]. The reasonable layout of logistics centers has taken more and more attention, and it is also the research focus of many scholars.

Y. Liu (✉) · Q. Zhao
School of Economics and Management, Beijing Jiaotong University, Beijing 100044,
People's Republic of China
e-mail: 912688323@qq.com

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At first, people use their experience and feeling to design the logistics centers. In the 1950s, developed from the traditional small systems to big and complex systems, it is difficult to design the logistics centers only with experience. And so, with the integration development of the diverse discipline, the system engineering concept and system analysis method have been used in layout planning [2], and some more advanced design methods have gradually emerged. One of the most representative methods is systematic layout planning (SLP) proposed by American R. Muther in 1961. Study on facilities layout problem is developed from qualitative stage to quantitative stage on the basis of SLP [3]. SLP is also widely applied to various production systems and service systems [4]. Finally, it improves to move line SLP.

2.2 The Goals, Influencing Factors, and Conditions of Logistics Center Layout

2.2.1 The Goals of Logistics Center Layout

After determining the location of a logistics center, the overall goal of logistics center layout is to make the personnel, equipment, and material space in the logistics activity process be in the most appropriate allocation and the most effective combination [5]. The specific goals can be the minimum total cost of material flow, work units¹ of high relationship close degree close to each other, simplifying transport routes, shortening the distance between similar work units, avoiding roundabout transport, etc.

2.2.2 Influencing Factors of Logistics Center Layout

Layout design has a significant effect on a production performance or service system performance [6]. For a logistics center, its layout has direct influence on logistics, information flow, the logistics operation efficiency, cost, and safety of the whole system. So the influencing factors of logistics center layout are as follows:

1. The nature and function of a logistics center. Because the nature and function of the logistics centers is different, it is different to choose equipment type and quantity. The size and layout of logistics centers are also not the same. According to its core function, the logistics center has three types: transit logistics center, storage logistics center, and distribution logistics center.

¹ The sectors at all levels in a logistics center are called work units.

2. The basic operation process of a logistics center. The main activities of the logistics center are purchasing, warehousing, distribution, circulation processing, packing, returning, and so on [5]. The operation process has an influence on the move line of personnel, equipment, and material. To realize the efficient logistics, the basic operation process of a logistics center should be in consideration when layout designing.
3. Logistics relationship and non-logistics relationship between work units. Logistics relationship is that there is logistics contact between work units. And interpersonal contact, administrative affairs, and other activities can be expressed as non-logistics relationship between work units. Work units of high relationship close degree should be close to each other.

2.2.3 Application Conditions of SLP in the Layout of Logistics Center

It is necessary to specify five basic elements, namely P (logistics products), Q (logistics quantity), R (logistics routes), S (service sectors), and T (logistics operation time or technology) before applying SLP to logistics center layout. The first two basic elements are the most important. Different logistics products have different demands on storage, loading, and other logistics activities. Ultimately, it leads to different logistics routes. What is more, using different logistics equipment and technology determines logistics operation time. The work quantity of the logistics center reflects the logistics intensity² of all work units; logistics routes, distance, and logistics intensity have an influence on layout, which is reflected in the logistics cost and efficiency [7]. Therefore, SLP can be used in the layout of a logistics center based on logistics product category, logistics quantity, and other factors.

2.3 The Main Steps of Layout Based on SLP

Under the guidance of SLP, the first step is to use quantification method to analyze the logistics relationship and non-logistics relationship between work units and then to get the composite correlation between work units. The close degree relationship between work units determines the distance between work units. According to that, we can arrange its location. Through further amendments and adjustment based on the move line and other factors, we can get the feasible layout plan. The specific layout procedure is as follows.

² The distance of movement of logistics products in a certain time of cycle is called logistics intensity.

2.3.1 Logistics Operation Process and Work Units’ Settings

The main activities of the logistics center are purchasing, warehousing, distribution, circulation processing, packing, returning, and so on. It is necessary to make clear the main logistics operation process before layout designing. And then, we analyze the corresponding P, Q, R, S, and T elements. Based on the analysis, we can divide the work units.

