

Research on layout optimization of a certain workshop based on SLP

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Abstract: With the development of the economy, competition among enterprises has become more and more intense, and the market's requirements for enterprises are getting higher and higher in all aspects. In particular, cost has become an important bottleneck for enterprise development. Having a reasonable facility layout design (SLP) can reduce material handling costs and shorten the moving distance of production personnel, thereby improving the efficiency of the production system. This study will use SLP technology to analyze and improve the current layout of a company's sofa processing workshop. In the first step, the production process and logistics flow of the workshop were analyzed and measured, and it was found that the production system had problems such as repeated handling of materials, roundabout logistics lines, and complex logistics operations. The second step is to use the relationship diagram between logistics and operating units, and make appropriate adjustments to shorten the transportation distance of materials, reduce transportation time, and make the layout more reasonable and production while ensuring that it can adapt to product processing, process flow, etc. Logistics operations are smoother, achieving the purpose of improving the economic benefits of the entire production system. Finally, two sets of optimized layout plans were determined based on the specific conditions of the workshop and the weighted factor method was used to evaluate the plans to determine the best layout plan.

Keywords: System layout planning (SLP), work unit related diagram, production logistics, logistics cost.

1. Introduction

With the rapid development of the modern economy, market demand has become more and more diverse. It has developed into an era of personalization and diversification. The market has also transformed from a seller's market to a buyer's market. A more open market environment has also made enterprises feel more competitive pressure than before. , for companies around the world, this is a global competition for survival, and the result of the competition is survival of the fittest and survival of the fittest. Those companies that can produce high-quality and low-cost products that are demanded by the market faster will be able to more quickly Survive well. At present, all processing and manufacturing enterprises are transforming from mass production and large-scale production to multi-variety, small-batch production, and even large-scale production in a fiercely competitive environment. Effectively applying the ideas and theories of plane facility layout to production activities, improving the production efficiency of enterprises, and thus forming a greater competitive advantage are goals that many enterprises need to achieve [1].

Improving production efficiency is the most important, basic and difficult thing for an enterprise to do, while floor layout optimization is a more difficult problem to solve. In the face of fierce market competition and a wide variety of modern management theories and methods, complex and changeable internal Due to the external environment and factors, companies often feel unable to succeed. Management theory itself is the unity of science and artistry. It has strong practicality and cannot be copied mechanically. Therefore, when we draw on and absorb the theory of workshop floor facility layout to optimize the layout of workshop floor production facilities, it is necessary to have an in-depth understanding of it, and then consider the characteristics of

the enterprise for targeted application. Only in this way can we truly make good use of this theoretical tool and give full play to it. Some functions must not be blindly imitated or copied mechanically. The dross should be removed and the essence should be retained. Purposeful selection and exploration of usage methods suitable for the company's situation.

Nowadays, with the rapid economic development, almost all enterprises are faced with the challenge of multi-variety and small-batch production. If enterprises continue to follow the path of large-scale operations, they will face huge risks. However, in this market environment, the production layout of most enterprises The previous layout method divided by functions during large-scale mass production is still maintained. It is this traditional layout model that cannot adapt to frequent changes in market demand that directly affects the economic benefits of the entire company. Therefore, it is completely necessary to analyze and improve the workshop layout. Enterprises can carry out advanced and reasonable layout by analyzing and improving the layout of the workshop with little or no investment, making full use of the enterprise's own financial, material and human resources, and taking the path of internal development. , tap the enterprise's own potential, improve the enterprise's production efficiency and reduce costs, and enhance the enterprise's competitiveness [2].

Workshop layout analysis is a technology that combines economic, technical and environmental protection factors. Excellent workshop floor plan layout can improve the production efficiency of the company, reduce material handling costs, and improve the company's competitiveness. If the company's production capacity cannot meet market demand as its market share increases, it will need to re-organize the floor plan of the workshop. Layout optimization design.

