Research on Warehouse Scale and Information Construction in Logistics Parks

Wei Wang[a], Jing An[b], Meng Zheng[*], Fangshu Qiao[c]

Shandong Port Land-Sea International Logistics Group Co., LTD., Jinan 250013, China

[a]1242713125@qq.com, [b]512346679@qq.com, [c]794540632@qq.com
[*]Corresponding author's e-mail: 82228344@qq.com

Abstract. The reasonable determination of warehouse size in logistics park is crucial for improving logistics efficiency and reduce logistics cost and investment cost. This paper proposes the construction requirements and construction scale measurement methods of storage and distribution warehouse, futures warehouse, refrigerated freezer warehouse, circulation processing warehouse and container stuffing and destuffing warehouse, and takes a port area as an example to carry out a case study, and the measurement results verify the scientific validity of the measurement method. At the same time, combined with the intelligent development trend of logistics industry, the general requirements of warehouse information construction are put forward. The research results have a certain guiding role for the determination of warehouse scale and information construction of logistics enterprises.

Keywords: warehouse; construction requirements; scale measurement methods; informatization

1 Introduction

The Central Economic Work Conference and the fourth meeting of the Central Financial and Economic Affairs have repeatedly emphasised that logistics is the backbone of the real economy, linking production and consumption, domestic and foreign trade, and must effectively reduce the logistics costs of the entire society. Logistics parks, as important infrastructures in the logistics industry, play the roles of improving the efficiency of logistics, optimising the regional layout of logistics, and upgrading the service quality of logistics enterprises. As the most important functional area of the logistics park, the warehouse undertakes the functions of loading and unloading, storage, sorting, packaging, distribution, etc. It is the place with the most intensive operation activities and the largest value-added space in the whole logistics park. Most of the existing literature studies the location selection and layout of logistics parks[1-5], while there are fewer and less in-depth researches on the calculation methods for the reasonable scale of warehouse storage areas in logistics centers[6-8], without considering the impact of warehouse storage and operation types on scale. In terms of warehouse informatization

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construction, the existing research is mostly based on the design of specific logistics parks[9-11], and has not put forward universal requirements for the warehouse informatization construction in logistics parks, which is not very instructive and replicable. This article carries out research on the method of determining the scale of construction of different types of warehouses and the basic requirements of information technology construction, which can help to scientifically and reasonably build modern warehouses, improve the comprehensive competitiveness of logistics parks and reduce the logistics costs of the whole chain.

2 Definition and Classification of Warehouse

Warehouse refers to the general term for buildings and places used for the storage and safekeeping of goods[12]. In this paper, based on the warehouse storage of goods and types of operations, the warehouse is divided into three categories: storage and distribution warehouse, refrigerated freezer warehouse and container stuffing and destuffing warehouse.

3 Warehouse Construction Requirements and Construction Scale

3.1 Storage and Distribution Warehouse

Construction Requirements.
Warehouses should be equipped with high level shelving and all use standardised pallets or swing baskets; at least 4 forklifts per 10,000 square metres, including no less than 2 high lift trucks; the use rate of electronic tags in the warehouse area reaches more than 80%; the whole operation in the warehouse area is monitored, and the content of the monitoring needs to be kept in the file for more than 3 months.

Construction Scale Measurement.
Storage and distribution warehouse focuses on goods storage, sorting and distribution, transportation, and its area can be calculated according to the following formula:

$$S_W = (Q_w K t_{dc} \beta)/(T_Z K_c N_c) \quad (1)$$

Where S_W is the area of storage and distribution warehouse (ten thousand m^2); Q_w is the average annual cargo handling capacity (ten thousand tons); K is the imbalance coefficient; t_{dc} is storage cycle of goods (d); β is the floor space per unit of goods (m^2/t); T_Z is the annual operating days, the recommended value is 350; K_c is the utilization rate of warehouse area, it should be determined according to the warehouse selected machinery, cargo characteristics, warehouse structure and access arrangements and other factors; N_c is the utilization rate of warehouse space, its value depends mainly on the way the goods are stacked.

