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TEMPERATURE CONTROLLED WAREHOUSE AND COLD CHAIN BUSINESS IN HONG KONG: A LITERATURE REVIEW

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Abstract

Nowadays, most of the countries, especially Southeast Asia, due to weather conditions, requires temperature controlled means for their transportation of perishable products to the markets. Thus, a special type of supply chain management called Cold Chain Management (CCM) has been established. With its huge capital investment on facilities & equipment, strict temperature requirements, and energy dependence, the cold chain has always been a demanding logistics segment.

In this paper, a cross profile of cold chain delivery that associated with Temperature Controlled Warehouse (TCW) employed by various local supply chain service providers will be studied. Also, the conceptual framework is developed to evaluate several criteria for qualify TCW in Hong Kong and Pearl River Delta (PRD) region. Discussion and directions for future research will be finally provided.

Keywords: Temperature Controlled Warehouse, Cold Chain, Hong Kong.

1. Introduction

Most of the countries in South East Asia, due to weather conditions, require temperature controlled means for their transportation of perishable products to the markets. Thus, a special type of supply chain management called Cold Chain Management (CCM) has been established. Temperature monitoring and control are essential mechanisms in CCM, because they are necessary for maintaining product's freshness and quality. Obviously, temperature controlled warehouse (TCW) is the utmost and vital node to ensure top quality of product deliver throughout the supply chain (Fearne & Hughes, 2000; Bogataj, Bogataj & Vodopivec, 2005; Donselaar et al., 2006; Viswanadham, 2006; Joshi, Banwet, & Shankar, 2011). However, the construction, maintenance and operations of TCW are also costly to logistics service providers as requirements and operation mode of TCW are far differ from the understanding in normal warehouse (Lorenz & Brehm, 1989; Ikuharu et al., 2005).

In the local market, around six companies out of thirty that were listed under Hong Kong Trade Development Council (HKTDC) are able to provide cold storage under -18°C. With the import of frozen and fresh food, the number of TCW available is limited and suffered from various forms of problems that prolong the total transport time taken for the delivery due to the operation mode in this sector.

In this paper, a cross profile of cold chain delivery that associated with TCW employed by various local supply chain service providers will be studied. Also, the conceptual framework is developed to evaluate several criteria for qualify Temperature Controlled Warehouse (TCW) in Hong Kong and Pearl River Delta (PRD) region. Discussion and directions for future research will be finally provided.

2. Objectives

The objectives of this study are:

1. To identify the operational mode and productivity of local TCW
2. To identify related policies and regulations that can affect the viability of local TCW establishment and operations
3. To identify the factors that contributes to the sustainability of local TCW
4. To enrich the body of knowledge regarding the extent of business operations in TCW

3. Literature Review

Cold Chain: Definitions and Activities

The term "cold chain" refers to two distinct components, 'cold' refers to the need to control temperature in preventing the growth of microorganisms in food while maintaining its wholesomeness as it is processed, shipped, delivered and stored at the stores. The term 'chain' focuses on monitoring the 'chain of custody' in which each segment of the processing, storage, transport and delivery functions are linked to the step before and after with proper documentation and records (Cold chain management).

The cold chain consists of the series of businesses engaged in manufacturing, transporting, storing, retailing and serving refrigerated and the flow of chilled and frozen foods (i.e. frozen or chilled) foods through them to consumers, who buy those products and transfer them home for food preparation. The effectiveness of the cold chain in maintaining the safety, durability and quality of foods relies on controlling product temperature through each and every step in the cold chain. The delivery and receipt of safe and high-quality food products to consumers requires the food premises at all links in the cold chain to understand and meet cold chain temperature requirements for chilled and frozen foods (Australian Food and Grocery Council, 2013).

A network of refrigerators, cold stores, freezers and cold boxes organized and maintained so that goods are kept at the right temperature to remain potent during goods transportation, storage and distribution from factory to the point of use (Mid-Level Management Course for EPI Managers, 2008).

In the cold chain, there are involved some activities that are cold chain management, supply chain management for perishables, sourcing that includes food security, contract farming, risk management, resource and development, on-site trials, training and education and project management (Wee, 2013).

