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Operation of Smart Refrigeration Logistics Center based on Cold Chain System

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Abstract

This paper focuses on the frozen storage warehouse located in Busan area, and it is because Busan is the most dense area in Korea. Busan is a port city, and almost all of the frozen refrigerated cargo imported from abroad is concentrated. By taking advantage of its strength as a fishery industry as well as importing, Busan is building the largest international fishery logistics base in Northeast Asia and plays an important role in the export of refrigerated cargo is. Therefore, although the freezing and chilling facilities seem to be developed with the latest technology, the reality is not so. Most of them are functioning as a warehouse, that is, a storage function, and a considerable number of refrigerated warehouses are in a state of aging. Therefore, in this paper, the facility and function restructuring of the freezing storage warehouse have been set as a solution task, and the introduction of the cold chain system containing the latest smart technology has been proposed as a solution.

Keywords: Cold Chain System, Refrigeration Logistics Center, Smart Logistics, Operating System

I. INTRODUCTION

In order to efficiently manage frozen and refrigerated goods, the role of the frozen storage warehouse is important. When the role of the refrigerated warehouse is largely categorized, it can be classified into three kinds of storage, transportation, and shipping agency. However, most of the refrigeration warehouses in the nation are operated mainly by the storage function, and they are not equipped with competitiveness for various logistics services which are recently required. Also, domestic and international multinational logistics companies have entered into freezing and refrigeration business, so the domestic freezing and refrigeration industry is having difficulty in management.

Currently, there are 804 refrigerated warehouses nationwide. Among them, there are 120 companies (about 15%) in Busan and more than 50% of the nation's freezing and refrigerating capacity is being carried out. In this regard, it can be seen that the refrigeration warehouses in Busan have a large and important role in freezing and refrigeration logistics. The location of the freezing / chilling facility is more efficient in carrying out the logistics process in the region adjacent to the import route. This is the reason why the largest numbers of refrigerated warehouses are operating in Busan. However, as mentioned above, the freezing and cold storage warehouse in Busan is also centered on the storage function. There are 32 (27%) of the 120 companies that have been aged more than 31 years. In order to improve the domestic refrigeration logistics process, it is necessary to revitalize overall logistics operation.

However, in Korea, refrigerated warehouses, which are located in Busan port, are experiencing difficulties in competitiveness and management due to warehousing functions. As a result, the lack of customized logistics services by customer needs and the establishment of a collaborative global business network are insufficient. Until now, refrigerated warehouses have been mainly operated for storage, and related researches have limitations on the presentation of direction to smart refrigeration logistics center by evaluating efficiency of storage and technical improvement of operating facilities.

In this paper, we have proposed a cold chain system which contains the latest smart technology as a solution to the facility and function reorganization of the refrigeration warehouse.

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II. REFRIGERATED LOGISTICS INDUSTRY

Generally speaking, the term "freezing refrigeration" refers to the operation of cooling or freezing fish foods and refrig- erating them, and the facility is defined as a refrigerated warehouse. However, the Food Industry Promotion Act does not define refrigeration refrigeration if it is frozen by processing meat or when the refrigeration capacity is less than 5 tons.

The freezing and refrigerating industry is part of the national industry as a national food storage, and it contributes greatly to the revitalization of the local economy by improving dietary life and hiring idle workers in the region through the role of processing, exporting and storing agricultural, Industry. In addition, it has a function to stabilize the price of food through freezing and refrigerating business, thereby facilitating income and consumption life of fishermen along with national economic development, and playing a big role in increasing competitiveness of food logistics industry.

1. Features of a frozen storage warehouse

The business activities of a freezing and cold storage warehouse are basically similar to ordinary warehouses, but they have the characteristics of a freezing and cold storage warehouse.

First, the number of operators, refrigeration and freezing capacity are increasing year by year, and the number of freezing and refrigerated warehouses existing in the consumption area is relatively lower than the production area.

Second, the quantity of goods and the quantity of stocks are increasing every year in view of the trend of refrigeration and freezing capacity, and the increase trend of seafood is expected to continue in the future considering additional opening.

Third, most of the stored items are aquatic products, and they are generally composed of 60% of marine products, 20% of livestock products, 10% of agricultural products, 5% of frozen foods and others.

Fourth, from the viewpoint of the cost structure of the refrigerated warehouse, it is a business that has more expensive facilities and cooling facilities than ordinary warehouses, and relies heavily on depreciation and power costs of the facility because its operation depends on electricity.

Fifth, frozen and refrigerated warehouses tend to require more capital in the early stage because they require more facility cost than general warehouses.

