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Improving the Space Utilization of Oriental Yuhong Building Waterproofing Materials Warehouse

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Abstract. The continuously increasing number of engineering projects and the gradually accelerating delivery speed have brought continuous pressure on the warehousing of building waterproofing material companies. As a leader in the industry, Oriental Yuhong's overall warehouse capacity can basically meet business needs, but the space distribution inside the warehouse, storage location management, and even organization methods are uneven and inefficient as a whole., resulting in "locally crowded, aisle piled up, and some storage locations even idle for a long period of time" in some storage links, resulting in an increase in time and operating costs The reason is to analyze the challenges from three levels: spatial structure + operational methods + data management. After summarizing the results of relevant research on warehouse space utilization, layout optimization, and building materials warehousing, this paper focuses on analyzing the space utilization problems of Oriental Yuhong's warehouse of building waterproofing materials from the perspective of "time cost + monetary cost". It tries to find out the reason from three levels: spatial structure, operation mode and data management, and find a method that can improve the warehouse space utilization without significantly expanding the storage capacity. These methods will provide a feasible improvement solution for the similar building materials company.

Keywords: Oriental Yuhong, building waterproofing materials, warehouse space utilization, storage location management, logistics efficiency

1. Introduction

With the continuous development of urbanization and infrastructure construction in recent years, people are paying more and more attention to the construction waterproofing project in the whole life cycle of the buildings. Water-proofing materials such as waterproof membrane water-proof coating and so on usually have such characteristics as large volume, heavy weight, short stackage height and limited scope and sensitivity to temperature and humidity. They are generally stored and transported in whole pallets or whole rolls, which generally puts forward stricter requirement on warehouse shape, succeeding place arrangement and passage planning [1]. If the organization of warehousing and the organization of spot material supply are not reasonable, it is easy to cause overload of local warehouse, blockage of passage, repeated stacking and loading and unloading, etc., which will prolong the waiting time of construction, increase inventory and operating costs.

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Effective management of its materials can affect the cost, schedule and efficiency of engineering projects greatly [2].

In the true supply chain, building materials companies link many production bases at one end with many construction sites and distribution channels at the other. In a study of a systematic material management approach, material flow and on site operation coordination can be made more efficient through planning, replenishment, inventory and transportation coordination [3], and in studying modeling and monitoring of the engineering material supply chain, points where bottlenecks or risk occur are identified [4]. As land and warehouse costs increase, it can no longer be a case of simply "expanding the area and building new warehouses" where there is a need to accommodate fluctuating demand. Rather, the company must work to make the best use of warehouse space and optimize it within available storage space.

A large number of studies in warehousing have focused on warehouse layout optimization, space utilization calculation and storage location allocation strategies, forming a systematic framework from process and layout to control decision-making, providing methods and tools for improving warehousing efficiency [5]. Subsequent systematic literature reviews also indicate that warehouse design research is constantly developing in the direction of multiple objectives and multiple constraints, but there are still few cases in which real constraints are studied and design is oriented to specific industries [6]. On the whole, existing literature mainly focuses on warehouses storing standard palletized goods or small items, while less attention has been paid to building waterproofing materials that are "large in volume, with limited stacking capacity and fluctuating demand". More studies emphasize mathematical models and algorithms, assuming complete data and reconfigurable systems, while there are relatively few cases on how to "gradually" enhance space utilization under the condition of existing warehouse conditions and management capabilities.

In the background of the above problem, after selecting a specific case, this paper chooses Oriental Yuhong, a representative enterprise of sealing materials for buildings, as the research object, and implements case analysis under the theme of "the overall utilization rate of warehouse space of sealing materials for buildings". In terms of research methods, the use of combination of literature research and case analysis: on the one hand, through research on the theory of warehouse design and design of building materials logistics, to gain concept, perspective and ideas for analytical purposes; On the one hand, through relying on information that can be discovered at the company and usual business scenario, the space distribution, storage location arrangement, channel usage and management mechanism of sealing materials for buildings warehouse of Oriental Yuhong is structured descend described, so as to find out the main existing problems and causes, and give out the einnotion which is rational in the constraints of existing site layout and management ability for reference for Oriental Yuhong and such company.