The cold chain management means the intersection of food safety and logistics (Cold chain management). The people firstly evaluate the whole cold chain and then arrange its transportation. The sourcing should be checked to ensure the food security and then contract the farming to discuss the detail of contract. The risk management is involved like the quality and safety of food and whether the source may be contamination and packaging or handling

storage, i.e. Temperature Controlled Warehouse (TCW) and transport operation (Wee, 2013).

Shipment Operation Practices of Cold Chain Business

Moving a shipment across the supply chain without suffering any setbacks or temperature anomalies requires the establishment of a comprehensive logistical process to maintain the shipment integrity. This process concerns several phases ranging from the preparation of the shipments to final verification of the integrity of the shipment at the delivery point.

Shipment preparation

When a temperature sensitive product is being moved, it is vital to first assess its characteristics. A key issue concerns the temperature conditioning of the shipment, which should already be at the desired temperature. Cold chain devices are commonly designed to keep a temperature constant, but not to bring a shipment to this temperature, so they would be unable to perform adequately if a shipment is not prepared and conditioned. Other concerns include the destination of the shipment and the weather conditions for those regions, such as if the shipment will be exposed to extreme cold or heat along the transport route. Using a reefer with its own power unit usually mitigates such concerns.

Modal choice

Several key factors play into how the shipment will be moved. Distance between the origin and the final destination (which often includes a set of intermediary locations), the size and weight of the shipment, the required exterior temperature environment and any time restrictions (perishability) of the product all effect the available transportation options. Short distances can be handled with a van or a truck, while a longer trip may require an airplane or a container ship. In this case, the cost / perishability ratio becomes a factor in modal choice.

Custom procedures

If the freight crosses boundaries, custom procedures can become very important, since cold chain products tend to be time sensitive and more subject to inspection than regular freight (e.g. product, pharmaceuticals and biological samples). The difficulty of this task differs depending on the nation (or economic bloc) and the gateway since there is variations in procedures and delays. Customs issues are commonly identified as the most crucial in establishing reliable international cold chains.

The "Last Mile"

The last stage is the actual delivery of the shipment to its destination, which in logistics is often known as the "last mile". Key considerations when arranging a final delivery concern not only the destination, but the timing of the delivery so the critical labor and warehousing space is available. Trucks and vans, the primary modes of transportation for this stage, must meet the specifications necessary to transfer the cold chain shipment. Since many deliveries of cold chain products, particularly groceries, are taking place in an urban setting congestion and parking difficulties. Also important is the final transfer of the shipment into the cold storage facilities as there is potential for a breach of integrity.

Integrity and quality assurance

After the shipment has been delivered, any temperature recording devices or known temperature anomalies must be recorded and made known. This is the step of the logistical process that creates trust and accountability, particularly if liability for a damaged shipment is incurred. If problems or anomalies that compromise a shipment do occur, an effort must be made to identify the source and find corrective actions.

Therefore, the setting and operation of cold chains is dependent on the concerned supply chains since each cargo unit to be carried has different requirements in terms of demand, load integrity and transport integrity. Because of the additional tasks involved, as well as the energy required for the refrigeration unit transportation costs for cold chain products is much higher than regular goods. The ongoing rise in standards of living and economic specialization will remain important to drivers for years to come in the growing demand for perishable goods and the cold chain logistics supporting their transport.

Warehouse and Storage Operation Practices of Cold Chain Business

Layout design of Temperature Controlled Warehouse (TCW)

The purpose of warehouse has some that involve increasing storage, decreasing handling costs, improving order-picking efficiency etc. to optimize warehouse functions. In general, a warehouse operation has 5 main areas that involve Goods in; main store (reserve stock); order picking (forward stock); marshaling and goods out (Tan, Ling & Teo, 2007).

In goods in, it means incoming of goods. The function is receipt, check, record receipts and discrepancies, unpack, repack if necessary and decide goods location. In receipt, the goods unload and temporary hold. For check, the staff corrects goods received, grade, package, quantity and damage or shortages.

For main store, in this area, the goods are located goods in reserve storage area, and then confirm the location to control function. Also, there is to issue the goods to replenish order picking stock. Then, for order picking, the goods are picked, which are listed in the order. In marshaling, it is to assemble the goods by customer or by vehicle load. Lastly, it is goods out. It means outgoing goods. There are vehicles for loading facilities and vehicle dispatch schedules (Tan, Ling & Teo, 2007).