2.3.2 Interrelation Analysis Between Work Units

It is reasonable to describe the logistics relationship between work units by logistics intensity. Logistics intensity is divided into five ranks: A, E, I, O, and U [8], as shown in Table 2.1.

We can use relationship close degree proposed by R. Muther to describe the non-logistics relationship between work units. If two work units have frequent activity, their relationship close degree is high and vice versa. First, the relationship close degree is divided into six levels: A, E, I, O, U, and X, as shown in Table 2.2.

Then, list the reason for close relationship (see Table 2.3). Using these two kinds of information, we can determine the correlation between work units. According to the correlation, the higher the degree is, the closer their distance is.

2.3.3 The Composite Correlation Analysis Between Work Units

Integrate the logistics relationship and the non-logistics relationship. According to the certain weight of each relationship, calculate the composite correlation between work unit i and work unit j ($i, j = 1, 2, \dots, n$ and $j \neq i$).

Table 2.1 Logistics intensity rank

Logistics intensity rank	Sign	Logistics routes’ proportion (%)	Logistics quantity (%)
Absolutely important	A (4)	10	40
Extremely important	E (3)	20	30
Important	I (2)	30	20
Ordinarily important	O (1)	40	10
Unimportant	U (0)		

Table 2.2 The classification of relationship close degree

Sign	Relationship close degree	Proportion (%)
A	Absolutely important	2–5
E	Extremely important	3–10
I	Important	5–15
O	Ordinarily important	10–25
U	Unimportant	45–80
X	Ignored (or negative close degree)	Discretionary

Table 2.3 The reason for close relationship

Serial number	Reason
1	Using common original records
2	Sharing equipment or site
3	Material handling
4	Frequent contact and file exchange
5	Safety and pollution
6	Continuous work flow
7	Manageable
8	Others

2.3.4 Determine the Relative Position of All the Work Units and Get the Final Feasible Layout Plan

To design a logistics center layout, the first step is not directly considering the floor space and shape of all the work units but the composite correlation between work units. If two work units’ composite correlation is high, their distance is shorter and vice versa. During the layout, according to the composite correlation degree in sequence, we locate different work units. If some work units are at the same level, we determine their relative position by scores.

According to the above steps, we can get the preliminary theory position of all work units, and then, we get the final feasible layout plan through further amendments and adjustment based on the actual area, move line, and other factors.

2.4 Case Analysis

This paper uses a medicine logistics center as an example to design and analyze according to the characteristics of medicine logistics, move line, and the actual ground condition. This paper rationally divides each function areas, solves the evacuating problem, saves land, meets the relevant regulations, and aims to verify the feasibility and rationality SLP.

2.4.1 Business Background

Y medicine logistics center [4] located in Jiangsu Province is a third-party medicine logistics enterprise. It mainly provides a medicine trading platform, stocking, storage, picking, packing, distribution, information processing, and many value-added services for entering enterprises. The logistics center plans to cover 125 units of area. Its construction area is 180,000 m², and its storage area is about 80,000 m².

Medicine logistics center has its own characteristics. Medicines can be divided into three types, namely the normal drugs at room temperature, some medicines requiring refrigeration, and psychiatric drugs. These three types of drugs must be stored separately using different storage facilities and paid different attention to. So this paper divides Y medicine logistics center into several work units as follows.

(1) office area; (2) arrival and sorting area; (3) automatic storage/retrieval system (AS/RS); (4) cold storage; (5) psychiatric drugs storage; (6) picking area; (7) packing and processing area; (8) gathering and distribution; and (9) service sectors.