2. Cold Chain System

Compared to the general logistics center handling room temperature, the freezing and refrigeration logistics center deals with the logistics process of the cargo with the characteristics requiring temperature control, that is, the freezing refrigerated cargo. Therefore, it is necessary to maintain the best quality condition by properly controlling the temperature and humidity of the refrigerated cargo. For this, introduction of the cold chain system is indispensable. The Cold Chain System guarantees the quality and safety of products through constant temperature control throughout production, storage, transportation, sale and consumption of temperature sensitive products such as agricultural, fishery, aquatic products, foodstuffs, this is a logistics system. Figure 1 shows the purpose of extending the freshness and the value of the product by properly maintaining these refrigerated goods at the appropriate temperature. Classification of cold chain systems is divided into main technologies including pre-cooling, packaging, transport, storage, and consumer cold storage facilities and assistive technologies that perform other functions.

III. APPLICATION OF COLD CHAIN SYSTEM

A company is a freezing and refrigerating automation logistics center equipped with automation system completed in Busan New Port in Busan New Port in December 2015. It has a land area of 11,329.60m^2 and a total floor space of 24,395.42m^2, Is a 90,000-ton storage center with a nominal tonnage of 90,000 tons. Songjeong-dong Logistics Center, the first freezing and refrigerating automation logistics center in Pusan New Port, boasts the best logistics location as the center of maritime logistics and distribution in Northeast Asia. Songjeong-dong automated logistics system, constructed by Shinsegae E & C, is an automated logistics center that automatically stores and stores frozen cargo in the extreme environment of minus 25 ℃. Its storage efficiency is 9 times higher than general warehouse, minimizes energy loss, Is an automated logistics system upgraded to maximize the customer's sales capability. 1 basement floor, 6 aboveground floors Total floor space 7,375 pyung It is a logistics center consisting of entrance and exit with a storage capacity of 43,000 pallets, a manual warehouse, a quench room, and a refrigeration automation logistics center. The automated warehouse part is designed as a building rack type based on stable structure facilities that can stand the C class in the side of the coast and can be built safely in the factory. A building rack serves as a building structure as well as a product storage.

As shown in <Table 1>, frozen food (F class) consists of ice cream, aquatic products, livestock products, processed frozen foods and bread, and frozen foods C) is made up of food, dairy products, foodstuffs, agricultural products, and fruits. In addition, other products such as chocolate and other products are handled at room temperature.

Table 1. Cargo for Company A.

Frozen (Class F) 30,000 pallets	Frozen (Class C) 14,000 pallets	Normal Room Temperature
Frozen: -25 °C Ice cream, aquatic products, livestock products Frozen: -18 °C Processed frozen food Frozen: -10 °C Bread, etc.	Refrigerated: -10 ° C, + 10 °C Food, dairy products, etc. Frozen: -5 °C, + 5 °C Food raw materials, agricultural products, fruit	Chocolate, other products

IV. APPLICATION TECHNOLOGY OF COLD CHAIN SYSTEM

1. Packaging technology

The roll cabinet is an easy-to-find type of refrigerated container that is similar to a general refrigerator. It can accommodate a variety of products by dividing the temperature by temperature. It can be moved because it is not fixed type. It is also characterized by the use of refrigerant without mechanical cooling.

The roll cabinet is introduced and the elastic effect is used according to the situation.

First, various product groups that require different temperatures can be subdivided into desired temperature ranges and managed according to the characteristics of the products. During the transportation, it is common to manage in two stages of refrigeration and refrigeration, but by using the roll cabinet, it is possible to finely divide into three sections or four sections to manage the cargo For example, cereals can be completed at room temperature, fruits and vegetables at 10 to 14 ° C, refrigerated products at 2 to 4 ° C, and refrigerated products at -18 ° C.

Second, because it is a non-fixed type mobile container, it can be loaded in a vehicle. If it is carried out only on the contrary, it can be transported to a warehouse or a showcase such as a wholesale market or a mart, the temperature deviation can be minimized.

Third, because it uses dry ice, which is a cryogenic material rather than a mechanical cooling method, as a refrigerant, it does not require a separate power source, so it can reduce the cost of distribution such as fuel.

1.1. IoT fusion packaging technology

At the heart of the cold chain system is packaging technology. However, it is difficult to keep the temperature inside the container constant due to the lack of temperature maintenance performance, which is commonly used in the freezing and refrigerated logistics delivery. Therefore, there is a high risk of deterioration in the delivery process, The waste is large, and the temperature and humidity of the inside of the container and changes in the state of the product cannot be confirmed during delivery. In order to secure these disadvantages, the smart refrigeration logistics center, which will be introduced in the future, will utilize special (PCM: Phase Change Materials) container to maintain temperature and humidity through constant temperature maintenance and RFID / USN, , Security information of opening and closing, etc., monitoring of the products will be able to get the effect of deterioration and damage security. It can be used for express service of high-priced cargoes sensitive to temperature and external impact, such as fresh food, high-performance electronic and medical products.