As the main executor of production activities in manufacturing enterprises, the workshop is also the most basic product materialization unit in the manufacturing system. Its working ability is closely related to the production method of the system and the manufacturing technology adopted, and will directly affect the development of products. cycle time, manufacturability, cost of product production, and product quality. As the large-scale production model is replaced by the multi-variety, small-batch production model, manufacturing companies need to make business changes. Improve the flexibility of production management. At the same time, users' requirements for products gradually change from product quantity to requirements for product delivery time, product quality, cost and after-sales service comprehensive strength requirements, which requires enterprises to continuously tap production potential. On the one hand, companies can build new factories and add workshops; on the other hand, they can optimize and transform existing factories to improve efficiency to reduce costs, quickly meet market demand and customer service needs, and improve the economic benefits of the company.

2. Analysis of current situation of workshop facilities layout

2.1. Company and research product profiles

Take the sofa production workshop of Chengdu Ming zhu Home Furnishing Factory No. 10 as an example. This factory mainly produces sofas. Because the factory will carry out strategic upgrades, it will improve the sofa production workshop. According to the process flow and required raw materials of the sofa produced by the company, the BOM table of the sofa production is produced, as shown in Table 1.

Table 1 Sofa BOM list

level	Name	quantity	Make or buy
0	Shafa	1	Make
1	Inner frame	1	Make
1	Outer leather case	1	Make
1	Lining sleeve	1	Make
1	Connectors and feet	6	buy
2	Leather	1	buy
2	cloth	1	buy
2	timber	1	buy

2.2. Analysis of existing problems in the workshop

After investigation and interviews, it was found that the workshop logistics routes crossed frequently, and logistics congestion and even short circuits occurred during production. A large amount of waste is produced during station production to block the channels, which enlarges the logistics route, wastes time, increases the logistics burden, reduces production efficiency, and increases production costs.

In addition, the interaction between workstations was not considered in the layout. For example, the woodworking cutting area and the turning area are too close, causing a large

amount of dust generated during the wood cutting to contaminate the leather and fabric. This results in increased cleanup operations and unnecessary waste of time.

3. Analysis of original facility layout using SLP

The logistics relationship diagram collects the logistics flow data between each unit to obtain the logistics flow from to table, see Table 2

Table 2 Logistics flow from to table

	1	2	3	4	5	6	7	8	9	10	11	12	13
1						50				52			
2									36			35	
3				10		10							
4					34							26	
5							35					25	
6							50					30	
7								51				25	
8											51	13	
9													
10													
11													
12													23
13													

Use the weighted method to conduct comprehensive relationship analysis and create a comprehensive interrelationship table. There are the following requirements for making a comprehensive correlation table:

(1) When comprehensively considering logistics and non-logistics relationships, it is necessary to determine the relative importance of the two relationships. This importance is expressed by the ratio m:n, which should generally not exceed 1:3 3:1;

(2) If the ratio is greater than 3:1, the logistics relationship dominates, and only logistics can be considered for facility layout;

(3) When the ratio is less than 1:3, it means that the impact of logistics is very small, and only non-logistics relationships can be considered;

(4) In actual situations, depending on the relative importance of the two, the ratio can be 3:1, 2:1, 1:1, 1:2, 1:3;

(5) With this ratio and two correlation diagrams, it is necessary to quantify each closeness level in the correlation diagram;

(6) Finally, use the following formula to calculate the comprehensive correlation closeness CR_{ij} between the two operating units i and j . The formula is as follows:

$$CR_{ij} = mMR_{ij} + nNR_{ij};$$

(7) Among them, MR_{ij} and NR_{ij} are the logistics interrelationship level and the non-logistics interrelationship level respectively, and then the comprehensive level can be

divided according to the comprehensive value;

(8) Pay attention to the processing of level X here. When the relationship between any first-level logistics intensity and X-level non-logistics intensity is combined, it should not exceed level 0;

(9) For some operating units that must not be approached, the mutual relationship can be rated as XX level. Finally, the comprehensive relationship diagram is appropriately adjusted based on experience and actual constraints.

