Spatial Layout Optimization of Warehouse Based on Improved SLP

Jing Wang[1, a], Xinsheng Ke[2, b]

[1]School of Economics and Management, Beijing Jiaotong University, Beijing 100044, China;

[2]School of Economics and Management, Beijing Jiaotong University, Beijing 100044, China.

a18125493@bjtu.edu.cn, bxske@bjtu.edu.cn

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Abstract: With the continuous development of global integration, China's agricultural machinery industry has ushered in the era of small profits. In the fierce competition, a complete warehousing system is one of the key factors affecting the economic efficiency of enterprises. This paper considers to use improved SLP method to optimize the spatial layout of workshop warehouse, which takes into account the impact of logistics and non-logistics factors, calculates the comprehensive proximity of each operation unit, draws the location correlation map of the operation unit, obtains the final optimization scheme, and evaluates the optimized scheme. Based on the actual situation of the steel parts processing workshop warehouse in Hongyu Agricultural Machinery Enterprise, the turnover rate and space utilization rate of materials in the warehouse have been greatly improved.

1. Introduction

In the fierce competition environment, the role of warehouse has changed greatly. Although its original function of storage and storage has not changed, to adapt to JIT production and diversified, personalized and rapid response market environment, the importance of picking, delivering and distributing in warehouse has exceeded its storage function [1]. In our country, there are still many problems in the spatial layout of self-owned warehouses of most small and medium-sized manufacturing enterprises, which indicates that the planning of warehouse layout is still in the stage of theoretical research. Empirical research, especially how small and medium-sized manufacturing enterprises optimize warehouse layout and improve their logistics development, needs further study. Scientific and reasonable warehouse layout can improve the space utilization rate of warehouse, reduce logistics costs, shorten the handling distance, and improve the efficiency of warehousing operations [2]. Therefore, it is essential to build a reasonable warehouse spatial layout.

SLP method is generally recognized as the mainstream method of facility layout. This paper takes the warehouse of steel parts processing workshop of Hongyu Agricultural Machinery Co., Ltd. as an example. The space needed by the warehouse personnel, equipment and materials is allocated most appropriately and effectively to obtain the maximum economic benefits of production [3].

The traditional system layout design method was put forward by Richard Muther [4] in 1961. SLP theory was originally put forward for the layout of plant equipment, but with the continuous application of traditional SLP method in layout planning, some problems have gradually emerged [5]. This paper improves the traditional SLP method as follows: firstly, because the object of study is the layout of warehouse, the turnover of parts is the main factor to determine the logistics relationship among functional areas; secondly, it refines the non-logistics factors that affect the layout of warehouse and ensures the comprehensiveness of the layout scheme; thirdly, it is necessary to constantly try and error the linear graph method. Because of the lack of quantification, the relational table method is used instead of the traditional linear graph method to obtain the initial location layout of the warehouse functional area, to increase the accuracy of the scheme. The detailed analysis steps of the improved SLP method [6] are shown in Figure 1.

