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Simulation and optimum design of cold chain logistics storage process

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Abstract. With the rapid development of fresh electricity business, cold chain logistics has attracted more and more attention. As a key node of cold chain logistics, cold chain storage process design has become an important current cold chain logistics problem. however, in real life,unreasonable design of often lead to low efficiency of storage system operation. In view of this situation, this paper analyzes the current situation of domestic and foreign research, using the RaLC simulation software to explore the ZM cold chain logistics storage system process, finds that many of its problems are rooted in the layout planning, equipment selection, unreasonable staffing. On this basis, this paper discusses the construction of realistic adaptability and forward-looking fresh electricity business warehousing process design.

Keywords: simulation, cold chain logistics, storage process optimization

1 Introduction

In recent years, China's per capita spending power has increased significantly with the economic development, and China's cold chain logistics development is very rapid[3, 13, 14]. In addition, according to the "CPC Central Committee on the formulation of national economic and social development thirteenth five-year plan recommendations": the implementation of "Internet +" action plan. In the "Internet +" action plan, a large number of capital will be poured into fresh electricity business. China's cold chain logistics market prospects are optimistic, and the cold chain logistics market will continue to maintain steady and rapid growth.

However, in the context of rapid growth in demand for cold chain, cold chain storage, as cold chain logistics key node, has not become the crowning touch. On the one hand, the shortage of cold storage has led to the low level of the per capita cold storage in our country, and the gap will be widening[2, 6, 8, 21]. On the other hand, the low level of automation of cold storage and regional uneven distribution are prominent. The development of cold storage in the central and western regions of China is poor, and the number of eastern regions has advantages but the quality is not much different from that of the west[19, 23]. Both regions have great development space. Not only that, the "thirteen five" planning proposal also put forward the concept of innovation, coordination, green, open, shared development, which will mean that the construction of cold storage more emphasis on environmental protection and energy saving. Above all of the cold chain storage development, means challenges, but also opportunities[10, 12, 20].

ZM Modern Logistics Co., Ltd. as one of the earliest companies engaged in cold chain logistics, is now in the industry-leading level. In recent years, ZM company puts forward the strategy of the library, in the background of increasing national cold storage construction policy support, the eastern region of the low level of automation, cold storage in the western region, fresh electricity into the cold chain market, Improving the level of automation is the key to the leading supply chain solution provider.

On the basis of fully studying the current situation of domestic and foreign research, it is found that domestic scholars will use the modeling and simulation to deal with the logistics process, and the influencing factors such as layout will be taken into account in the analysis process.

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This paper uses the logistics simulation software RaLC to model the existing storage system process of ZM cold chain logistics company, analyze its bottleneck, and change its existing layout, equipment and equipment model, personnel configuration and other parameters to achieve the purpose of optimization, and put forward a series of optimization proposals. In addition, in the process of cold chain storage system planning for fresh electricity business, this paper adds the inspiration to analyze the existing cold chain storage system in the basic principle of process planning, and make a more reasonable program for cold storage process design.

2 Literature review

From the relevant literature, domestic scholars mainly explore storage system planning and design from system layout, process, and intelligent aspects. Among them, Zhou Jian[24] takes the system layout design SLP method as a guide to carry out the layout optimization of cold chain logistics center, at the same time, the author combining the general warehouse with cold storage analysis, takes into account the special characteristics of cold storage.

Li[18] uses the system analysis method to carry on the internal layout and the process plan to the distribution center of the fresh product, and constructs the distribution center model with flexsim simulation software, and optimizes the model scheme at the same time.

Liang[11] takes the SLP theory as the main method of the internal layout planning of a logistics center, and makes the location selection, scale positioning, functional area planning and layout of the logistics center. On this basis, he obtains several sets of internal layout planning scheme and use the program evaluation method to evaluate the various programs, and finally puts forward the corresponding information system planning according to the final plan.

Based on the characteristics of cold chain logistics and the basic flow of logistics, Xu[22] establishes the model of cold chain logistics flow. The model includes transportation, storage, loading and unloading, purchasing and so on. Finally, the index classification system is established to analyze the storage process nodes of fresh meat products, and a series of suggestions are put forward for the normal operation of the process.

