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Enterprise Workshop Facility Layout Planning based on SLP Method

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Abstract

With the development of economic globalization, logistics has become another source of profit for enterprises. Due to the frequent loss and waste of resources in the logistics process, facility layout is an important factor in improving processing and production efficiency for small and medium-sized manufacturing enterprises. This paper will use the systematic layout planning (SLP) method to design the facility layout scheme for Z Company's processing workshop, conducting logistics and non-logistics relationship analysis within the enterprise workshop and drawing diagrams of workstation locations to enhance processing and production efficiency.

Keywords

Logistics Analysis; Production Management; Facility Layout; SLP Method.

1. Introduction

1.1. Research Background

In the 21 century, the competition among enterprises is becoming increasingly fierce, and logistics has become the third largest source of benefit for many enterprises [1]. For the whole logistics network system, the layout of logistics facilities is a very important link. However, according to the data, in the whole process of product production, the processing time of the product itself only accounts for about 20% of the total production time, and most of the remaining time is spent on material transportation, waiting for products to operate, and so on [2]. It is very important for enterprises to have efficient facility layout, which can reduce the cost of material transportation and improve production efficiency.

1.2. The Main Contents of Research

Z company is a small and medium-sized enterprise specializing in processing power cabinets. According to the summary table of logistics intensity between the various work units in the company's processing workshop, this paper will use the SLP method to design the layout scheme of these four kinds of product processing workshop facilities.

2. Summary of Systematic Layout Planning

2.1. The Concept of Systematic Layout Planning

The SLP method(Systematic Layout Planning) of integrated facility layout is mainly a detailed analysis of the production and transportation process of enterprise materials, and then a method of facility layout planning and design by sorting out and analyzing the logistics and non-logistics factors between operating units [3]. The data is presented in the form of charts, and the plant and facility configurations are designed in a clear and orderly manner.

2.2. Steps of Systematic Layout Planning

First of all, it is necessary to analyze the production process of the factory, divide and analyze all the working units in the factory. Secondly, quantify the relationship between the operation

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units, and draw the position correlation diagram of the operation units, then adjust the position of the operation units to reduce the distance between the operation units. Finally, draw the correlation diagram of the operation unit area, evaluate the location of the operation unit, and select the optimal layout scheme [4].

3. Layout of Production Logistics System in Workshop

3.1. Division of Operation Units and Drawing of Logistics from to Table

In order to facilitate the following description, first number each job unit in the workshop, as shown in Table 1.

Table 1. Job Unit Numbering

Serial number	Name
1	Raw material area
2	Stamping area
3	Assembly area
4	Welding zone
5	Bend area
6	Blanking area
7	Waste equipment storage area
8	Box-type substation operation area
9	Assembly raw material area
10	Finished product area
11	Auxiliary area

It is known that the summary table of logistics intensity between the working units in the workshop, as shown in Table 2, the unit is kg. The material flow from to table can be obtained by sorting, as shown in Table 3.

Table 2. Logistics Intensity Summary

Serial number	Job unit pair	Logistics intensity (kg)
1	1-2	35100
2	2-3	34925
3	3-4	24332
4	4-5	6573
5	4-7	19759
6	5-6	6573
7	6-11	34915
8	7-6	20509
9	11-1	30915

3.2. Analysis on the Interrelation of Logistics

With from to table, we need to divide the corresponding logistics intensity levels of each operation unit. Generally, there are five grades represented by the letters A, E, I, O and U respectively, which are ultra-high, extra-high, large, general and negligible. See Table 4 for details.

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Table 3. The Material Flow of the Workshop from to Table

	1	2	3	4	5	6	7	8	9	10	11	Total
1	-	35100	0	0	0	0	0	0	0	0	0	35100
2	0	-	34925	0	0	0	0	0	0	0	0	34925
3	0	0	-	24332	0	0	0	0	0	0	0	24332
4	0	0	0	-	6573	0	19759	0	0	0	0	26332
5	0	0	0	0	-	6573	0	0	0	0	0	6573
6	0	0	0	0	0	-	0	0	0	0	34915	34915
7	0	0	0	0	0	20509	-	0	0	0	0	20509
8	0	0	0	0	0	0	0	-	0	0	0	0
9	0	0	0	0	0	0	0	0	-	0	0	0
10	0	0	0	0	0	0	0	0	0	-	0	0
11	30915	0	0	0	0	0	0	0	0	0	-	30915
Total	30915	35100	34925	24332	6573	27082	19759	0	0	0	32915	211601