3.2 Refrigerated Freezer Warehouse

Construction Requirements.
Refrigerated freezers warehouse mainly meet the basic needs of the cold chain, the storage area should have a good rainwater drainage system, and the roads and return yards should have measures to prevent water accumulation; closed platforms can be set up according to the needs, and the closed platforms shall be arranged together with the cold storage hall, and the partition wall between the cold storage room and the hall shall be a fireproof partition wall; platforms shall be arranged with steps and ramps to and from the platform that meet the needs of the use.

Construction Scale Measurement.
The area of the refrigerated freezer warehouse can be calculated according to the following formula.

$$A=(Q\times T\times K\times \alpha)/f \tag{2}$$

Where A is the fresh storage area (m^2); Q is the maximum daily storage throughput of warehoused goods for fresh commodities (*t/d*);T is the average storage period of goods, optionally 5-9 days, if it has special requirements, it can be extended appropriately; K is the entry coefficient; α is the average floor space per ton of cargo (m^2), determined according to the type of goods stored, stacking height, etc; f is the area utilization factor.

3.3 Container Stuffing and Desuffing Warehouse

Construction Requirements.
Container stuffing and desuffing warehouse should be set in the back of the park and form a relatively independent operation area; the height of the unpacking platform should be 1.2m-1.5m, the width should not be less than 6m, and a certain number of ferry boards should be set up if necessary; the site for parking container trailers and a certain number of sites for unpacking operations should be set up in front of the unpacking platform, and the total width should not be less than 30m;there should be a truck running lane and parking area on the side of the freight trucks outside the demolition warehouse, and the total width should not be less than 20m;when there is no container trailer loading and unloading platform in the demolition warehouse, it is appropriate to set up a certain number of loading and unloading sites outside the warehouse, and its width should not be less than 36m;unpacking operation machinery should be used in the container box forklift.

Construction Scale Measurement.
The area of the container stuffing and desuffing warehouse can be calculated according to the following formula.

$$S_{cz}=(Q_Z\ K_{cz}\ t_{dc})/(T_{yc}\ f\cdot g) \tag{3}$$

Where S_{CZ} is the area of container stuffing and destuffing warehouse（ten thousand m^2）;Q_Z is the average annual cargo handling capacity (ten thousand tons); K_{cz} is the imbalance coefficient; t_{dc} is the average stacking period of cargo, the recommended value is 3~10d; T_{yk} is the annual number of working days, the recommended value is 350; f is the area utilization factor; g is the value of area required for stacking per ton of cargo(m^2/t).

4 Case Study

4.1 Empirical Analysis of JM Port Warehouse Case

JM Port warehouse is an investment and construction project for enterprises, with 51,600 square meters of storage and distribution warehouse, 36,000 square meters of refrigerated freezer warehouse , and 0.1 million square meters of container stuffing and destuffing warehouse. It has been in stable operation for many years, and the warehouse area basically meets the operation needs. A case study of JM port warehouse is carried out. By substituting warehouse operation data into the formula proposed in this paper, the gap between the measured scale and the actual construction scale is compared to verify the scientificity of the measurement method.

Verification of the Construction Scale of Storage and Distribution Warehouse. Storage and distribution warehouse operation data are as follows: the average annual cargo handling capacity is 250,000 tons, the imbalance coefficient is taken as 1.3, the cargo access cycle is 180 days, the unit cargo area is 0.17 square meters / ton, the annual operating days is 365 days, the warehouse area and space utilization rate are taken as 75%.Substituting the above parameters into equation (1),the calculated storage and distribution warehouse area is 48,400 square meters, with a relative error of 6.2% compared to the actual construction area of 51,600 square meters, indicating that the calculation method is scientific and reasonable.