In foreign countries, many scholars study the storage system. Among them, Fang et al.[5] analyze the traveling salesman problem and the solution of the problem, and establish the storage system model with the improved genetic algorithm.Osvald and Stirn[17] use the mathematical model to optimize the cold chain distribution problem as a VRP problem with a time window, and evaluate the proposed solution.McGinnis[16] studies the performance of the order satisfaction rate, warehouse operation efficiency, inventory management efficiency of warehousing system.Kozenski and Behn [9] argue that the use of WMS can effectively improve the efficiency of cold chain storage operations.

These domestic and foreign scholars with a clear algorithm and modeling approach to solve the storage system layout, operation process, equipment selection and other issues, and point out that the important role of the cold storage in the cold chain[1, 4, 7, 15]. In addition, the scholars also propose that WMS can be applied to the cold chain storage medium, these views not only show the scholars' deep concern about the logistics technology, logistics engineering, but also show that the scholars have a very In-depth insights its logistics disciplines, logistics industry.

3 Simulation and optimization of the present situation of warehousing process

The purpose of the design is to facilitate the operation, the design must be used to create conditions, or cold storage design must serve the needs of the operation, so that cold storage can improve operational efficiency and benefit. In this chapter, the status quo of cold storage operation in Chengdu is analyzed by field investigation and RaLC 4.5 simulation software. The simulation optimization model is obtained by adjusting the internal layout, personnel configuration and equipment selection. This paper presents a visualization of the design of the process based on layout planning, equipment selection and personnel allocation, which is

based on the analysis of the flow problems caused by the lack of attention to the internal layout and equipment selection.

3.1 Overview of the status quo of chengdu cold storage

ZM Chengdu cold storage was built in Shuangliu West Port Logistics Park, in May 2015, serving the contract warehousing, electricity business warehousing. there are total 3200 square meters in cold storage and freezers, the room temperature library has office area, tray forklift temporary storage area, cold storage with collection, delivery area, storage area, adjustable closed platform, pretreatment processing area and so on, There are 2 dispensers / forklift workers, 1 order information officer, 2 unloading staff, 1 documentary, 1 warehouse manager, 1 warehousing manager, 2 sorting crew, packer 1 name. The job content and job division of the general situation is as follows:

1. Contract warehousing service According to the storage instructions, order information staff prints the storage list, shelves and other documents related to warehousing, the customers' arriving time, according to the information stored in the warehouse order information staff checks the consistency of physical information; cargo acceptance, the warehouse staff attributes the goods based on goods category, as well as the classification of the temperature requirements, forklift / tally clerk according to the shelves of a single tray on the shelves; received picking notice, the library staff arranges a library operations.Forklift in accordance with customer orders, sorts goods, To the temporary storage area, and the goods will be transferred to the vehicle by batch, until the driver check the finished goods, and the library is completed.

2. Fresh electricity business warehousing service library operations After receiving the customer orders, the company receives the order and prepares the storage. According to the agreed time, when the goods arrive, the quality inspection staff to test the number of products, quality specifications, the list of goods to audit At the same time, the statistics staff print bar code, and paste with the goods, the label must be consistent with the goods; According to the customer order requirements, sorting the goods, sent to the temporary storage. The package of the pack; the packer on the picking area from the goods according to its packaging requirements, select the appropriate packaging in turn packaged, tally officer to the distribution vehicle driver.

Combined with the characteristics of fresh electricity commodity demand and ZM partners (mainly Jingdong) fresh purchase site awareness, set the storage data, according to the average level of logistics equipment and logistics operations personnel operating efficiency experience, set the equipment Running speed and staff operation efficiency, and set the refrigerator to the library time for the random data.

1. Storage data Cold storage 9:00 am - 17:00 pm between the total storage of 7 goods, a total of 101 trays, each tray about 30 boxes of goods, packaging size $20 \times 30 \times 40mm$, of which 34 tray boxes storage, 77 tray unpacking in bulk. Specific storage data in the table below (Tab. 1).