2. Problem statement: space utilization challenges in oriental Yuhong's warehouse

Focusing on the building waterproofing materials industry, most companies face the following reality: there is a surge in demand at the peak periods of each project node. Waterproofing membranes and coatings are cumbersome, heavy, and have a low stacking height, which puts a lot of pressure on warehouse space and storage and operation organization. If space allocation and storage and operation organization are not carefully planned, it is easy to have local warehouse overloads, aisle stocked up, and frequently stall and re-stack up to the peak. This may affect progress, increase the inventory, handling, overtime, and so on. Oriental Yuhong has built many production and warehousing bases across the country, forming a multi-level delivery network of "production base – regional warehouse – project site", and the overall storage capacity can meet the needs of work.

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However, in practice, because of the large volume characteristics of building waterproofing materials, plus the peak and valley characteristics of engineering project delivery, regional warehouses also face the dual pressures of "not enough room to store" and "fast turnover" in a limited building area: during peak waterproofing construction, some areas are congested and walkways are blocked, and the warehouse must go to overtime and temporary adjustment in order to keep up with the delivery and increase the entry and exit; and at the same time, some shelves at the high level and corner places are idling for long time, and the warehouse gap between nominal capacity and actual usable capacity is large.

At the management level, the existing arrangement and adjustment of storage locations relies heavily on the experience of warehouse staff and forklift drivers, without specific rules for grading and dynamically adjusting storage locations based on turnover characteristics and order structure; data records on spatial data are not sufficient, and there is no continuous monitoring and review of indicators such as area utilization, aisle congestion, and picking routes. Overall, the spatial structure, operation methods, and management mechanism have not yet formed a coordinated system, which severely restricts the actual processing capacity of the warehouse in peak periods. Based on this, this paper takes the Oriental Yuhong building waterproofing materials warehouse as a case study to further analyze the current situation and problems, and do a good job of laying the foundation for optimization measures in later.

3. Current situation: warehouse system and space utilization of Oriental Yuhong

Founded in 1995 and based in Beijing, Oriental Yuhong has changed from a single waterproof material manufacturer into a comprehensive service provider of which building waterproofing is their main focus and widely covers a variety of building functional materials. It has established a number of production, R&D and logistics bases in and out of home and constructed a "national layout and regional service" business network [7]. The supply chain structure presents a multi-level structure of "production base - regional warehouse - project site". The regional warehouse is responsible for the concentrated storage and secondary distribution of waterproof membranes, waterproof coatings and so on, and is an important link between the factory and the construction site.

Looking at waterproofing products from the perspective of their characteristics, waterproof membranes tend to be 'big rolls' and heavy, and so need to be stacked in rolls or on pallets. Waterproof coatings tend to be in drums, with limited amounts of stacking possible. Building waterproofing materials, compared to 'ordinary' boxed items, need strict control of stacking height, adequate aisle width, and require much thought about safe manual and fork truck working in storage. This makes very high density racking storage impossible, and the effective space available per square foot must always be limited.

In a typical warehouse, the distribution of both "high-bay racking + floor storage" configuration is a medium- to long-term storage medium, and makes it easy to allocate between projects, while floor storage is often the source of rapid goods picking, recently arrived goods and goods waiting for shipment. This "high-bay racking + floor storage" can help increase nominal storage capacity, but if management is not attentive, it is easy to become "if unused high-bay racking and overcrowded floor storage areas and main aisles". During the boom period of waterproofing construction, there is a considerable phenomenon of large-scale centralized delivery and centralized shipment. The ground area near the entrance and main passage is filled or even reached the passage within a few days, and some of the high-level shelves in the depth of the warehouse are still relatively spacious, showing a "hot spots tight and cold spots idle" pattern. This kind of internal imbalance was considered to

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severely reduce the system throughput capacity by Wang and Zhang in warehouse operation research [8].