2.4.2 Application of SLP

1. Analyzing the logistics relationship (see Fig. 2.1) and non-logistics relationship (see Fig. 2.2) between work units.
2. Determining the relative importance of logistics relationship and non-logistics relationship. For Y medicine logistics center, the weight of two relationships is 1:1.
3. Quantifying the logistics intensity rank and the non-logistics relationship close degree. Usually, $A = 4$, $E = 3$, $I = 2$, $O = 1$, $U = 0$, $X = -1$.
4. When the number of work units is N , the total matching number can be calculated using the following equation: $P = N(N - 1)/2$. Here, $N = 9$ so $P = 36$.
5. Calculating the composite correlation between work units (see Table 2.4).
6. Switching the composite correlation scores (see Table 2.4) to the composite correlation close degree rank (see Table 2.5). Then, drawing the composite correlation chart (see Fig. 2.3).
7. Determining the relative position of all the work units. According to Fig. 2.3, the higher the work units' composite correlation is, the shorter their distance is (see Fig. 2.4).
8. Analyzing the move line. The move lines of the logistics centers are different for their different land areas and logistics products. There are five types, namely I, L, U, O, and S. Type I is the most simple, and it is suitable for the rectangular logistics center whose entrance is to the exit. Type S is the most complex, and it is suitable to arrange a long logistics route. Y medicine logistics center is near-rectangular. The main activities of Y medicine logistics center are stocking, storage, picking, packing, distribution, information processing, and many value-

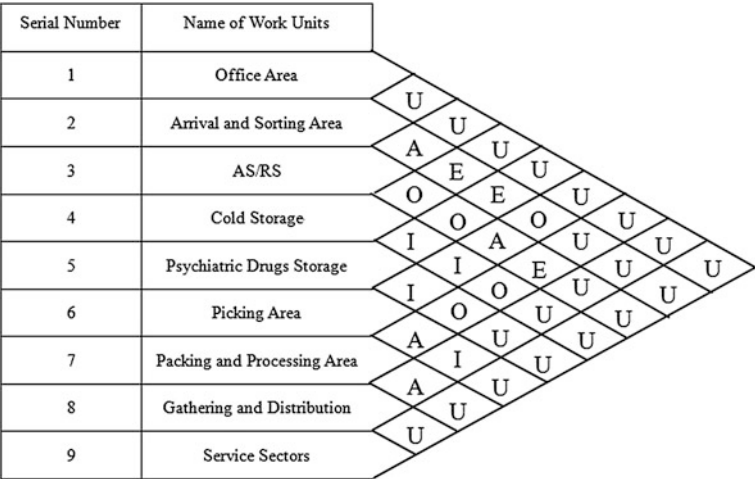


Fig. 2.1 Logistics relationship between work units

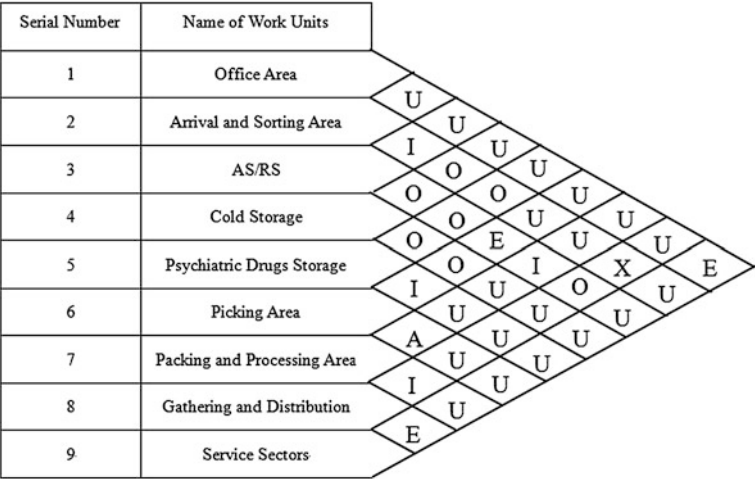


Fig. 2.2 Non-logistics relationship between work units

added services. So this paper intends to design Y medicine logistics center combining type L with type U (see Fig. 2.5).