2. Out of the library data Cold storage one day receives about 2,000 customer orders, and the model will bulk orders out of the amount of "box" for the unit count, the library standard box size $20 \times 30 \times 40mm$, bulk cargo orders out of the unit set to " Tray ", the specific out of the library data shown in the table below (Tab. 2):

Table 1: Storage data sheet

	Trailer area	Racking shelf area
Adjustable library	7	20
Cold storage (dairy)	13	5
Cold storage (meat and poultry eggs)	6	12
Freezer (ice cream, etc)	3	11
Freezer (aquatic products)	3	9
Air conditioning library	3	8

3. Equipment and personnel operating target efficiency data

The speed of the shuttle is set at 1.11 m / s, the forklift is set at a speed of 15 km / h, the sorting conveyor is set at a speed of 7,000 / hour, the packer is set at 25 / Speed of 3 minutes / tray, pretreatment processing

Table 2: Out of the library data table

	Trailer Rack Area (Pallet)	Fluent Rack Area (Box)
Adjustable library	7	600
Cold storage (dairy)	13	150
Cold storage (meat and poultry eggs)	6	360
Freezer (ice cream, etc)	3	270
Freezer (aquatic products)	2	330
Air conditioning library	3	240

operator unpacking speed of 5 minutes / tray, storage sorting rack speed of 0.4 minutes / turn box. Out of the library, each customer orders about 1.65 items, bulk pickers picking speed of 2.6 pieces / min, cargo loading operator loading and unloading efficiency of 10 / min.

3.2 Analysis of cold storage operation and suggestions for optimization

Through the operation of the model, the operator statistics are as follows (Fig. 1 and Fig. 2): From 9:00 am to 5:00 pm, the operator's workload and operating time are as follows:

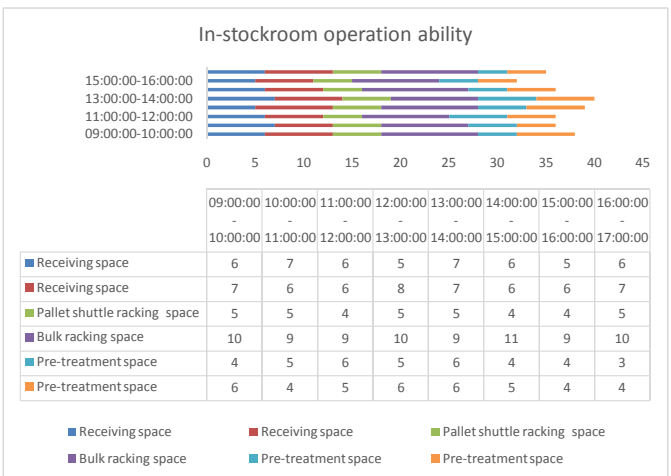


Fig. 1: Hours of efficiency of each operator in storage operations

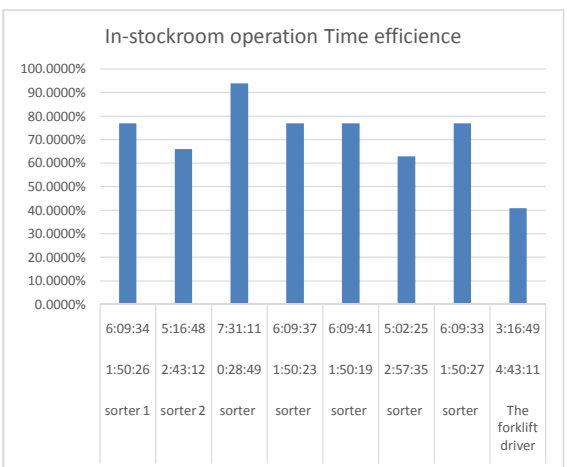


Fig. 2: Time chart for the efficiency of each operator

Receiving area unloader 1: unloading yards a total of 48 pallets, the actual working time of about 62%;

Receiving area unloader 2: unloading yards a total of 53 pallets, the actual working time is about 66%;