Verification of the Construction Scale of Refrigerated Freezer Warehouse. Refrigerated and freezer warehouse operation data are as follows: the average daily throughput of refrigerated goods in the port area is 1,250 tons/day, all the goods in storage are frozen, the average storage period of the goods is 90 days, and the area occupied by each ton of goods is taken as 0.25 square meters/ton, and the area utilization coefficient is 0.85.Substituting the above parameters into equation (2), the calculated refrigerated freezer warehouse area is 33,000 square meters, with a relative error of 8.3% compared to the actual construction area of 36,000 square meters, indicating that the calculation method is scientific and reasonable.

Validation of the Construction Scale of Container Stuffing and Destuffing Warehouse.
Container stuffing and destuffing warehouse operation data are as follows: the port annual container stuffing and destuffing volume is 40,000 tons, cargo imbalance coefficient is 1.2, the average cargo storage period is 4 days, the annual working days is 365 days, the area utilization coefficient is 0.65, each ton of cargo required area value is 1.2 square meters/ton. Substituting the above parameters into equation (3), the container stuffing and destuffing warehouse area is 970 square meters, with a relative error of 3% compared to the actual construction area of 1,000 square meters, indicating that the calculation method is scientific and reasonable.

4.2 Empirical Analysis of other Warehouse Cases

Verification of the Construction Scale of Storage and Distribution Warehouse.
An industrial silicon warehouse in QD port has an annual cargo handling capacity of 60,000 tons, a cargo imbalance coefficient of 1.2, a cargo storage cycle of 700 days, a unit cargo area of 0.6 square meters/ton, an annual operating days of 365 days, a warehouse area utilization rate of 0.7, and a warehouse space utilization rate of 0.8.Substituting the above parameters into equation (1),the calculated storage and distribution warehouse area is147,900 square meters, with a relative error of 7.7% compared to the actual construction area of 159,300 square meters, indicating that the calculation method is scientific and reasonable.

Verification of the Construction Scale of Refrigerated Freezer Warehouse.
The maximum daily throughput of goods in the refrigerated freezer of NN agricultural products trading center is 904 tons/day, the warehousing coefficient is 0.7, the average storage period of goods is 8 days, the unit cargo covers an area of 2 square meters/ton, and the area utilization coefficient is 0.6. Substituting the above parameters into equation (2), the calculated refrigerated freezer warehouse area is 28,000 square meters, with a relative error of 6.6% compared to the actual construction area of 30,000 square meters, indicating that the calculation method is scientific and reasonable.

Validation of the Construction Scale of Container Stuffing and Destuffing Warehouse.
The annual cargo handling capacity of the container stuffing and destuffing warehouse in SH Port area is 170,000 tons, the cargo imbalance coefficient is 1.1, the average storage period of goods is 7.5 days, the annual working days are 360 days, the area utilization coefficient is 0.7, and the required area value of the unit goods is 1.2 square meters/ton. Substituting the above parameters into equation (3), the container stuffing and destuffing warehouse area is 6678.57 square meters, with a relative error of 4.6% compared to the actual construction area of 7,000 square meters, indicating that the calculation method is scientific and reasonable.

4.3 Brief Summary

In summary, according to the warehouse scale measurement method proposed in this paper, the difference between the area of storage distribution warehouse, refrigerated freezer and container destuffing warehouse and the actual construction scale of various warehouses in the research example is within 10%, which effectively verifies the scientific nature of the measurement method.

In the past, the warehouse construction scale of logistics enterprises was mostly decided by subjective way. To a certain extent, there was a phenomenon that the warehouse scale did not match the actual demand. If the warehouse scale is too small, enterprises must rent additional storage space to store products, resulting in increased logistics costs and warehousing costs, hindering the development of enterprises; If the warehouse scale is too large, it will lead to insufficient utilization of warehouse space, resulting in a waste of resources, and also increase the investment cost of the enterprise.