Before comprehensive analysis, it is necessary to determine the important rows of the relationship between logistics relationship (m) and non-logistics (n), that is, the weighted value. There is no obvious difference between the relationship between logistics and non-logistics in this workshop. Therefore, assuming the relative importance ratio of the relationship between logistics and non-logistics is 1:1, a comprehensive relationship table is obtained. As shown in Table 3 below.

Table 3 Comprehensive interrelationship table

serial number	operating unit	closeness of relationship				Comprehensive relationship	
		Logistics (weighted value 1)		Non-logistics (weighted value 1)			
		Level	Points	Level	Points	Level	Points
1	1-2	U	0	U	0	0	U
2	1-3	U	0	U	0	0	U
3	1-4	U	0	U	0	0	U
4	1-5	U	0	U	0	0	U
5	1-6	A	4	A	4	8	A
6	1-7	U	0	U	0	0	U
7	1-8	U	0	U	0	0	U
8	1-9	U	0	U	0	0	U
9	1-10	A	4	A	4	8	A
10	1-11	U	0	U	0	0	U
11	1-12	U	0	U	0	0	U
12	1-13	U	0	U	0	0	U
13	2-3	U	0	U	0	0	U
14	2-4	U	0	U	0	0	U
15	2-5	U	0	U	0	0	U
16	2-6	U	0	U	0	0	U
17	2-7	U	0	U	0	0	U
18	2-8	U	0	U	0	0	U
19	2-9	E	3	A	4	7	A
20	2-10	U	0	X	-1	-1	X
21	2-11	U	0	U	0	0	U
22	2-12	E	3	E	3	6	E
23	2-13	U	0	O	1	1	O
24	3-4	O	1	E	3	4	I
25	3-5	U	0	U	0	0	U
26	3-6	O	1	E	3	4	I
27	3-7	U	0	U	0	0	U
28	3-8	U	0	U	0	0	U
29	3-9	U	0	U	0	0	U
30	3-10	U	0	X	-1	-1	X
31	3-11	U	0	U	0	0	U
32	3-12	U	0	U	0	0	U
33	3-13	U	0	U	0	0	U
34	4-5	E	3	A	4	7	A
35	4-6	U	0	U	0	0	U
36	4-7	U	0	U	0	0	U
37	4-8	U	0	U	0	0	U
38	4-9	U	0	U	0	0	U
39	4-10	U	0	X	-1	-1	X
40	4-11	U	0	U	0	0	U
41	4-12	I	2	I	2	4	I
42	4-13	U	0	U	0	0	U
43	5-6	U	0	O	1	1	O
44	5-7	E	3	E	3	6	E
45	5-8	U	0	O	1	1	O
46	5-9	U	0	U	0	0	U
47	5-10	U	0	X	-1	-1	X
48	5-11	U	0	U	0	0	U
49	5-12	I	2	E	3	5	E
50	5-13	U	0	U	0	0	U
51	6-7	A	4	A	4	8	A
52	6-8	U	0	O	1	1	O
53	6-9	U	0	U	0	0	U
54	6-10	U	0	O	1	1	O
55	6-11	U	0	U	0	0	U
56	6-12	E	3	A	4	7	A
57	6-13	U	0	U	0	0	U
58	7-8	A	4	A	4	8	A
59	7-9	U	0	U	0	0	U
60	7-10	U	0	U	0	0	U
61	7-11	U	0	U	0	0	U
62	7-12	I	2	I	2	4	I
63	7-13	U	0	U	0	0	U
64	8-9	U	0	U	0	0	U
65	8-10	U	0	X	-1	-1	X
66	8-11	A	4	E	3	7	A
67	8-12	O	1	I	2	3	O
68	8-13	U	0	U	0	0	U
69	9-10	U	0	X	-1	-1	X
70	9-11	U	0	U	0	0	U
71	9-12	U	0	U	0	0	U
72	9-13	U	0	O	1	1	O
73	10-11	U	0	X	-1	-1	X
74	10-12	U	0	U	0	0	U
75	10-13	U	0	U	0	0	U
76	11-12	U	0	U	0	0	U
77	11-13	U	0	U	0	0	U
78	12-13	I	2	I	2	4	I