Shuttle car shelf area forklift workers: a total of 37 trays, the actual working time of about 43%;

Unpacking Bulk Carrier: A total of 77 pallets are handled, the actual working time is about 48%;

Through Fig. 3 and Fig. 4, we can get the following information:

Pretreatment processing area package demolition staff 1: unpacking 37 pallet goods, a total of 1110 boxes, the actual working time is about 88%;

Pretreatment processing area package demolition staff 2: unpacking 40 pallet goods, a total of 1200 boxes, the actual working time is about 90%;

Warehouse sorting crew 1: handling 520 turnover boxes, the actual working time is about 87%;

Warehouse sorting crew 2: handling 601 turnover boxes, the actual working time is about 89%;

Adjustable Warehouse Bulk Picker 1: Sampling sorting A total of 483 items from 293 orders, the actual working time is about 77%;

Adjustable library bulk cargo picker 2: Sowing sorting from 307 orders of a total of 507 goods, the actual working time is about 81%;

A total of 585 items from 355 orders sorted, the actual working hours of about 94%;

Refrigerated Warehouse 2 (Dairy Store) Bulk Cargo Picker: Sampling sorting a total of 482 items from 165 orders, the actual working time is about 77%;

Freezers 1 bulk cargo picker: sowing sorting from 165 orders a total of 482 pieces of goods, the actual working time is about 77%;

Freezer 2 (aquatic product store) Bulk out Porter: Sowing sorting A total of 392 items from 245 orders, the actual working time is about 63%;

Air cargo library (high-grade fruit and vegetable products) bulk cargo out of the porter: sowing sorting from 165 orders a total of 482 pieces of goods, the actual working hours of about 77%;

Detailed data on the full-time workload of the operator are shown in the following Fig. 3 and Fig. 4:

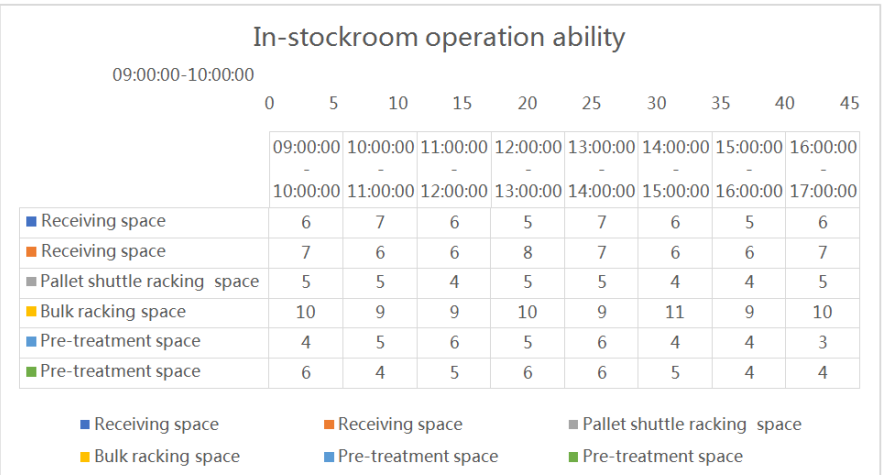


Fig. 3: Work experience of each operator in the storage operation (unit: tray)

Through the Fig. 5 and Fig. 6, we find the following result:

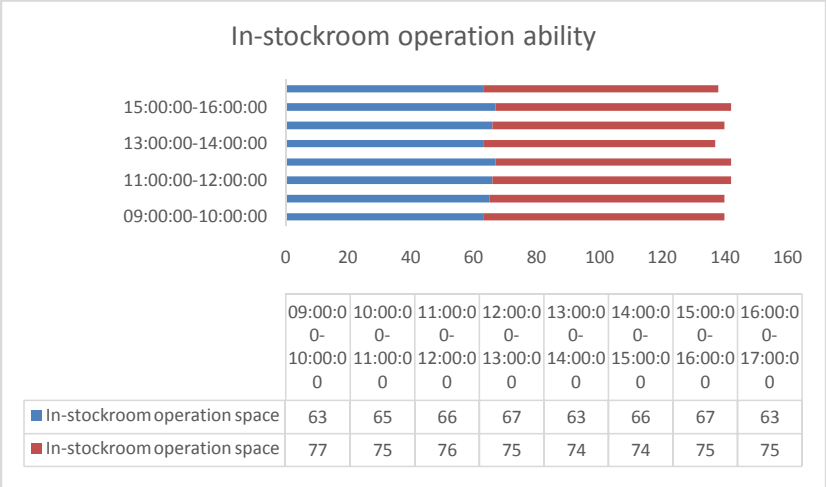
Bulk Cargo Forklift / Porter: 31 pallet cargo handling, totaling 930 boxes of goods, the actual working time is about 41%;

Cargo loading operator 1: handling 1725 goods, the actual working hours of about 72%;

Cargo loading operator 2: handling 1867 goods, the actual working hours of about 78%.

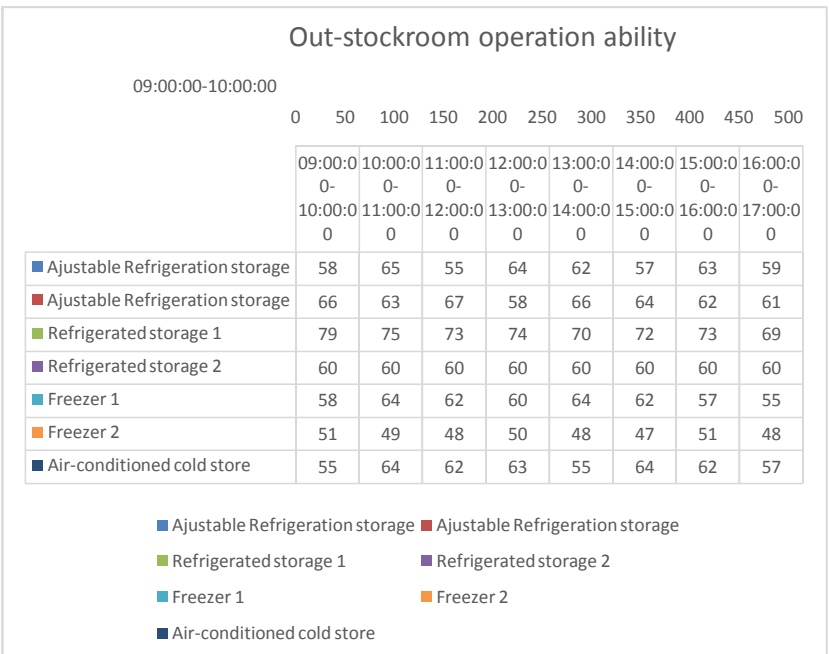
Based on the above statistical results data, the following results can be obtained:

The model has a special collection and delivery area, located in the cold storage on both sides, which shipped the bulk of the bulk of the bulk of the platform and bulk cargo out of the platform, in the day of



	09:00:00-10:00:00	10:00:00-11:00:00	11:00:00-12:00:00	12:00:00-13:00:00	13:00:00-14:00:00	14:00:00-15:00:00	15:00:00-16:00:00	16:00:00-17:00:00
In-stockroom operation space	63	65	66	67	63	66	67	63
In-stockroom operation space	77	75	76	75	74	74	75	75

Fig. 4: Bulk warehousing sorting operator operating capacity chart (unit: box)