Table 4. Logistics Intensity Level Reference

Logistics intensity grade	Symbol	Proportion of material flow undertaken (%)	Proportion of logistics routes (%)
Logistics intensity grade	A	40	10
Extra high logistics intensity	E	30	20
Greater logistics intensity	I	20	30
General logistics intensity	O	10	40
Negligible handling	U	0	0

By comparing the logistics intensity of each unit and sorting its size from the table to the table, and then dividing the reference table according to the logistics intensity grade ratio, we can further draw the logistics intensity analysis table of each production unit pair, as shown in Table 5. Sorting out the relationship between each logistics operation unit can get the logistics related table between the operation units, as shown in Figure 1.

Table 5. Logistics Intensity Analysis

Serial number	Job unit pair	Logistics intensity value	Logistics intensity	Logistics intensity
1	1-2	35100		A
2	2-3	34925		A
3	6-11	34915		A
4	11-1	30915		E
5	3-4	24332		E
6	7-6	20509		I
7	4-7	19759		I
8	4-5	6573		O
9	5-6	6573		O

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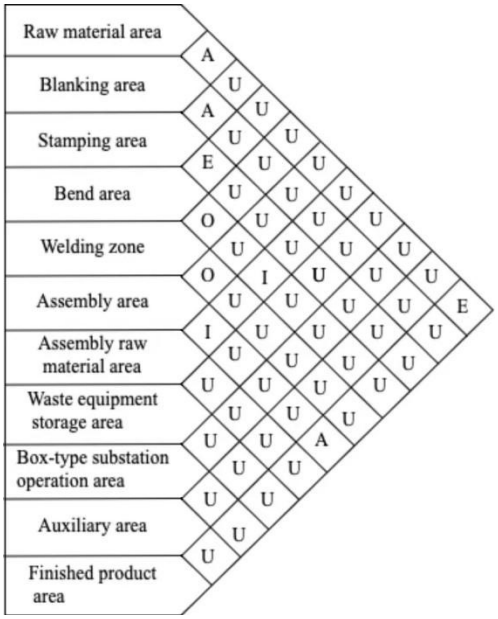

Figure 1. Logistics Interrelation Diagram

3.3. Analysis of the Relationship between Non-logistics

In manufacturing companies, the interrelationship between operating units includes logistics and non-logistics [5]. The non-logistics factors of the workshop are shown in Table 6.

Table 6. Reason Analysis of Non-logistics Factors

Coding	Reasons
1	Material handling
2	Easy to manage
3	Production service
4	Safety and pollution
5	Continuity of workflow

The reference table is divided according to the level of non-logistics closeness, as shown in Table 7, the five reasons are graded, and the table of non-logistics interrelation between operation units is drawn, as shown in Figure 2. The upper part of Figure 2 shows the degree of closeness, and the lower part shows the reasons for choosing this level.

Table 7. Non-logistics Level Reference

Meaning	Symbol	Job unit pair ratio (%)
Absolutely necessary to approach	A	2~5
Especially mainly close to	E	3~10
Important	I	5~15
General closeness	O	10~25
Unimportant	U	45~80
Don't want to approach	X	It depends on the situation

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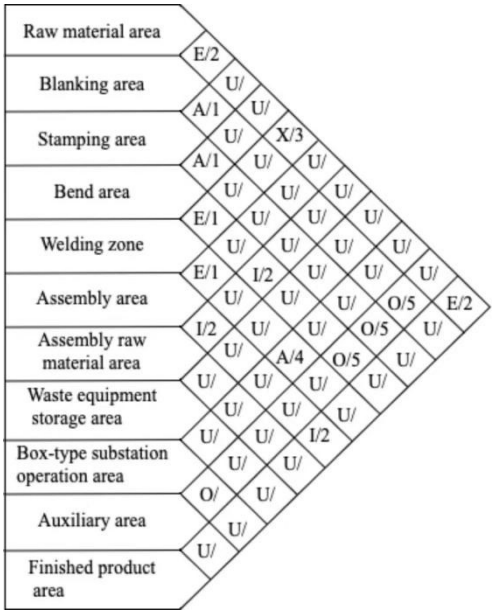