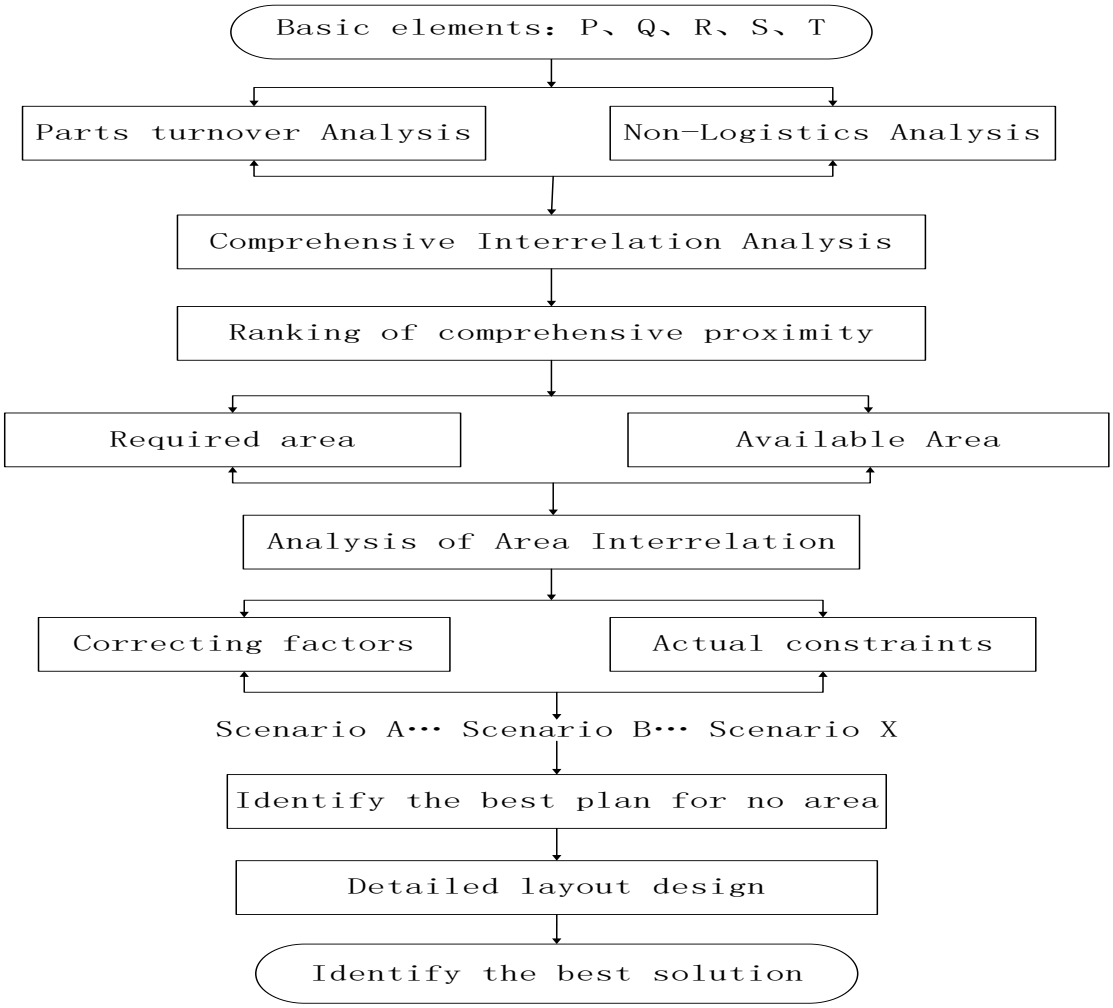

Fig 1. Analysis steps of improved SLP method.

2. Warehouse Problem Analysis

In the traditional SLP method, logistics relationship is mainly determined by logistics analysis in facilities. For warehouse, logistics analysis in warehouse is mainly to analyze the movement of stored goods in warehouse, including the moving order and quantity of goods in function area. Through on-the-spot investigation, we found that the warehouse mainly has the following problems:

1) There are various kinds of sundries, blanks of spare parts and idle machines in the warehouse, which result in the waste of inventory cost.

2) The functional areas are not complete, the non-logistics factors between functional areas are not considered, and the division is not clear.

3) A and B warehouses are separated, each warehouse has only one import and export, and transportation is inconvenient and has certain security risks.

4) Linear flow mode is adopted, but the import and export are on one side, and the logistics route is not flexible.

3. Problem optimization

3.1 Analysis of Logistics Relations.

Logistics relationship refers to the size of logistics volume between functional areas. According to the analysis of the original warehouse and the forecast of the future logistics volume, the original logistics volume of the warehouse functional area is obtained from the table, as shown in Table 1.

Tab.1 Primitive Logistics Volume from Form to Form

Work unit	Loading area	Tally area	Lifting shaft area	Slide valve area	Main control valve area	Other area	Shipment area	Equipment placement area	Total
Loading area	--	3500	0	0	0	0	0	0	3500
Tally area	3500	--	1000	400	500	1600	0	0	3500
Lifting shaft area	0	1000	--	0	0	0	790	0	790
Slide valve area	0	400	0	--	0	0	270	0	270
Main control valve area	0	500	0	0	--	0	370	0	370
Other area	0	1600	0	0	0	--	1480	0	1480
Shipment area	0	0	790	270	370	1480	--	0	0
Equipment placement area	0	0	0	0	0	0	0	--	--

The related tables of logistics are introduced to express the overall logistics situation of workshop in a concise and clear form. Firstly, the degree of closeness is given, including A, E, I, 0 and U. The quantified value and proportion are shown in Table 2.