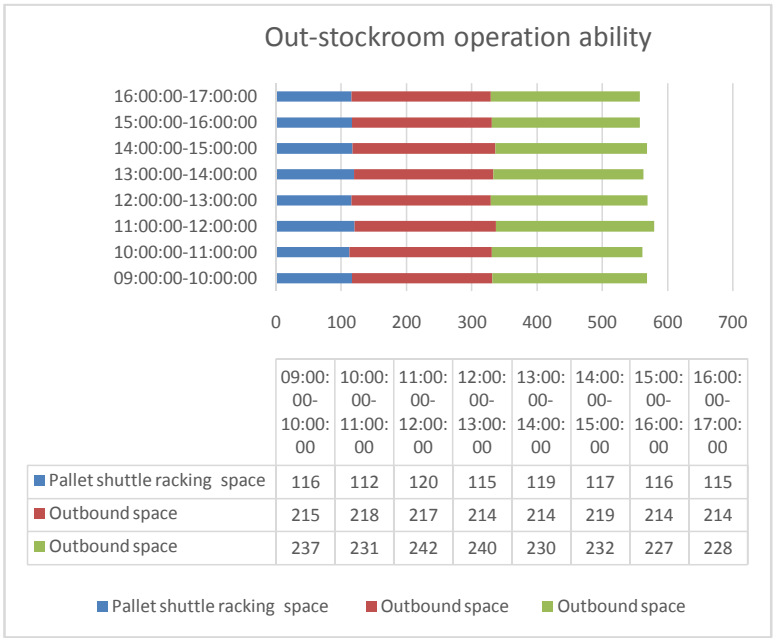


	09:00:00-10:00:00	10:00:00-11:00:00	11:00:00-12:00:00	12:00:00-13:00:00	13:00:00-14:00:00	14:00:00-15:00:00	15:00:00-16:00:00	16:00:00-17:00:00
Ajustable Refrigeration storage	58	65	55	64	62	57	63	59
Ajustable Refrigeration storage	66	63	67	58	66	64	62	61
Refrigerated storage 1	79	75	73	74	70	72	73	69
Refrigerated storage 2	60	60	60	60	60	60	60	60
Freezer 1	58	64	62	60	64	62	57	55
Freezer 2	51	49	48	50	48	47	51	48
Air-conditioned cold store	55	64	62	63	55	64	62	57

Fig. 5: Bulk sorting out the work of the operator sorting ability (unit: pieces)

cold storage operation simulation process, And the use of shuttle car shelves system, the forklift on the shelf work efficiency than ZM cold storage significantly improved, the workload of similar working hours is only about 40%, this time forklift employment methods available part-time, other workers are more saturated. The use of sowing sorting with fluent shelves and steel frame structure and other equipment, sorting warehousing operators and bulk sorting out of the library staff processing time is reduced, the workload is saturated. In order to ensure that the cold storage operation can not only meet the conventional logistics can also cope with unexpected situations, but also training forklift learning sorting operations in the forklift leisure time to help sort, making the overall efficiency of cold storage has been further improved, and can save labor costs.

In addition to the above statistics, the overall workload there is a greater room for improvement, if you do not consider the introduction of sorting conveyor, set up two sorting division sorting, the overall workload will tend to saturation.



	09:00:00-10:00:00	10:00:00-11:00:00	11:00:00-12:00:00	12:00:00-13:00:00	13:00:00-14:00:00	14:00:00-15:00:00	15:00:00-16:00:00	16:00:00-17:00:00
Pallet shuttle racking space	116	112	120	115	119	117	116	115
Outbound space	215	218	217	214	214	219	214	214
Outbound space	237	231	242	240	230	232	227	228

Fig. 6: The bulk of the goods sorted out the library staff work ability map

4 Conclusion

With the vigorous development of ZM cold chain logistics company, the company puts forward the urgent need for cold storage design, and how to design a good cold storage is the specific problem for enter prises and related departments. In the traditional cold storage process design, equipment selection, internal layout, personnel set's split often lead to cold storage operation bottleneck. Therefore, based on the concept of integrated system, this paper constructs the optimized design scheme of cold storage process for fresh electricity merchants. The main work of this paper is as follows:

- Through the field investigation and RaLC4.5 simulation software, this paper analyzes the status quo of ZM cold storage operation, the author gives the inspiration of the process optimization design from the perspective of cold storage operation.
- Based on the results of the scheme design, the RaLC4.5 simulation software was used to simulate the cold storage operation for the fresh electricity business, and the model was equipped with the appropriate personnel. By analyzing the workload and time efficiency of the operators, the cold storage operation verification scheme feasibility.

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