44	5-7	E	3	E	3	6	E
45	5-8	U	0	O	1	1	O
46	5-9	U	0	U	0	0	U
47	5-10	U	0	X	-1	-1	X
48	5-11	U	0	U	0	0	U
49	5-12	I	2	E	3	5	E
50	5-13	U	0	U	0	0	U
51	6-7	A	4	A	4	8	A
52	6-8	U	0	O	1	1	O
53	6-9	U	0	U	0	0	U
54	6-10	U	0	O	1	1	O
55	6-11	U	0	U	0	0	U
56	6-12	E	3	A	4	7	A
57	6-13	U	0	U	0	0	U
58	7-8	A	4	A	4	8	A
59	7-9	U	0	U	0	0	U
60	7-10	U	0	U	0	0	U
61	7-11	U	0	U	0	0	U
62	7-12	I	2	I	2	4	I
63	7-13	U	0	U	0	0	U
64	8-9	U	0	U	0	0	U
65	8-10	U	0	X	-1	-1	X
66	8-11	A	4	E	3	7	A
67	8-12	O	1	I	2	3	O
68	8-13	U	0	U	0	0	U
69	9-10	U	0	X	-1	-1	X
70	9-11	U	0	U	0	0	U
71	9-12	U	0	U	0	0	U
72	9-13	U	0	O	1	1	O
73	10-11	U	0	X	-1	-1	X
74	10-12	U	0	U	0	0	U
75	10-13	U	0	U	0	0	U
76	11-12	U	0	U	0	0	U
77	11-13	U	0	U	0	0	U
78	12-13	I	2	I	2	4	I

The drawing position is related as shown in Figure 1.

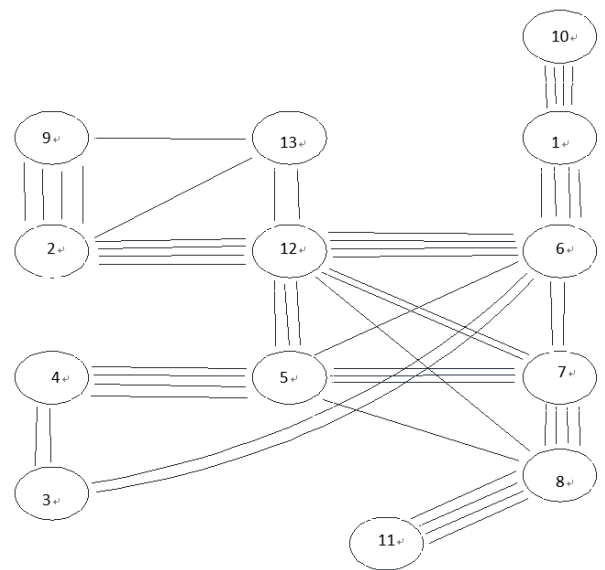


Fig. 1 Work unit location related map

Combining the floor area of each operating unit and its spatial geometry to the operating unit location correlation map, the operating unit area correlation map is obtained. In this process, it is first necessary to determine the actual floor space and appearance of each operating unit. The basic floor

space of an operating unit is determined by factors such as equipment floor space, logistics mode and its passages, and personnel activity venues.

The steps for drawing the work unit area related map are as follows:

Once you have the area and shape of the operating unit, you can draw a diagram related to the area of the operating unit on graph paper.

(1) Choose an appropriate drawing scale. The general ratios are 1:100, 1:500, 1:1000, 1:2000, 1:5000, and the drawing unit is meters (m) or millimeters (mm).

(2) Input the relevant diagram of the location of the operating units onto the graph paper. In order to facilitate the arrangement of the operating units, the symbols of each operating unit should be arranged separately to leave as much space as possible. In order to make the layout diagram more concise, only the closely related levels such as A, E and X level connections are drawn.