Figure 2. Non-logistics Interrelation Diagram

3.4. Comprehensive Relation Analysis and Calculation

The grades of logistics and non-logistics interrelationships are calculated as numerical values, which are generally taken as A=4, E=3, I=2, O=1, U=0, X=-1 [6]. The grade of logistics and non-logistics interrelationships will be according to Eq: CRij=m×MRij+n×NRij Merged together (MRij represents the level of logistics relationship between i and j, NRij represents the level of non-logistics interrelationship between i and j) [7].By summing up the two operating units i and j according to the proportion of m:n=2:1, the comprehensive score of the job pair can be obtained. Then the comprehensive relation grade of each operation unit pair is divided according to the logistics intensity grade proportion of Table 4, as shown in Table 8.

Table 8. Comprehensive Relation Calculation

Serial number	Job unit pair	Closeness of relationship			Grade
		Logistics relationship score (weighted: 2)	Non-logistics relationship score (weighted: 1)	Comprehensive relation score	
1	1-2	4	3	11	A
2	1-3	0	0	0	U
3	1-4	0	0	0	U
4	1-5	0	-1	-1	X
5	1-6	0	0	0	U
6	1-7	0	0	0	U
7	1-8	0	0	0	U
8	1-9	0	0	0	U
9	1-10	0	0	0	U
10	1-11	3	3	9	I
11	2-3	4	4	12	A
12	2-4	0	0	0	U
13	2-5	0	0	0	U
14	2-6	0	0	0	U
15	2-7	0	0	0	U
16	2-8	0	0	0	U
17	2-9	0	0	0	U
18	2-10	0	1	1	O
19	2-11	0	0	0	U

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Table 8. Comprehensive Relation Calculation(continued)

Serial number	Job unit pair	Closeness of relationship			Grade
		Logistics relationship score (weighted: 2)	Non-logistics relationship score (weighted: 1)	Comprehensive relation score	
20	3-4	3	4	10	E
21	3-5	0	0	0	U
22	3-6	0	0	0	U
23	3-7	0	0	0	U
24	3-8	0	0	0	U
25	3-9	0	0	0	U
26	3-10	0	1	1	O
27	3-11	0	0	0	U
28	4-5	1	3	5	O
29	4-6	0	0	0	U
30	4-7	2	2	6	I
31	4-8	0	0	0	U
32	4-9	0	0	0	U
33	4-10	0	1	1	O
34	4-11	0	0	0	U
35	5-6	2	0	4	I
36	5-7	0	0	0	U
37	5-8	0	0	0	U
38	5-9	0	4	4	O
39	5-10	0	0	0	U
40	5-11	0	0	0	U
41	6-7	2	2	6	I
42	6-8	0	0	0	U
43	6-9	0	0	0	U
44	6-10	0	0	0	U
45	6-11	4	2	10	E
46	7-8	0	0	0	U
47	7-9	0	0	0	U
48	7-10	0	0	0	U
49	7-11	0	0	0	U
50	8-9	0	0	0	U
51	8-10	0	0	0	U
52	8-11	0	0	0	U
53	9-10	0	1	1	O
54	9-11	0	0	0	U
55	10-11	0	0	0	U

The comprehensive related table of the job unit can be drawn from Table 8, as shown in Figure 3.

3.5. Facility Layout of Enterprise Workshop

Quantifying the proximity between individual unit pairs, still organized by taking A=4, E=3, I=2, O=1, U=0, and X=-1, results in a proximity calculation table, see Table 9.Ranking the combined proximity levels gives an idea of which operating units are to be brought closer together in the facility layout.

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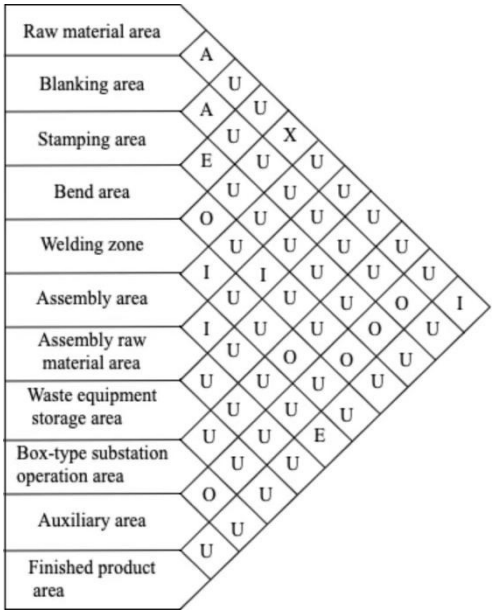