2. Transportation technology

2.1. PCM

Domestic refrigerated cargo is transported by using a freezing / refrigerated vehicle or a styrofoam box and a refrigerant which are transported by using a refrigerating machine to a vehicle. Therefore, new technologies should be applied to improve the efficiency of refrigerated cargo. First, it is necessary to make a vehicle using PCM technology in a refrigerated cargo or to maintain the proper temperature by using a twin freezer. It is also necessary to cope with a change in the volume of cargo by dividing into a refrigerator and a freezer by using a movable partition inside a vehicle. It is necessary to install an air shutter or a dual heat sink door inside the vehicle to solve the temperature change during the up and down movements and to cut off the external temperature and measure the temperature and humidity which can not be confirmed during operation using RFID / USN technology in real time To the logistics center to precisely understand

the difference between the temperature and humidity generated inside the vehicle, so that the product sensitive to temperature changes such as fresh food or cosmetics should be managed safely.

2.2. RFID-based temperature management system

Recently, distributors have managed to manage the temperature and temperature records by interval for the delivery quantity. However, there is still a lot of temperature monitoring in the loading space, not the temperature of individual products. Consumers who have received the product have complained that they can understand the status of the product after opening the package. The RFID-based temperature management system suggested as a solution is to attach a passive RFID temperature tag to the outside of the packaging box so that consumers scan the QR code attached to the package after receiving the product through the smartphone, So that the product management state of the entire transportation process can be provided to the customers.

3. Storage technology

3.1. Real-time WMS monitoring using RFID / USN and 3D technology

It is necessary to precisely manage the location and information of the cargo. However, the storage place for the domestic refrigeration warehouse is composed of several layers such as 3 and 5 stages. It is difficult to grasp the information of the products stored in each floor by managing the system or the management based on the memory of the worker. The smart refrigeration logistics center, which will be built in Busan New Port in the future, will utilize the RFID / USN for each rack cell in the forklift or warehouse to enhance the productivity of the forklift and to keep the information of the products stored in the cell in real time Information on the products stored in layers from the first layer using the 3D technology is displayed on the touch screen in 3D image, and the information on the inventory status by the expiration date of the product, the progress of the packaging, the inventory status by the number of days stored, It will be possible to manage warehouses more efficiently with the visibility of the inside of the warehouse such as 3D display. Figure 2 shows a conveyor system incorporating RFID technology.

3.2. Activate MPS using the Internet

MPS (Multi Purpose System) is a system that can improve the efficiency and accuracy by automatically informing the worker of the goods and quantity when applying the electronic tag technology to work such as goods receipt / warehouse / inventory survey. When attaching a terminal to a rack, which is a shelf for storing goods, and then issuing a work instruction through the system, the device and the quantity of the work item are automatically displayed on the terminal in the corresponding position. In addition, when the box is passed through the R-gate at the time of shipment, the time and the efficiency of the work can be improved because the history and quantity of the product can be grasped. Moreover, this technology makes it possible to shorten the work time. In the case of fresh logistics where temperature maintenance is the top priority, it is essential to shorten the working time through this technology. In addition, it has advantages such as easy installation and operation in wireless form and low initial installation cost.

3.3. Logistics Warehouse Management (Smart WMS) using Big Data

The 'AI WMS Warehouse Management System (Smart WMS)' was developed to measure the efficiency of the collection work by picking up the goods from the logistics warehouse shelf and putting them in a specific box for inspection. As a result, the working time was shortened by 8% appear. Since existing business systems operate according to pre-designed programs, it has been difficult to redesign the field work. Because of this, it was difficult to give effective instructions in response to changes in the field situation. The big data accumulated in the business system is composed of numerical values such as quantity, time, product code, and various kinds of data in which characters and symbols are mixed. For this reason, in order to reflect the data into artificial intelligence, it is necessary to perform a preliminary analysis by a highly skilled expert in each type of business or task, and it took time. Artificial intelligence, however, is a form of continuously adding work data that is stored automatically without going through the hands of the person, drawing out work methods that increase work efficiency and instructing workers. This system prevents the congestion caused by the worker on a specific shelf by instructing the work order once a day. This is intended to improve the efficiency of the business considering the situation in response to fluctuations in demand. Ultimately, artificial intelligence automatically responds to environmental changes.

