

A STUDY ON COLD CHAIN MANAGEMENT IN INDIA

PROJECT REPORT

Submitted by

YASH JOHRI

in the partial fulfilment for the award of the degree of

MASTER OF BUSINESS ADMINISTRATION

IN

INTERNATIONAL TRANSPORTATION AND LOGISTICS

MANAGEMENT

School of Maritime Management

Under the guidance of

Dr. Jayan P.A.



INDIAN MARITIME UNIVERSITY, COCHIN CAMPUS

JUNE 2021

DECLARATION

I, Yash Johri, the student of MBA – International Transportation and Logistics Management School of Maritime Management, Indian Maritime University, Kochi, declare that the Project Report entitled “A Study on Cold Chain Management in India”, being submitted to the School of Maritime Management, Indian Maritime University, in partial fulfilment of the requirements for the award of Degree of MBA – International Transportation and Logistics Management, is my original work without been copied from any other websites, books and other reading materials and the same was not earlier submitted to any other Degree, Diploma, Fellowship or any other similar title or prizes.

Date: 29th June 2021

Name: Yash Johri

Place: Kochi

ACKNOWLEDGEMENT

I wish to express my sincere gratitude to the Management of the School of Maritime Management, Indian Maritime University-Cochin, who enhanced my knowledge in the field of International Transportation and Logistics. Even though I have taken efforts in this project, it would have not been possible without the kind support and help of many individuals and organizations. I would like to express my sincere thanks to all of them.

My thanks and appreciation to my Institution in developing the project and people who have willingly helped me out with their abilities. I wish to express my sincere gratitude and take immense pleasure in thanking my Mentor and Project Guide Dr. Jayan P.A. Head of Department of School of Maritime Management for moral support, able guidance and useful suggestions which helped me in completing this project work in time.

I perceive as this opportunity as a big milestone in my career development. I will strive to use gained skills and knowledge in the best possible way, and I will continue to work on their improvement, in order to attain desired career objectives. Hope to continue cooperation with all of you in the future. I also thank my family and friends for the continuous support in completing my project work.

Date: 29th June 2021

Name: Yash Johri

Place: Kochi

Table of Contents

S. NO.	Contents	Page No.
1	Executive Summary	5
2	Chapter 1 – Introduction	6-11
3	Chapter 2 – Literature Review	12-16
4	Chapter 3 – Industry Profile	17-24
5	Chapter 4 – Analysis	25-47
6	Chapter 5 – Conclusion	48-50
7	Bibliography	51

Executive Summary

At present, India is largest producer of milk, second largest producer of fruits & vegetables, food grains and marine products and fifth largest producer of meat & meat products. Presently, India is self- sufficient in food grain production and its horticulture production has grown at a phenomenal pace from 146 million tonnes in 2001 to 314 million tonnes in 2018-19. Currently at a nascent stage, the Indian cold chain market continues to emerge driven by increased focus on overall improvement of quality & product sensitivity, changing consumption patterns, growth in organized retail, urbanization, changes in lifestyles, growing demand for nutraceuticals, government initiatives and growing pharma sector.

As a result of Government of India's continuous efforts on cold chain development, the value chains are developing at an accelerated pace. However, there is a huge gap between existing capacity & requirement of cold chain infrastructure. The sector offers private participation in the growing untapped market in creation of storage facilities at the farm level, transportation, and food processing units.

The cold chain sector in India has not progressed at par with the global developments in the monitoring and control technologies. Even though new entrants in the sector are employing some of these modern technologies, most of the earlier generation cold storages are still dependent on the manual modes of monitoring assisted with conventional measuring systems. The upcoming trends that need to be fully embraced by Indian companies are RFID based systems for unit level measurement, WSN based systems for a local unit, and IoT based monitoring systems for covering the entire supply chain.

This report gives an overview of the cold chain sector in India covering need for cold chains, growth drivers, government support and incentives, present scenario, key challenges, opportunities & outlook.