In terms of management, Oriental Yuhong has built a warehouse management system to manage orders, inventory quantities, and batches in a unified manner. In terms of storage location arrangement and space utilization, however, regional warehouses still rely heavily on on-site experience. Newly arrived goods are often put in priority next to the convenient location. High-frequency products may not occupy the "shortest path" storage location, while low-frequency products may be left close to the main aisle for a long time. The system provides sufficient support for "inventory quantity and accounts", but the statistical analysis of spatial indicators such as area utilization, aisle congestion and picking routes is relatively weak. Overall, Oriental Yuhong's total warehouse capacity is enough to support the current scale of business, but there is still optimization space in the internal spatial structure and management methods.

4. Problem analysis

4.1. Uneven spatial distribution: congested hotspots and underutilized cold spots

During busy times on the job the areas of floor storage by the door and main aisles, together with some levels of shelves, become "hot-spots," most intensely used, even to the point of encroaching upon aisles; the more remote portions of the warehouse, the top shelves, and some corners remain undisturbed, with low percentage-pull rates. The storage is "very full," but there is severe local congestion in some places and space lying idle in others.

First of all, big bulky and heavy goods causes front line staff, in the absence of rules, to cluster frequently handled items nearby in such a way as to minimise handling trips. During busy periods, on the other hand, large groups of new and pending shipments present themselves at the same time, with all too little space to absorb them, forcing new goods to be "squeezed in" to hotspots. Without a regular corrective measure based on turnover data, early habits of space usage become frozen in and it becomes difficult to draw the less popular places into use again. In short, this is a characteristic of mismatch between space structure and flow structure from one area to another.

An uneven spatial distribution reduces effective storage capacity directly: hot spots are overfull and hot-footed, passageways are congested, work paths are lengthened, waiting and detours increase; cold spots are hard to assimilate into actual processing capacity. Time and money costs directly increase through increased passive expenditure of time and funds; a wide discrepancy appears between nominal storage capacity and actual usable storage capacity.

4.2. Experience-based warehouse management: lack of a turnover-oriented hierarchical strategy

Storage assignment and adjustment is left largely to the experience of picker and fork-lift driver. Incoming products are often placed in empty places that appear "convenient" rather than arranged on a practical basis considering outbound frequency, turnover days, order pattern, and so on. High-frequency products are not necessarily placed in "shortest path" locations, and some low-frequency products have long been given "prime" locations, close in to the main aisle.

The existing system deals with extension, batch and age of inventory and has limited support for "goods-space"match up. It has unwieldy location analysis tools. Frontline staff frequently apply familiar practices under high-stress day-to-day operations. Performance evaluation looks more at completion of orders fairly on time rather than demonstrating hard indicators of space utilization and

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location rationality. Simple existing research has shown that even a slight categorization of location risk based on relevance and turnover speed can significantly reduce the number of picker turns and accelerate walking time down aisles [9].

Experience-based warehouse management allows fast-moving items to not continually go back to keeping optimum locations while slow-moving items are allowed to persist in good locations for many months. Experience-based management compounded the pressure in busy areas of the plant and compounded the reducing of the overall space usage in the warehouse. Without a set of common rules, one cannot turn experience into a managing artefact that is available to everyone in the almost linear manner.

4.3. Disorganized access and work arrangements: temporary stockpiling occupies movement space

During the period of maximum construction more or less of the area contiguous to doorways and main aisles is utilized as a temporary place of storage and the aisles themselves are overrun by rolls and piles of material on skids. Areas needed for the passage of vehicles and men are made to serve temporary storage purposes and the fork truck and the men themselves are forced to thread their way between closely placed obstacles and may even have to move the same pile a number of times.

Design phase paid insufficient attention to buffers for peak periods. Some ground areas designed to be both passageway and potential storage. Insufficient coordination of inbound and outbound plans so that there was potential for considerable peak-hour overlap. High-pressure situation emphasized "unloading first, loading, and moving first" without hard and fast rules about protection of passageways. Passively, passageways were allowed to deteriorate from "spaces to provide flow" into "temporary storage spaces, utlimately both efficiency and safety declined at the same time."

If aisles are blocked for long periods of time, traffic routes for the fork-lift and personnel arrive at parent points much further from their source of supply; consequently, vehicles that would otherwise have no difficulty in passing awaiting their turn or in clearing away packing debris, must be content to wait, no matter how long it takes. Temporary stacking means frequent handling, besides adding to the work load of the power truck; the risk of accident is also considerably increased. Admittedly this may increase the short time stacking capacity of the warehouse, but at the expense of the actual, and not the so-called "apparent", handling capacity of the warehouse.