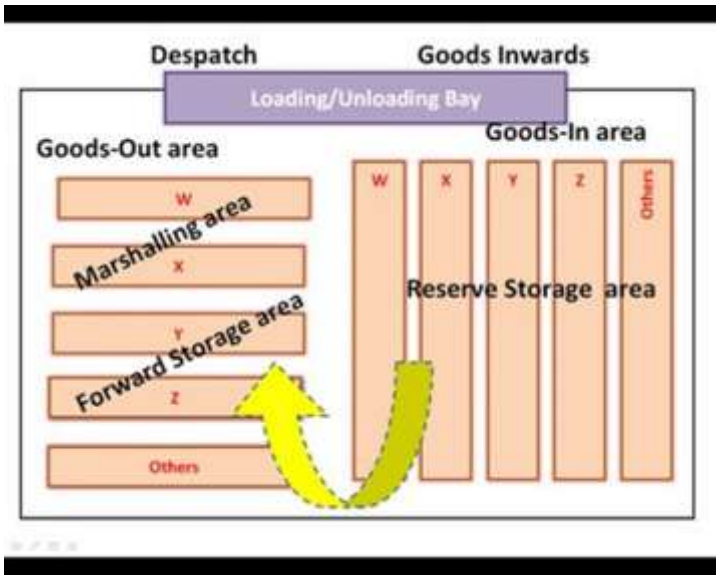

Figure 1: Warehouse Layout Design

For Temperature Controlled Warehouse (TCW), some more requirements are required in goods-in (Australian Food and Grocery Council, 2013).

When receiving products, the process is always as follows:

1. Identify the product immediately upon arrival at the cold store is as ordered.
2. Check condition of vehicle before unloading to ensure product has been stored hygienically.
3. Check that co-mingling of hazardous goods has not cross-contaminated the foods such as pesticides, chemicals, and high bacteria loaded products e.g. potting mix.
4. Record on the designated Inwards Goods Check Sheets, the receipt date / time and conduct at least two product temperatures of each consignment received.
5. Check and record that Use-By, Best-Before, or Packed on Date, or batch codes, are in place to meet the regulatory requirements and also meet the minimum shelf-life limits agreed between both parties.
6. Mark and/or transfer completed product, after performing above receipt checks, are moved as quickly as possible to storage areas and ensure that at least the Maximum Out-Of-Refrigeration-Time limits set within this guide are met.

TCW and Cold Chain Business in Hong Kong

Warehouses have over 300 buildings in Hong Kong and the types of warehouses mainly are: warehouse with ramp way; traditional warehouse with lift / elevator; and cargo terminals in container port & airport. The licensed TCWs in Hong Kong have around 41 stores (Centre for Food Safety, 2014) such as Brilliant Cold Storage Management Limited (I), Kerry logistics, Diary Farm, DCH Logistics Company Ltd etc. It's quite niche and unique market in Hong Kong.

One example is Brilliant Cold Storage Management Limited (I) which is a 17-storied building with total gross floor area of 380,000 sq. ft. Their warehouse facilities have freezers, chiller, air-conditioned room, bonded warehouse, general godown and ice manufacturing (Warehouse

Service, 2014). For freezer, its temperature is between -18 °C and -20°C which stores meat, seafood and frozen food products and so on. About chiller, it is between 0.5°C and 6°C and stores fruits, dried fruits, sea products, vegetables, eggs, Chinese herbs and photo paper etc.

The air-conditioned room is between 15°C and 20°C and keeps films, crisps, chocolate, spring water and pharmaceutical products etc. The bonded warehouse is between 16°C and 20°C and stores Cigarettes, liquor and dutiable goods. For general godown, it is normal room temperature and store general dry goods. Lastly, it is ice manufacturing which manufactures high quality ice bars for freezing or carving purposes and produce ice cubes for industrial and food use (Warehouse Service, 2014).

Since our customers in both HK and PRD region are more demanding on the frozen foods and products, qualify and recognized TCWs are required. The evaluation criteria of TCWs in cold chain are becoming critical to maintain our competitive role in supply chain and trade logistics business.

Evaluation criteria of qualify Temperature Controlled Warehouse (TCW)

In this study, comprehensive literature review has been made to identify several major evaluation criteria for qualify Temperature Controlled Warehouse (TCW). With reference from the literatures, a research framework is developed and summarized in the table 1.