CHAPTER 1
INTRODUCTION

In a world of finite resources, in order to lead a sustainable life, it is important to produce better and consume intelligently. In India, one-third of horticultural produce especially fruits and vegetables are wasted every year. In today's world though there is enough food for everyone but not everyone eats, owing to the inefficient supply chains and poor processing levels. Millions across the country suffer from malnutrition and die due to hunger. India, with a Global Hunger Index Score 28.5 in 2016, has 15.2% of undernourished population. In such a dire situation where food preservation must be given high priority, the estimated annual value of losses of Agri produce is Rs. 92,651 crores. Of these perishable products like fruits and vegetables, meat, fish, and milk account for an estimated loss of Rs. 50,473 crores. Reducing postharvest food losses to at least 15% from the current 30% level could provide 18.3 million tons of fresh foods each year, valued at \$3.9 billion.

Food losses and their prevention have an impact on the environment, food security, quality, and safety. This in turn also has an impact on socio-economic development as food loss also represents a waste of the labour, water, energy, land, and other inputs that go into producing food. The carbon footprint alone of food produced and not eaten is estimated to be 3.3 G tonnes of CO₂ equivalent - in other words, food loss and waste would rank as the third top GHG emitter after USA and China if it were a country. Cold Chain sector holds a key solution to address the problems of food loss, directly by increasing the shelf life of the food and indirectly by increasing the reach of the food to markets and processing facilities.

The development of cold chain systems is a force multiplier that can generate exports and open new markets over multiple sectors over an extended period, rather than a one-off export transaction that can be quantified simply as an export success. U.S. businesses understand the need for viable and efficient cold chain systems; they spend hundreds of millions of dollars each year to build and maintain both cold storage and transportation systems, which allow U.S. businesses to flourish. Export promotion and trade policy agencies should focus on the development of international cold chains through improved regulatory environments, increased skill level of workforce and encouragement of infrastructure investment, thereby promoting the benefits of U.S. services.

Cold chain systems are crucial to the growth of global trade in perishable products and to the worldwide availability of food and health supplies. Each year, billions of tons of fresh food products and millions of dollars' worth of U.S. exports are lost due to poor cold chain systems

in developing markets. The World Economic Forum lists food crises as fourth on its top global risks of highest concern for the next 10 years. Globally, billions of dollars are spent on improving agricultural processes to create higher food yields, but the fact that nearly half of all food never makes it to a consumer's plate is largely ignored.

Global losses in the food industry total more than \$750 billion annually. ³ These losses primarily result from lack of proper facilities, improper food safety handling procedures and insufficient training for those personnel working in the cold chain. Additionally, over \$260 billion of annual biopharma sales are dependent on cold chain logistics to ensure the efficacy of their products.

FUNDAMENTALS OF FOOD SUPPLY CHAIN DESIGN

In this Adjunct, I outline the requirements of an ideal food supply chain cluster. The concept of Food cold chain hub which is a collection of companies working together towards a common destiny. It is important that companies are interconnected logistically for movement of raw materials, semifinished and finished goods. They should also be connected via a secure extranet for transfer of business information. The flow of funds also needs to be smooth across the stake holders.

The food supply chain can be subdivided into a number of sectors. Agriculture, horticulture, fisheries, and aquaculture are the primary producers, the manufacturers who process the food for ready to eat or cook format together with the packaging companies are in the intermediate stage, and the retailers, wholesalers and caterers are in the last stage of the supply chain. At each stage value is added by the new ownership such as processors, distributors, packers, etc. and the cost and profits are part of the business. The food items can go to the final consumer from any of the three stages: from farmers in the form of fresh produce, to the caterers directly from the manufacturer, and finally from the retailer (small or big) to the consumer. The movement of goods from one stake holder to another is facilitated by the in house or third-party logistics service provider. The information management is done by the all the stake holders and their information systems are all interconnected seamlessly. What we described above is the state of food chain in the advanced countries. In India and other developing countries, the state of food chain is more fragmented and primitive we have dealt with it in the earlier sections.

Temperature controlled cargoes are inherently perishable and present greater challenges and risk exposures for the logistics operator than ambient cargoes. The process of correctly packing, handling, and monitoring refrigerated containers and their cargoes is one that will demand to attention.

