Research on layout planning of disinfection tableware distribution center based on SLP method

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Abstract. This paper is taking Kangjie disinfecting tableware distribution center as an example. First of all, analyze the basic operation processes and the whole area is divided into eight parts. Use SLP method to analyze the correlation between logistics and non-logistics, the combination of these two can get a comprehensive correlativity. And determine the extent of distance correlation between regions and to determine the location of each operation area. The goal of this paper is to relatively optimize the design of the spatial layout and area of the Kangjie disinfection tableware distribution center, and further improve the rationality of the distribution center.

1 introduction

Disinfection tableware is a necessity in people's life, and its significance is obvious. Especially in the new environment of modern economy, people's purchasing power is increasing, and their awareness of the safety of catering is also very high. An increasing number of people prefer to using sterilized tableware when dining out. With the refinement of industry division and the rapid development of modern logistics industry, if the planning and design of the distribution center for disinfection tableware supplies is reasonable, work efficiency will be greatly improved and overall costs will be greatly reduced.

System Layout Planning (SLP) is a method of rationally planning the layout of the distribution center. Through the division of the distribution center operation unit, logistics and non-logistics correlation analysis, the new layout plan is finally determined by the comprehensive correlativity. The SLP law was proposed in 1961 by Richard Muther, a well-known American logistics expert [1]. The scientific application of this method can make the layout of the various functional areas of the distribution center more reasonable.

This paper is organized in four sections. Section 2 describes the status of distribution Center, including the operation flow of distribution center and layout problem. Section 3 presents SLP method and determine the relative position of the operating unit based on SLP method. Section 4 shows the results for the layout planning and evaluates the proposed method's performance. Finally, section 5 concludes the paper and point out the limitations and further work on this paper.

2 Status of Distribution Center

2.1 Distribution center operation flow

The disinfection tableware distribution center is a processing distribution center. Its basic operation flow adopts the remanufacturing closed-loop supply chain network design. The main operation flow includes warehouse storage, cleaning and disinfection, packaging, warehousing, order picking, distribution and recycling [2], as shown in Figure 1.

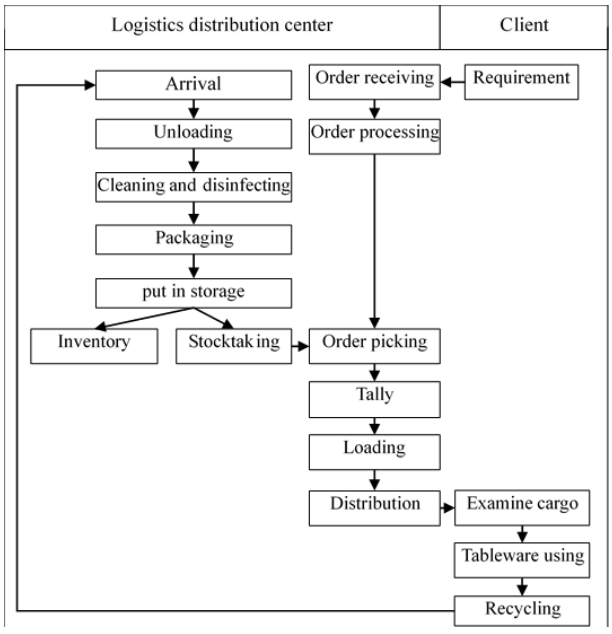

Figure 1. Distribution center operation flow chart

2.2 Disadvantages of the original layout of the distribution center

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Kangjie disinfecting tableware distribution center is a large-scale distribution center that integrates tableware cleaning, disinfection and distribution services.

The distribution center's main business method is to sign third-party agreements with restaurants and other company engaged in the catering industry to provide warehouses and tableware recycling, disinfection and distribution services. In accordance with the order requirements of the partner, deliver the specified goods to different customers on time. The order requirements are complicated. Through a field survey of the company's distribution center layout, it was found that the distribution center had problems such as long waiting time for storage, long picking time, inaccurate warehouse inventory and vacant shelf space.