9. The final feasible layout plan. After adjustment, the final layout plan is shown in Fig. 2.6.

Table 2.4 The composite correlation between work units

Work units' pairing	Relationship close degree				The composite correlation	
	Logistics relationship		Non-logistics relationship			
	Degree	Score	Degree	Score	Score	Degree
1-2	U	0	U	0	0	U
1-3	U	0	U	0	0	U
1-4	U	0	U	0	0	U
1-5	U	0	U	0	0	U
1-6	U	0	U	0	0	U
1-7	U	0	U	0	0	U
1-8	U	0	U	0	0	U
1-9	U	0	E	3	3	O
2-3	A	4	I	2	6	E
2-4	E	3	O	1	4	I
2-5	E	3	O	1	4	I
2-6	O	1	U	0	1	U
2-7	U	0	U	0	0	U
2-8	U	0	X	-1	-1	X
2-9	U	0	U	0	0	U
3-4	O	1	O	1	2	U
3-5	O	1	O	1	2	U
3-6	A	4	E	3	7	E
3-7	E	3	I	2	5	I
3-8	U	0	O	1	1	U
3-9	U	0	U	0	0	U
4-5	I	2	O	1	3	O
4-6	I	2	O	1	3	O
4-7	O	1	U	0	1	U
4-8	U	0	U	0	0	U
4-9	U	0	U	0	0	U
5-6	I	2	I	2	4	I
5-7	O	1	U	0	1	U
5-8	U	0	U	0	0	U
5-9	U	0	U	0	0	U
6-7	A	4	A	4	8	A
6-8	I	2	U	0	2	U

(continued)

Table 2.4 (continued)

Work units' pairing	Relationship close degree				The composite correlation	
	Logistics relationship		Non-logistics relationship			
	Degree	Score	Degree	Score	Score	Degree
6-9	U	0	U	0	0	U
7-8	A	4	I	2	6	E
7-9	U	0	U	0	0	U
8-9	U	0	E	3	3	O
总计					36	100

Table 2.5 The composite correlation close degree rank

Total score	Relationship close degree	Matching number	Proportion (%)
8	A	1	2.8
6-7	E	3	8.3
4-5	I	4	11.1
3	O	4	11.1
0-2	U	23	63.9
-1	X	1	2.8
Total		36	100