Tab.2 Classification of Closeness Leve

Symbol	A	E	I	O	U
Significance	Absolutely	Especially	Important	General	Not
Quantization value	4	3	2	1	0
Proportion	5%	10%	20%	30%	35%

From the classification criteria, we can further determine the degree of closeness of the warehouse functional area according to the logistics relationship, as shown in Figure 2.

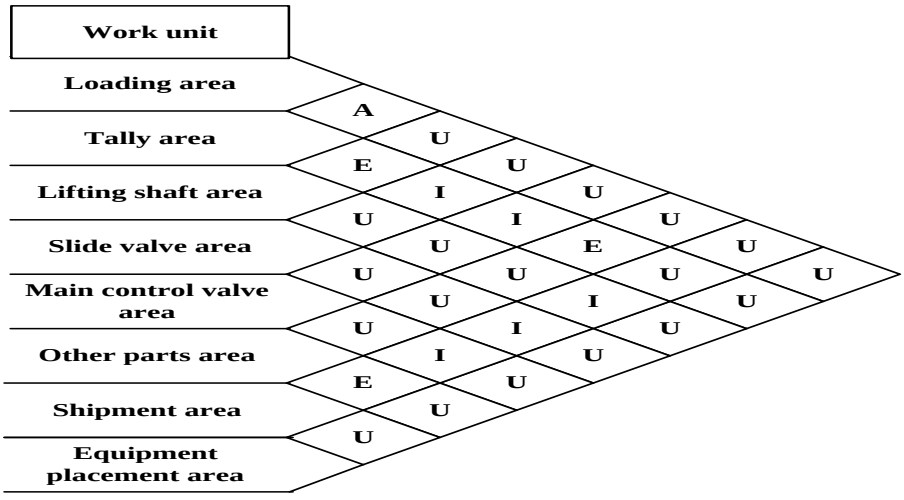

Fig. 2 The Closeness Degree of Warehouse Function Section Based on Logistics Relation

3.2 Analysis of Non- Logistics Relations.

These non-logistics relationships cannot be obtained by qualitative methods, so Table 3 gives some reasons for rating to determine the degree of close non-logistics relationships in functional areas.

Tab.3 Non-Logistics Relations Rating Standard

Number	Rating Reasons
1	Continuity of processes
2	Similarity of Storage Items in Different Functional Intervals
3	Similarity of Conditions between Functional Areas
4	Similarity of orders
5	Similarity of handling equipment
6	Environmental impact
7	Simplicity of working contacts
8	Convenience of supervision and management

According to the rating criteria, make a map of the degree of closeness of warehouse functional areas according to non-logistics relationship, as shown in Figure 3.

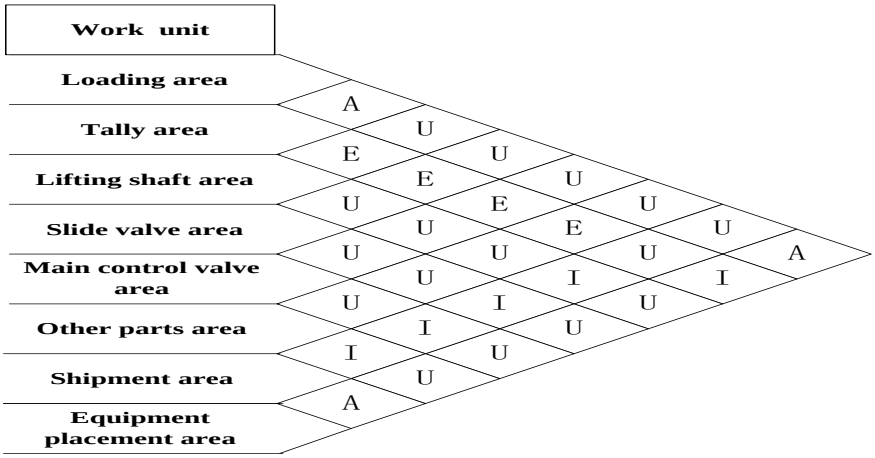

Fig. 3 The Closeness Degree of Warehouse Functional Section Based on Non-Logistics Relations