3 Application of SLP in distribution center layout

3.1 Distribution center operation area division

According to the on-site investigation of the distribution center, it can be divided into eight areas according to its basic operation process: loading area, temporary storage area, disinfection area, tally area, storage area, shipping area, equipment area and Office area [3].

Unloading area: the area for loading and unloading.

Temporary storage area: an area for temporarily storing recycled tableware.

Disinfection area: an area for cleaning, disinfection and packaging of contaminated tableware after entering the distribution center.

Tally area: the area for inspection, tally, inventory and other operations of clean tableware after disinfection.

Warehousing area: a storage place for disinfection tableware, an area that provides storage, storage, and warehouse access services.

Shipping area: the area where the final inspection and confirmation before delivery and the delivery-related affairs are handled.

Equipment area: storage area for pallets, cranes, forklifts and other facilities and equipment.

Office area: the area where employees of the distribution center engage in office activities, data storage management, and logistics information systems.

3.2 Analysis of the logistics correlation of each operation area

In the production and storage of products, corresponding logistics will inevitably occur between various processes. Therefore, in the research, logistics intensity is often used to express the logistics quantity. Logistics correlation is analyzed by logistics process diagram and process flow chart of various products. The logistics analysis is finally presented in the table of the correlation degree of the logistics of the operation unit [4].

SLP analysis of logistics correlation is usually based on logistics object - P and logistics quantity - Q, divided into five levels. They are A, E, I, O and U. Its logistics correlation level decreases from high to low in turn. Among them, A has the lowest proportion of routes but the highest logistics quantity, O has the highest proportion of routes but the lowest logistics quantity, and there is almost no logistics quantity between the two regions with level U, as illustrated in the table 1.

Table 1. Logistics correlation level list

logistics correlation	symbol	Route proportion	logistics quantity
Absolutely important	A	5%-10%	30%-40%
specially important	E	10%-20%	20%-30%
Very important	I	20%-30%	10%-20%
Commonly important	O	30%-40%	5%-10%
unimportant	U	0	0

Through the statistics and analysis of the distribution center's operation process and logistics quantity, the logistic quantity between the relevant operating units of the distribution center is obtained. And then, according to the operation process and circuit of disinfected tableware in distribution center, the logistics correlation between all regions is analysed combined with the actual operation of disinfection tableware distribution center. The logistic correlation diagram is used to simply represent the logistic correlation between two work areas. The letters corresponding to the two job areas indicate their degree of correlation [5], as shown in Figure 2.

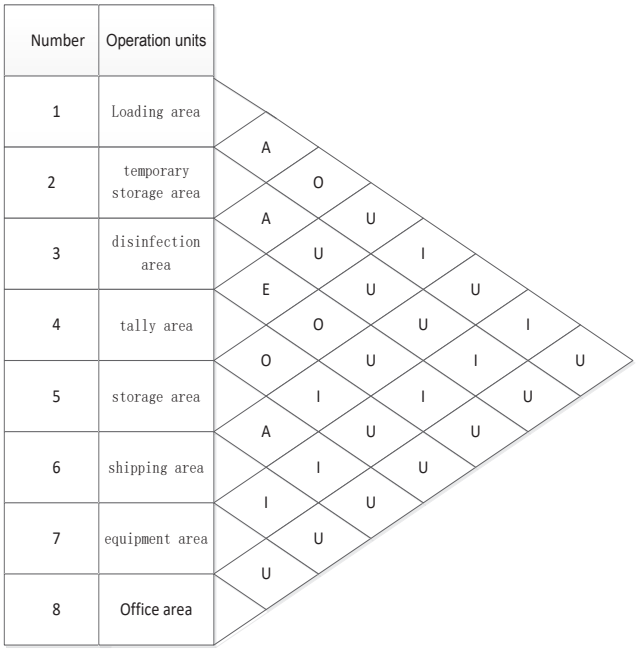

Figure 2. Operation unit logistics correlation figure

3.3 Analysis of the non-logistics correlation of each operation area

The non-logistics factors in the distribution center have a great impact on the process operation and efficiency of

the entire distribution center. For the layout of the distribution center, combined with the actual situation, the following factors need to be considered [6]:

- Degree of continuity between operations
- Operational correlation;
- Convenience of using facilities;
- Convenience degree of operation;
- Continuity of equipment running operations;
- Urgency of the service;
- Whether it is convenient for the staff to manage the operation process;
- Influence on the noise and hygiene of the surrounding environment;

According to the analysis of the non-logistics correlation, the level and mutual closeness of each operation unit are obtained, and the non-logistics mutual correlation diagram is obtained, as shown in Figure 3:

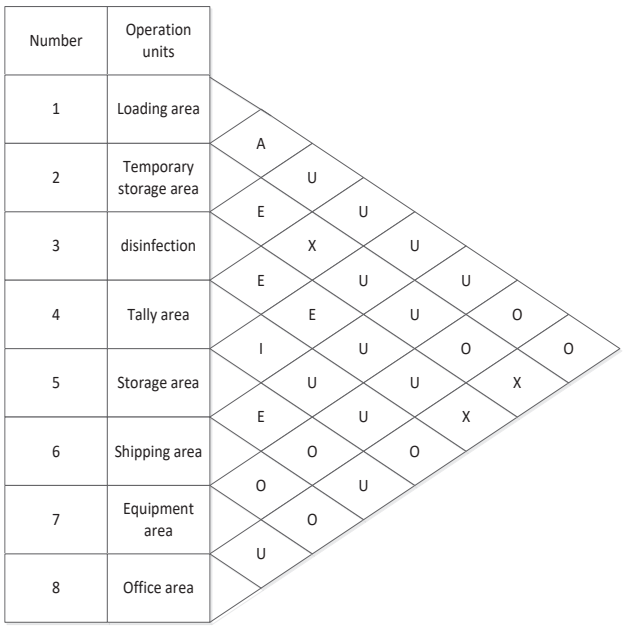

Figure 3. Operation unit non-logistics correlation figure

3.4 Comprehensive correlation of operation units

After determining the logistics correlation and non-logistics correlation between all operation units of the disinfection tableware distribution center, assign A, E, I, O, U, X to 4, 3, 2, 1, 0, -1 and then calculate. Considering that the impact of logistics correlation and non-logistics correlation is different (Obviously, logistics correlation is relatively more important), select a weighted value of logistics correlation: non-logistics correlation = 3:1 for weighted summation, so as to get the score of the comprehensive correlation between all operation units. And use letters to indicate the comprehensive correlation between them as below Figure 4:

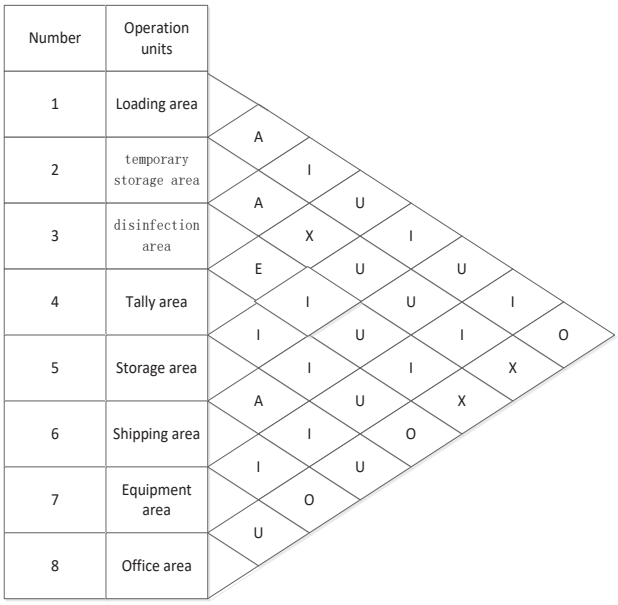

Figure 4. Operation unit comprehensive correlation figure

3.5 Determination of the relative position of the operating unit

According to the different levels of operation units in the comprehensive relationship table, the analysis of the distribution center operation unit is planned. The distance with high level is closer, and the distance with low level relationship is relatively far. The operation unit arranged in the middle has a higher comprehensive score, While the operation unit arranged on the edge has a lower score. Priority is given to the placement of A and E level relationship operation units. Secondly consider the I, O level operation unit.