Table 1: Evaluation criteria for qualify Temperature Controlled Warehouse (TCW)

Evaluation criteria	**Elements and Identified by**
(1) Location selection criteria	1. Physical and geographical location 2. proximity and accessibility to beneficiaries 3. connection to the airport, seaport, road and rail-road 4. disaster free location 5. the impact of climate on the area 6. geographical distance to other warehouses 7. Size of TCW a. storage space (general storage) b. temperature-controlled storage c. parking space Roh, Jang and Han (2013), Shankar et al. (2013), Demirel, Demirel and Kahraman (2010) and Ozcan, Celebi and Esnaf (2011)
(2) Facility requirements	1. has reliable electric system 2. availability of temperature-controlled storage 3. stored immediately after production 4. keep the quality of goods a. availability of different temperature-controlled storage b. store different range of required temperature goods at one warehouse 5. store different kinds of goods 6. availability of suitable humidity environment 7. efficient air movement and ventilation for cold storage 8. lighting: sufficient lighting to cover the warehouse 9. door, floor, wall and ceiling a. with sufficient inside safety opening device b. insulated and no air leakage c. door should be with air curtain d. door avoiding frequent moving of goods into and out of warehouse 10. height and width for transport convenient in exit or door 11. material handling system Colson and Dorigo (2004), Zhang, Habenicht and SpieB (2003), James and James (2010), Jul (1984), Liu and Ma (2012)
(3) Equipment requirements	1. Temperature tracking a. collecting temperature data is necessary b. collecting temperature data regularly by thermograph or manual c. enough temperature sensors located at

	different place 2. Enough equipment to maintain suitable temperature to store goods, e.g. chiller, initial freezer chamber 3. Enough equipment to hold or store the goods, e.g. racks, shelves, trays 4. Enough equipment for goods moving or handling, e.g. pallets, cages 5. Enough material handling systems, e.g. hand-lift, forklift, weighing scale Chan and Chan (2011), Roodbergen, Sharp and Vis (2008), Pohl, Meller and Gue (2009)
(4) Quality and Safety requirements	1. Approved sanitation program a. ISO 9001 Quality Management System b. ISO 14000 Environmental Management Systems c. ISO 28000 Security & Risk Management Systems for the supply chain d. HACCP e. Other quality standard and certification Warehouse Service (2014)
(5) Sanitary requirements	1. no pool of water in storage area 2. no condensation 3. provide a clean storage 4. provide a hand washing facility e.g. liquid soap, hand dryer, single- use paper towel and hand sanitizer 5. suitable protective clothing (e.g. gloves, jackets, safety shoes) Warehouse Service, (2014), Roodbergen, Sharp and Vis (2008)
(6) Operational arrangements	1. Smoothly traffic flow in warehouse a. deign warehouse layout b. clear separate the area of warehouse (e.g. goods in, main store, order picking, marshaling and goods out) c. smooth warehouse operation d. the movement of material handling system e. the movement of the goods f. clear guideline for the flow of goods 2. Storage method, e.g. 'First in, first out' to store the goods a. to maintain the quality of goods b. reduce the volume of waste due to the expired 3. Separates storage area of goods due to products compatibility

	4. Labeling the stored goods a. expired date b. required temperature to store Chan and Chan (2011), Roodbergen, Sharp and Vis (2008), Pohl, Meller and Gue (2009)
(7) Cost	1. Fixed cost, e.g. land, construction and equipment 2. Variable cost, e.g. operation, maintenance and labor Roh, Jang and Han (2013) and Demirel, Demirel and Kahraman (2010)
(8) Manpower	1. Important because of keeping the operation of warehouse smoothly 2. Certified knowledge dealing with cold goods and storage 3. Training certificate 4. Personnel hygiene and training Roh, Jang and Han (2013) and Demirel, Demirel and Kahraman (2010)

4. Discussion and Future Research

The proposed conceptual framework in this research provides insight to identify evaluation criteria for qualify Temperature Controlled Warehouse (TCW). With reference from literatures, eight evaluation criteria (Location selection criteria; Facility requirements; Equipment requirements; Quality and Safety requirements; Sanitary requirements; Operational arrangements; Cost; Manpower requirements) are included.

Data collection and analysis will be conducted to further validate the proposed research model in future research. The research results will be expected to contribute to logistics service management research field and provide meaningful implications for managerial activities.

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