4.4. Weak data and management mechanisms: making it difficult to form a continuous optimization loop

Oriental Yuhong inventory and batch control is relatively okay, but from a spatial perspective, there is basically no routine data recording of "area utilization rate, shelf level occupancy, congestion in aisles, picking routes and so on". Such spatial layout and storage strategy adjustment is all based on the feeling, intermediate inspection, measure, and lack of data-based mechanism.

The existing system mainly cares about inventory accounts and order execution, and has little regard for collection and presentation of space utilization data; the front-line operation personnel are busy with daily operation and have no energy to record space-related data; and space utilization indicators also have little weight in the performance evaluation of management. The study of intelligent warehouse and Warehouse 4.0, summarizes a data-driven, algorithm support, etc. are the direction of improving warehouse efficiency, but the premise is that enterprises have a continuous and reliable data foundation and corresponding management mechanism [10].

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Without data support and management methods to optimize space, warehouses have a mere "feeling" of their use of space. Warehouse optimization decisions are not based on data, and it is hard to build a closed loop of "record-analysis-adjustment-evaluation". Improvements in space utilization end up at making space tidier on a piecemeal basis, and "relocating" once and forget it. And the problem reappears.

The analysis above illustrates that the low space utilization rate of Oriental Yuhong's building waterproofing materials warehouse is not a simple matter of "not enough storage space", but rather a systematic result of multiple aspects such as space structure, storage location strategy, operational organization and management means. Irregular spatial distribution and experience-based storage location management intensifies the pressure on hotspot areas, and aisle and operational organization chaos exacerbated traffic inefficiency. Weak data and management mechanisms diminish the ability to detect problems and iterate continuously.

5. Conclusion

Taking a building waterproofing materials warehouse of Oriental Yuhong, the paper summarizes its existing problems in space utilization in a structured manner based on literature survey combined with real-world context. The research deduces that given a relatively adequate total storage capacity, the key bottlenecks to efficiency are in inner structure and management method: on the perspective of spatial distribution, hot spots are crowded, cold spots are abandoned, which leads to a large gulf between nominal capacity and truly usable storage capacity; on the perspective of storage location management, there is a lot of capriciousness, and no hierarchical and dynamic adjusting mechanism that depends on turnover rate; on the perspective of organizing operations, aisles are piled up in seasons, leading to a lot of repetitious handling; on the perspective of management mechanism, the spatial dimension data is weak, and continuous optimization loop is unable to be formed.

Therefore, the improvement of the space utilization rate of the building waterproofing material warehouse, what is not the "expansion" of the capacity of simply, but the re-construction of the spatial structure and the operating mechanism in essence to adapt to the existing facilities. Re-division of the long-term storage area, short-term buffer area, and picking and collection area; looking for the aisle "no-stacks" boundary; treat the aisle as a resource that should be first protected. On the basis of outbound frequency and turnover days, a simplified storage location classification rule is carried out, clustering the high turnover goods into the "golden storage locations" together, putting the low turnover goods away to the remote and high position area. Reduces the hierarchical internal visitation record table, simple region congestion recording table, and routine review mechanism, let scattered experience evolve to the "data + rules" driving progressive optimization path.

This study uses building waterproofing materials as a scenario to introduce general warehousing management concepts into engineering material warehouses, which provides a reference framework for similar enterprises to find out how much of the utilization of warehouse space is bottlenecked, although due to the limitations of data available to us, the authors of this paper can only rely mainly on public information and typical scenarios for qualitative analysis, lacking long-term continuous "operational data support", unable to quantify what are known as different optimization plans how much of the impact. This is an objective limitation of the research. The future work will collect more long-term and finer-grained warehouse operation data through the cooperation of enterprises, and use simulation and optimization models to quantitatively compare different layout schemes, preference storage strategies and how to organize operations by hand in turn evaluate the path and boundaries of improving the space utilization rate of the building waterproofing material warehouse.

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