Different line colors are used to indicate different levels of correlation. The two work areas with correlation level A are represented by red lines, the two work areas with correlation level E are represented by yellow lines, and the two work areas with correlation level I are represented by yellow lines. It is represented by a blue line, the two work areas with a correlation level of O are represented by a green line, there is no connection between the two work areas with a correlation level of U, and the two work areas with a correlation level of X are represented by a dotted line[7] as shown in Figure 5.

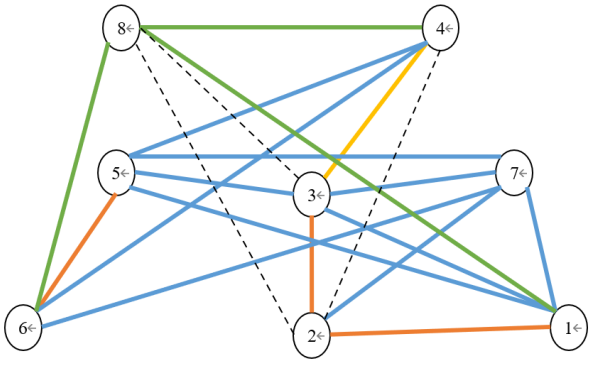

Figure 5. Operation unit correlation line figure

4 Program evaluation

Method of weighted factor comparing to take various factors that affect the existing layout of the distribution center, whether it is qualitative or quantitative, use these factors to express the satisfaction of the distribution center layout plan after comprehensive consideration [8].

4.1 Calculation of weighted factor comparison method

When classifying, the level of each class is assigned a different value. Different factors have different degrees of influence on the layout plan and need to set weight. Finally, comprehensively calculate the overall score of the layout plan. The level of the score can evaluate the rationality, advantages and disadvantages of the layout plan [9].

$$W = \sum_{i=1}^{a} n_i f_{ij} \quad (1)$$

W - Overall score of layout plan

f_{ij} - Evaluation of the i-th factor on the different grades of scheme j

n_i - i-th weight coefficient

The evaluation grade and score are A=7, B=5, C=3, D=1. The plan that total score is higher is better than the plan that total score is lower.

4.2 Determine the comparison evaluation level of the new and old layout plan

Comparative evaluation needs to determine the type of factors and the weight of each factor:

- The level of work efficiency: 0.5
- Reasonable layout: 0.2
- Job safety: 0.2
- Decrease rate of goods storage damage: 0.1

Thus, the comparison evaluation level of new layout plan:

- The level of work efficiency: A=7
- Reasonable layout: B=5
- Job safety: B=5
- Decrease rate of goods storage damage: C=3

The comparison evaluation level of old layout plan:

- The level of work efficiency: B=5
- Reasonable layout: C=3
- Job safety: C=3
- Decrease rate of goods storage damage: D=1

4.3 Comparing results

The calculation result of the new and the old layout plan evaluation level is as below:

New plan: 0.5*7 + 0.2*5 + 0.2*5 + 0.1*3 = 5.8

Old plan: 0.5*5 + 0.2*3 + 0.2*3 + 0.1*1 = 3.8

According to calculation, the score of the new plan is higher than that of the old scheme, so the layout of the new plan is more reasonable [10].

5 Conclusion

The distribution center layout is analyzed and calculated by the SLP method, and a new layout plan is obtained. Comparing the old and new layout plan, it is concluded that the location of the temporary storage area and the item storage area has not changed, and other areas have some adjustments. Through the optimized layout plan, the positional connection between the operation units is closer, which effectively improves the operation efficiency and reduces the operation time. In line with the company's requirements for the optimization of the distribution center layout, the warehouse layout is more reasonable, the operation route is clearer, and the operation efficiency is improved.

Limitations of this paper is lack of consideration of the latest science and technology. The future work includes the consideration of computer information systems for distribution center based on original method in order to operating intelligence, automation.

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