(3) Sort by the comprehensive proximity score, and arrange each operation unit on the map in order from large to small. When drawing, draw the geometric shape of the work unit with the work unit symbol as the center. Generally, the working units are rectangular, and a variety of layout options can be obtained by rotating the shape at a certain angle. If there is insufficient reserved space, the position of the operating unit can be appropriately adjusted, but it must be ensured that the adjusted position does not conflict with the requirements of the operating unit position correlation map.

(4) After adjusting and redrawing the work unit area correlation map many times, a more effective work unit area correlation map is obtained.

It is necessary to adjust the work unit area correlation diagram.

The work unit area correlation diagram is directly evolved from the position correlation diagram and is a theoretical and ideal layout plan. We have to make adjustments and corrections to get a feasible layout. In addition to the five basic elements that we must consider here, such as product, output, process, operating unit and time, we should also consider the impact of other factors on the layout plan. According to the SLP method, these factors can be divided into two categories: correction factors and actual condition limiting factors.

Based on the actual situation of the workshop, the main correction factors are: material handling methods. The analysis of the impact of material handling methods on the layout plan is mainly carried out from the aspects of the type of handling equipment, the basic mode of the handling system, and the classification of transportation units (boxes, trays, etc.)

Actual constraints include construction costs, workshop area, utilization of existing conditions in the workshop, policies and regulations, etc.

After comprehensively considering various factors in the workshop, the relevant diagram of the operating unit area is drawn as shown in Figure 2.

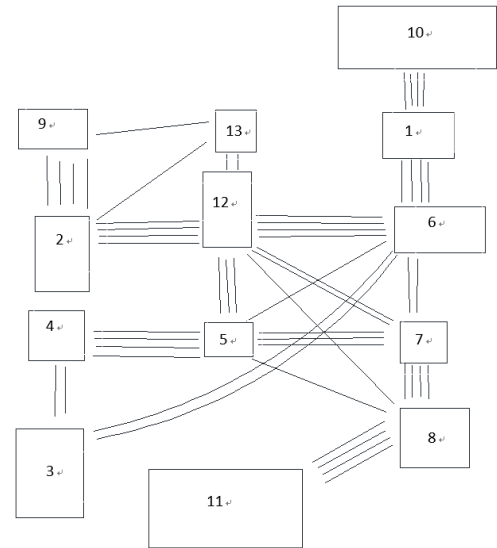
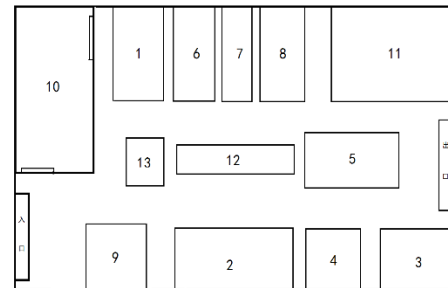


Fig. 2 Analysis related to drawing work unit area

4. Develop improvement plans and evaluate

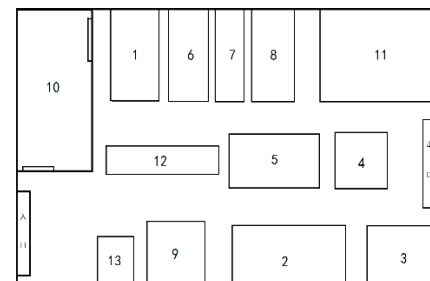
4.1. Improvement plan

Based on the work unit area correlation diagram, the following feasible improvement plans are obtained, as shown in Figures 3 and 4.