Figure 3. Comprehensive Correlation Diagram

Table 9. Proximity Calculation

Work unit code	1	2	3	4	5	6	7	8	9	10	11
1	-	$\frac{A}{4}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{X}{-1}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{I}{2}$
2	$\frac{A}{4}$	-	$\frac{A}{4}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{O}{1}$	$\frac{U}{0}$
3	$\frac{U}{0}$	$\frac{A}{4}$	-	$\frac{E}{3}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{O}{1}$	$\frac{U}{0}$
4	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{E}{3}$	-	$\frac{O}{1}$	$\frac{U}{0}$	$\frac{I}{2}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{O}{1}$	$\frac{U}{0}$
5	$\frac{X}{-1}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{O}{1}$	-	$\frac{I}{2}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{O}{1}$	$\frac{U}{0}$	$\frac{U}{0}$
6	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{I}{2}$	-	$\frac{I}{2}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{E}{3}$
7	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{I}{2}$	$\frac{U}{0}$	$\frac{I}{2}$	-	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$
8	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	-	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$
9	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{O}{1}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	-	$\frac{O}{1}$	$\frac{U}{0}$
10	$\frac{U}{0}$	$\frac{O}{1}$	$\frac{O}{1}$	$\frac{O}{1}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{O}{1}$	-	$\frac{U}{0}$
11	$\frac{I}{2}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{E}{3}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	$\frac{U}{0}$	-
Comprehensive proximity degree	5	9	8	7	3	7	4	0	2	4	5
Sort	5	1	2	3	9	4	7	11	10	8	6

In a location-dependent diagram, graphical representations of operational units are required. The symbols for the nature of the work of the operational unit and the representation of the closeness level are shown in Table 10 and Table 11, respectively.

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Table 10. Work Unit Work Nature Symbol

Effect	legend	Expansion symbols for homework units and areas
Operate	◯	Forming or processing machining area, assembly, assembly and disassembly of parts
Storage	▽	Storage operation unit / area

Table 11. Closeness Level Representation

Grade	Coefficient value	Line	Closeness degree
A	4	≡	Absolutely important
E	3	≡	Very important
I	2	=	Important
O	1	/	General
U	0	-	Unimportant
X	-1	∿	No expectation

In accordance with the order of the degree of integrated proximity of each operating unit, find the highest degree of integrated proximity placed in the center position, in order to deal with the operating unit pairs [8], such as Table 9, should be placed in the middle of the most 2 operating units, and then the rest of the operating unit relationship level of A operating units to this arrangement, the same with the other operating unit relationship level. Finally, combining Table 10 and Table 11, we can draw a correlation diagram for the location of the operating units in the workshop facility, see Figure 4.

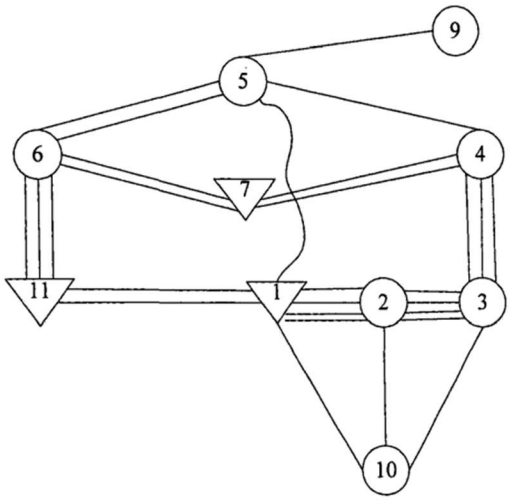

Figure 4. Location Related Diagram

4. Conclusion

This paper mainly carries out the facility layout of the machining workshop of Z Company by using the systematic facility layout SLP method. In the process, the logistics and non-logistics

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factors are analyzed, quantified and summed up according to the proportion of 2:1, and the correlation degree of each operation unit pair is obtained, and then arranged in turn according to the proportion of the relevant logistics intensity grade. finally, the position correlation diagram of the operation unit of the machining workshop is obtained. SLP method can design facility layout more scientifically, efficiently and objectively, so as to greatly improve efficiency, reduce logistics costs and promote the development of the company.

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