3.4. Picking operation using artificial intelligence transportation robot

The entire rack's storage needs are driven by automation stacker cranes or other transport equipment such as forklifts in the case of small gaps between the racks and racks, or movable racks other than fixed racks. Until now, forklifts operated by people have been commonly used in

logistics warehouses. However, introduction of artificial intelligent robots is needed in smart refrigeration logistics center to be introduced in the future.

In the case of Fuji Logistics in Japan, the inventory collecting robot, called Logistics Giraffe, automatically runs on the products attached with the RFID and carries out the inventory clearance process, and collects the lot number and the serial number of the IC tag collectively, This robot can be used in narrow passages where the worker goes in and out, and can be raised up to 5.4m height by automatic control of the antenna, so that the pallet rack It is possible to arrange the goods stored on the upper side without putting in the workforce. Above all, it is possible to ride the elevator, so that it can be used jointly at multiple sites. Since this robot grasps the terrain using the laser and moves, it can be used directly in a general warehouse without special guidance devices.

3.5. Self-driven roller conveyor system enables packing, inspection work and energy loss reduction

In the case of conventional conveyors, unnecessary energy consumption occurs because all sections are driven irrespective of whether the cargo is transported or not. On the conveyor belt that packages or inspects the goods, the information of the barcode or RFID is read out for more accurate operation It is necessary to work and to prevent the article from being damaged.

RFID detects the cargo, reads the information, recognizes the information of the cargo, and the self-driving roller with the motor operates separately for each motor, so that it can be operated only when the cargo is present and the cargo can be moved more quickly. There will be an energy saving effect of more than 50% compared to that.

V. CONCLUSION

In this study, the current situation of the domestic refrigeration warehouse and the improvement of the function were studied. In particular, the frozen storage warehouse in Busan, which is adjacent to the harbor, has a large volume of cargoes due to the development of fishery industry. However, And it is not responding adequately to changes in the internal and external environment. In addition, although the imports of aquatic products have increased recently, there is a problem that the frozen storage warehouses in Busan can not keep up with the demands of the consumers in terms of quality and merely perform the conventional storage function. In other words, individual products requiring proper temperature are classified and transported and stored only as frozen and refrigerated products.

In order to solve this problem, we have developed the function of WMS as a whole by not only storing and storing the frozen refrigerated warehouse operated by the simple storage function, but also realizing the input and output efficiency, real time information of the cargo information and providing it to the shippers. As a solution, we combined smart technology with cooling function, which is the basic function of cold chain system, which is the basis of freezing and refrigeration. In terms of packaging technology, real-time WMS monitoring using RFID / USN and 3D technology, activation of MPS using object Internet, Smart WMS , Picking work using artificial intelligence transportation robot, packaging using self-driven roller conveyor system, activation of inspection work and reduction of energy loss, and other measures include changing the perception of shippers, opening the legal system, and leading large-scale logistics companies.

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REFERENCES

[1] Kim, Dong-mook, "A Study on the Establishment of Support System for Expansion of Agricultural Products to China - Focusing on Cold Chain Logistics Support System" Dongguk University Graduate School, 2015.

[2] Jae Won Bae, "A Study on the Operating Strategy of Freezing and Refrigerating Warehousing: [Busan, Korea], Sungkyunkwan University, 2016.

[3] Yuyoung, "Introduction and Expected Effects of RFID & GPS in Cold Chain System of Livestock Products in China", Graduate School of Logistics Graduate School of Northeast Asia, 2013.

[4] Yoo, Kang Chul, "A Comparative Study on the Productivity of Pick to Light and Put to Light with the Change of the Shipment Volume of [Domestic Doctor] Distribution Center", Myongji University, 2011.

[5] Lee, Young-jun, "A Study on the Transition Plan of the Refrigerated Warehouse in Pusan Area to the Warehouse of Distribution Center", (Dong-A University Graduate School, 2011)

[6] Kim Byeong-sam, Current Status and Future Direction of Cold Chain System in Agricultural Products in

Korea, Equipment Journal .Volume 40 Issue 6 June 2011.

[7] Han, Kwan-Soon, "A Study on the Improvement of Cold Chain System for Efficiency of Fresh Agricultural Products Logistics," Journal of Logistics Volume 25, No. 4, 2015.

[8] Kim, Ho-Gyun, "A Study on the Revitalization of Freezing Refrigeration Business in Busan Area," Korea Ocean Research & Development Institute, Ministry of Land, Transport and Maritime Affairs, 2010.

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