3.3 Comprehensive Interrelation Analysis.

The layout of warehouse functional area is different from that of traditional production line. Logistics relationship is not the dominant factor. So as far as the layout of warehouse functional area is concerned, the importance of logistics relationship and non-logistics relationship is listed as 1:1 in this paper. The graph of the degree of closeness of warehouse functional areas is obtained according to the comprehensive interrelationship, as shown in Figure 4.

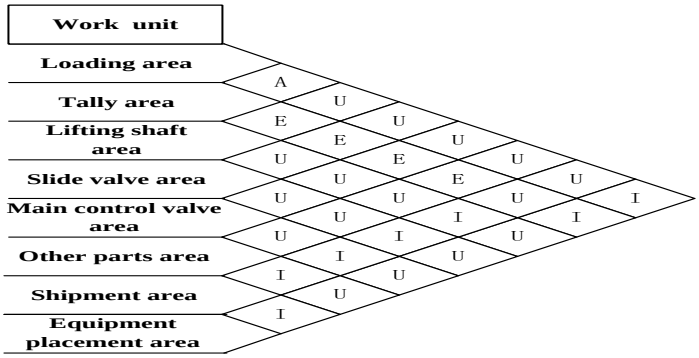

Fig. 4 The Closeness Degree of Function Section Based on Comprehensive Interrelation

3.4 Computation of Comprehensive Approaching Degree of Operating Units.

The comprehensive proximity of an operating unit is the sum of the quantified close scores between the operating unit and all other operating units. This value reflects whether the unit should be in the center or the edge on the layout chart. The higher the comprehensive proximity score of warehouse operation units (A = 4, E = 3, I = 2, 0 = l, U = 0), the closer the operation units are to the center of the layout map; conversely, the operation units should be located at the edge of the layout map. Firstly, according to the level of comprehensive interrelationship, the locations of operation units at different levels are determined in the order of A, E, I, 0 and U, while the operation units at the same level are arranged in the order of comprehensive proximity score.

3.5 Drawing position correlation map of operation unit.

The general layout methods are linear graph method, relation table method, graph theory method and spiral method, etc. Linear graph method needs constant trial and error, and its quantification is not strong. This paper will use the relational table method to obtain the initial location layout of the warehouse functional area. Regardless of the actual area of each functional area, make blocks of the same size for each functional area. Write the code of the functional area in the center, the name on the code, the four corners are placed with the relationship of A, E, I and 0 respectively, and the U-level relationship is not considered. According to the rules of placing non-area blocks: A-level relations should be sidelined, and E-level relations should be at least diagonal. Get several different relative position schemes, and then according to "If A-level edge gets four points, Angle gets three points, do not depend on no score; If E-level edge gets three points, Angle gets two points, do not depend on no score; I-level edge gets two points, do not depend on no score, O-level depends on one point, do not depend on no score" to evaluate the scheme, get a better scheme, score of 38 points, see Figure 5.