(1-woodworking area, 2-turning area, 3-foam cutting area, 4-software core area, 5-software kit area, 6-touch work area, 7-quality inspection area, 8-packaging area, 9-fabric warehouse, 10-woodworking blanking area, 11-finished product area, 12-temporary storage area, 13-outsourced accessories area)

Fig. 3 Floor plan 1



(1-woodworking area, 2-turning area, 3-foam cutting area, 4-software core area, 5-software kit area, 6-touch work area, 7-quality inspection area, 8-packaging area, 9-fabric warehouse, 10-woodworking blanking area, 11-finished product area, 12-temporary storage area, 13-outsourced accessories area)

Fig. 4 Floor plan 2

4.2. Improve results

After the improvement, the distance between adjacent workstations is shortened, the logistics route is shortened, the logistics efficiency is accelerated, and the production efficiency is improved. Separately arranging some workstations that affect each other improves the working environment of employees and eliminates unnecessary waste of time.

In Plan 1, the total logistics transportation distance of a single product is 288m, which is shortened by 67m. The handling and waiting time is 775s, shortened by 60 seconds.

In the second plan, the total logistics transportation distance of a single product is 270m, which is shortened by 85m. The handling and waiting time is 762s, shortened by 73s.

4.3. Program evaluation

Plan 1: Compared with the original layout, the busiest logistics workstations are arranged in the center of the entire layout, and the remaining workstations are arranged on both sides for leather, cloth processing and woodworking processing. Viewed vertically, leather and fabric flow from the lower half to the upper half, with no material return and no crossing of logistics routes. Viewed horizontally, woodworking materials flow from left to right without backflow. Overall, there is no material backflow and almost no route crossings. Greatly save time and cost.

Option 2 This option arranges the outsourced parts warehouse and the leather and fabric warehouse in Option 1 closer to facilitate management. In addition, the two relevant workstations of the software suite are arranged close to each other, which shortens the logistics route and further improves production efficiency.

The above two plans need to be evaluated and screened from multiple angles. After comparing the differences in many aspects and the impact of each factor, the weighted factor analysis method is used to evaluate and screen the two plans. When evaluating and screening plans, investigation and analysis should be conducted to summarize some of the main factors that affect the design of the system layout plan. Combined with the actual situation of this case, these factors mainly include logistics efficiency and convenience, simplicity of the logistics structure, comfort of the working environment, and handling of mutual interference between workstations. Relevant personnel of the project and external experts will conduct discussions and evaluations, and assign weights and grades to each aspect. The weight range is from 1 to 10, and the grades are divided into 5 levels, which correspond to different scores. A is four points, and E is four points. is three points, I is two points, O is one point, and U is zero points. Multiply the weight of a certain aspect by the score of its corresponding level to get the weighted score for that aspect. Then add the scores of each factor to get the score. The highest one is the best solution.

5. Conclusion

This paper uses the SLP method to analyze the layout of workshop production facilities of a furniture manufacturing enterprise. Based on the analysis of the BOM structure relationship and process of the products in the workshop, the

operation units are divided and the logistics and non-logistics relationships between the operation units are analyzed. The logistics intensity and non-logistics intensity between each operation unit are determined, and finally the comprehensive interrelationship and comprehensive proximity between operation units are obtained, and two sets of feasible solutions are proposed. The weighted factor method is used to conduct analysis, calculation and comparison, and finally the two sets of feasible plans are evaluated and the best plan is selected to achieve the purpose of improving production efficiency. After the improvement, the logistics route has been greatly shortened, the crossover of logistics routes has been greatly reduced, and the logistics efficiency and feasibility have been greatly improved. The mutual interference between workstations in the workshop has been greatly improved, and the working environment of employees has been greatly improved.

The research of this paper mainly completed the following aspects of work:

(1) Based on the concept, content, classification and design methods of workshop layout, the design process of workshop layout is explained with practical examples.

(2) The system layout design (SLP) model is introduced in detail, the specific design steps of the analysis method are given, and the theoretical part is introduced for workshop layout evaluation.

(3) Taking the Mingzhu Home Sofa production workshop as an example, we conduct a comprehensive workshop analysis using the system layout design (SLP) model, and finally propose a variety of improvement plans based on the actual situation, which gives flexible choices for workshop improvement.

(4) Comprehensively evaluate multiple improvement plans, select the best plan, and use the best plan as the workshop improvement plan. In this way, the plan can improve the workshop production capacity and is practical.

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