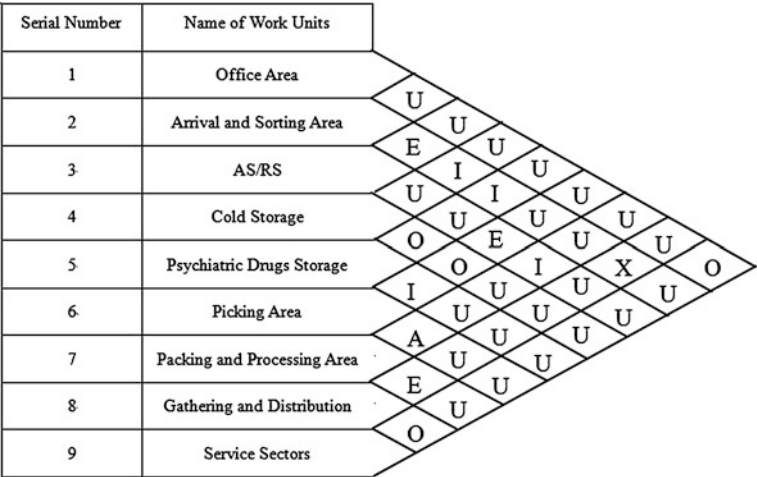


Fig. 2.3 The composite correlation chart

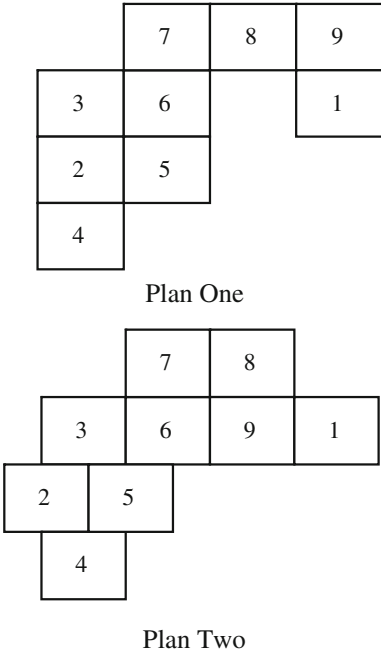


Fig. 2.4 The relative position of the work units

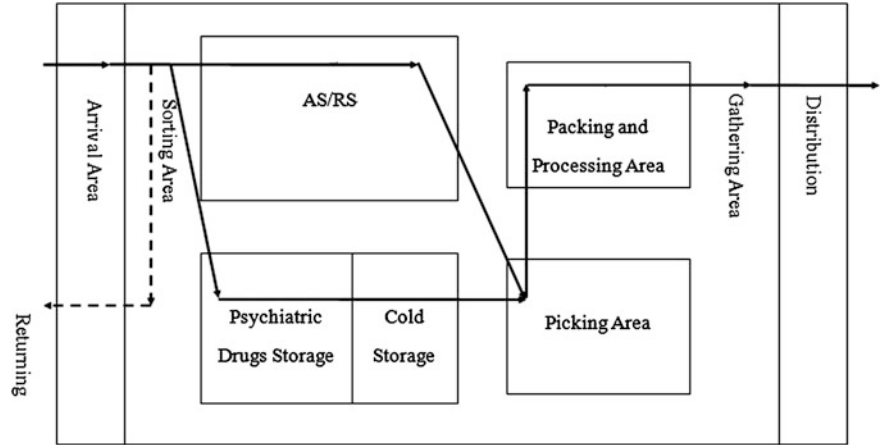


Fig. 2.5 The move line

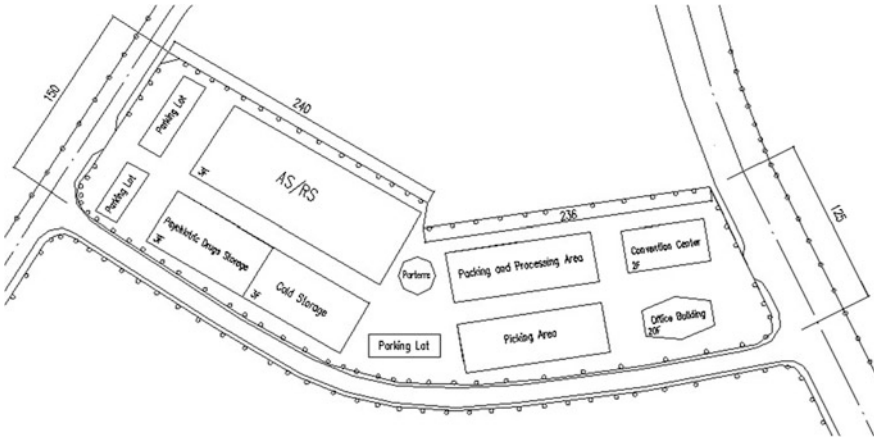


Fig. 2.6 The final layout plan

2.4.3 Evaluation

Through dividing the nine main work units, the paper designs Y medicine logistics center considering the logistics relationship and non-logistics relationship. So the final feasible layout plan is comprehensive. What is more, the main activities of Y medicine logistics center are stocking, storage, picking, packing, distribution, information processing, and many value-added services. Its storage area is about 80,000 m². Therefore, we put the three warehouses nearly in the middle considering the warehouse layout priority principle. This is helpful for the quick contact with the other circumjacent area, and this helps to improve the logistics center's operational efficiency. At the same time, the classification of warehouses contributes to the different storage requirements of different customers. And there is enough space for adjustment, greatly improving the flexibility of the storage system. The designed move line of Y medicine logistics center, combining both the layout of work units and the principle of avoiding circuitous transportation, can well ensure smooth logistics activities. Different storages can also use different move lines.

2.5 Conclusion

This paper focuses on the layout of the logistics center, proposes the use of SLP to design the layout of the logistics center, and adds to the move line analysis. Through the analysis of this paper, the main conclusions are as follows.

The overall goal of logistics center layout is to make the personnel, equipment, and material space in the logistics activity process be in the most appropriate allocation and the most effective combination. At the same time, the main

influencing factors of logistics center layout are the nature, function, basic operation process of a logistics center, logistics relationship, and non-logistics relationship between work units. Through the case analysis, after making clear the P, Q, R, S, and T elements, it is feasible and reasonable to use SLP in the layout of a logistics center.

It provides a good reference for other logistics center layout problem. It is necessary to point out some limitations and shortages. When drawing the relative position of the work units' figure, people have to constantly adjust and amend the plan in order to meet the corresponding condition. What is more, different designers' way of solving conflicts may lead to different design plans. How to use the computer simulation technology to compare SLP layout plan with other plans is one of our future research directions.

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