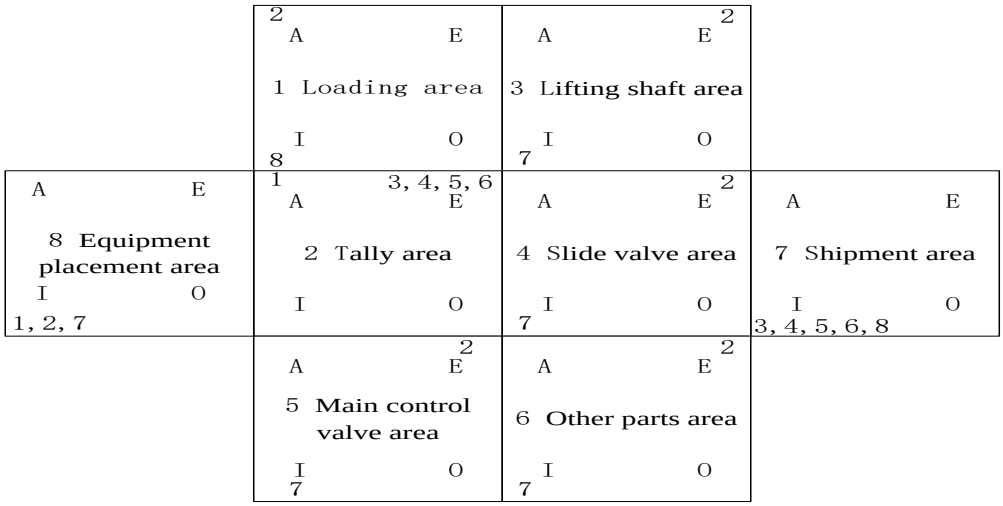

Fig. 5 Optimal layout without area

Different functional areas in the warehouse have different influencing factors. Storage is the main function of the warehouse. Storage area will account for 50% - 60% of the whole warehouse area. Combining with the original warehouse design, the layout chart of the area can be obtained as shown in Figure 6.

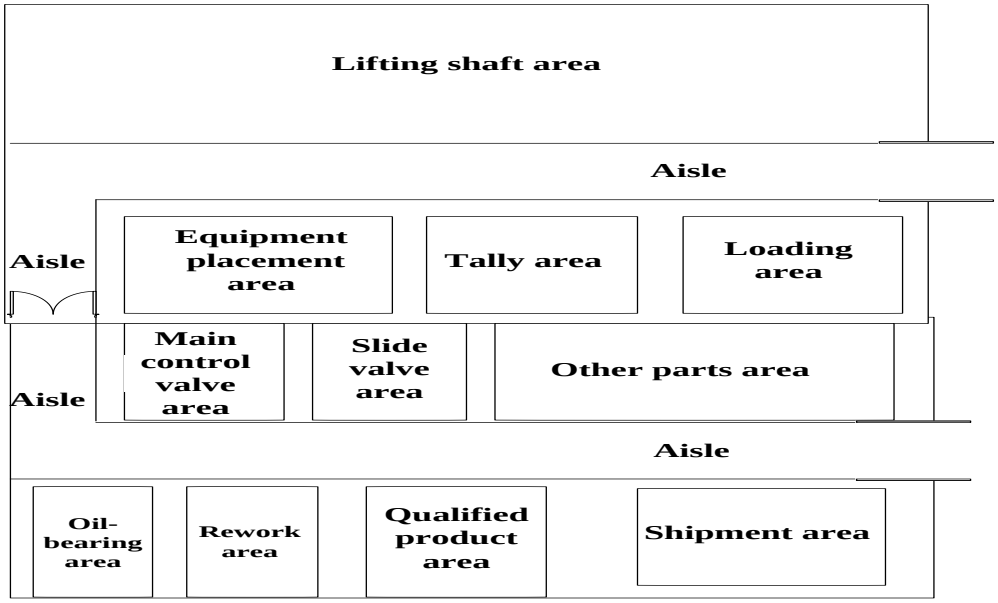

Fig. 6 Optimized warehouse layout

4. Improvement Effect Analysis

In this paper, the warehouse of steel parts processing vehicle of Hongyu Agricultural Machinery Co., Ltd. is investigated. The operation units of the warehouse are reasonably divided and arranged by the method of system layout design. Through this improvement process, the warehouse is realized:

1) The U-shaped logistics route is adopted to determine the location of each operation unit to make the system more flexible.

2) The turnover rate of parts in warehouse is improved, the reaction speed of warehouse is increased, and the production efficiency is also improved.

3) Make the storage clear, ensure the safety of production, inspire staff morale, and make the organization dynamic;

4) It reduces the waste of personnel, places and time, and reduces the production cost.

5) A neat working environment is conducive to improving and enhancing the corporate image.

Although warehouse layout is one of the key factors affecting enterprises, the most important thing for these small and medium-sized enterprises to survive in the era of low profit is to speed up industrial upgrading and adapt to the rapid development of society in the agricultural machinery industry with such fierce market competition at home and abroad.

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