The warehouse scale measurement method proposed in this paper can provide quantitative guidance for enterprises to build warehouses of appropriate scale. Enterprises should establish a dynamic adjustment mechanism, adjust the operating parameters in time according to their own business conditions and market demand, and obtain the most suitable warehouse area to meet the changing operational needs.

Table 1. Comparison table between actual construction area and calculated area of warehouse

warehouse type	actual construction scale (square meter)	calculating scale (square meter)	Whether the demand is met	relative error
storage and distribution warehouses	51600	48400	yes	6.2%
	159300	147900	yes	7.7%
refrigerated freezers warehouses	36000	33000	yes	8.3%
	30000	28000	yes	6.6%
container stuffing and desuffing warehouses	1000	970	yes	3%
	7000	6678.57	yes	4.6%

5 Modern Warehouse Information Construction Requirements

With the development of logistics industry, informatization, standardization and networking are the development trend of logistics park warehouse. The future warehouse is bound to be an intelligent unmanned warehouse, equipped with advanced logistics information management system and big data analysis platform, which can view the status of goods in the warehouse in real time, and realize the mining, collection, sharing, analysis and utilization of data.

5.1 Hardware Requirements

(1) Warehouse hardware facilities should adopt unified standards and interfaces to achieve compatibility, interoperability and replaceability of hardware facilities.

(2) Hardware facilities shall adopt advanced technologies and materials to realize high performance, high precision, high stability and high durability of hardware facilities, and to improve the working efficiency and service life of hardware facilities.

(3) Hardware facilities should be selected in accordance with different usage scenarios and environmental conditions, and appropriate models and specifications should be chosen to meet the requirements of functionality, applicability and aesthetics of the hardware facilities.

(4) Hardware facilities should establish a perfect maintenance system and carry out regular testing, cleaning, debugging and replacement, etc., so as to guarantee the normal operation and safe use of hardware facilities.

5.2 Network Infrastructure

(1) The warehouse network infrastructure shall adopt a hierarchical, multi-type, multi-technology network architecture.

(2) The network infrastructure should be rationalized in terms of size, bandwidth, protocols and modes based on business needs and development trends.

(3) The network infrastructure should use high-quality equipment and materials to realize high-speed transmission, high-capacity storage, high-efficiency processing and high-definition display of the network infrastructure, and to improve the service level and user experience of the network infrastructure.

(4) The network infrastructure shall establish a perfect operation and maintenance management system to achieve full-time monitoring, dynamic optimization, troubleshooting and security prevention of the network infrastructure, and to guarantee the stable operation and safe transmission of the network infrastructure.

5.3 Data Management

(1) Warehouse data management should be based on different data types, and data management standards, processes and methods should be rationally determined to meet the requirements of consistency, accuracy and timeliness of data management.

(2) Warehouse data management should adopt advanced technologies and tools to realize the functions of data management such as collection, cleaning, integration, storage and analysis, and to improve the efficiency and effectiveness of data management.

(3) Warehouse data management should establish a perfect sharing mechanism to realize open collaboration, orderly sharing and reasonable utilization of data management, and to guarantee the fairness and legitimacy of data management.

(4) Warehouse should establish a big data analysis platform for in-depth mining and analysis of logistics and warehousing data.

6 Conclusions

(1) The study proposes construction requirements and construction scale measurement methods for three types of warehouses, including storage and distribution warehouse, refrigerated freezer warehouse and container stuffing and destuffing warehouse.

(2) The JM port area storage and distribution warehouse, refrigerated freezer warehouse and container stuffing and destuffing warehouse are taken as examples for the study, and the results of the calculation are basically consistent with the actual construction scale, which proves the scientific reliability of the calculation method.

(3) In terms of hardware facilities, network infrastructure and data management, it puts forward universal requirements for warehouse informatization construction, which can guide the warehouse informatization construction.

(4) A complete standardization system of warehouse construction has been established, which has certain guiding significance for determining the scale of enterprise warehouse and information construction, and helps enterprises to improve the scientific decision-making.

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