For the logistics operator it is vital to know your shipper when handling temperature-controlled cargoes. In the first instance it is generally the responsibility of the shipper to provide specific instructions and requirements regarding the carriage of the cargo. It is increasingly the case, however, that this responsibility is passed to the logistics service provider, not least when full supply chain managed operations are undertaken. In these cases, the forwarder assumes responsibility for the entire supply chain. Whatever the circumstances the logistics provider should actively seek advice, clarification, and agreement from the shipper regarding such requirements, and contracts specifying these should be regularly checked, especially at renewal. It should also be noted that industry regulations – and therefore carriage requirements – have the potential to change for perishable cargoes fairly regularly.

For the majority of the cargoes, the shipper will normally declare a set temperature at which the cargo is to be maintained throughout the duration of the transit. For less sensitive chilled cargoes, a range of acceptable temperatures may be stipulated. In either case when subcontracting transport moves, whether short inter depot transfers or global containerised movements, it is essential to ensure that clear and accurate written instructions are passed down the contractual chain. The margins for error are often very small, the differences between “-” and “+” temperature can easily be confused in communications and will likely have catastrophic effects on the cargo. Freezing an ambient cargo can be just as damaging as overheating a frozen cargo.

Pre-packing checks and correct packing also plays an important role. The transport unit should be in good condition, clean and free from odour. The cargo must be evenly distributed with due care taken to ensure a free flow of air and pallets stacked safely and securely. Crucially, cargo should be cooled to the desired carrying temperature prior to loading. The reefer unit is not intended to cool cargo down, merely to maintain the set point temperature.

Importance of temperature control in food chain

Fresh foods continue to metabolize and consume their nutrients throughout their shelf life, from harvest or slaughter through packing, distribution, marketing, and sale. Processes like respiration, enzymatic breakdown and microbial degradation break down the carbohydrates, proteins and other nutrients into simpler compounds. The degradation processes are highly dependent upon temperature and most of these processes double their rate for each increase of 10°C (known as the Q10 coefficient). In addition to physiological deterioration, foods are also subject to molds, rots or decays caused by microbes and wilting, shrivelling caused by water loss. The rates of microbial growth and water loss increase with temperature increases.

In general, food degradation processes increase two or even three-fold with every 10°C increase in temperature. A perishable food product with a recommended handling temperature of 0°C will have only one-third to one-half of its maximum shelf life if handled at 10°C. If the handling temperature jumps to 20°C, the produce will have one-quarter of its potential shelf life. In other words, reducing storage temperatures by 10°C will double the shelf life of perishables.

Temperature °C	Assumed Q10	Relative shelf life	Losses per day (%)
0	-	100%	1
10	2.0 to 3.0	33 to 50%	2 to 3
20	2.0 to 2.5	13 to 25%	7 to 8
30	2.0	7 to 10%	10 to 14
40	1.5	4 to 5%	20 to 25

Table 1: Theoretical relationship between temperature, respiration rate and deterioration rate of a non-chilling sensitive fresh commodity

Cooling provides the following benefits for perishable horticultural foods:

- Reduces respiration lessens perishability and natural senescence
- Reduces transpiration lessens water loss, less shrivelling
- Reduces ethylene production slows ripening
- Increases resistance to ethylene action
- Decreases activity of micro-organisms
- Reduces browning and loss of texture, flavour, and nutrients

Based on the nature and perishability, the food is handled at different temperatures in the cold chain. The broad classification of Cold chain on the basis of storage temperature is provided in Table 2.

Category	Temperature	Examples
Frozen	< -18°C	Frozen ingredients, processed fruits & vegetables, Ice Cream, frozen meats (fish, poultry, livestock), etc.
Chilled	0°C to 10°C	Fresh fruits & vegetables, fresh meats, milk, butter, etc.
Mild chilled	10°C to 20°C	Sub-tropical Fresh fruits & vegetables, chocolates and seeds and some milk products.
Normal	>20°C	Whole Onion, Dehydrated Foods, Pickle, Jams and Oils and extracts.

Table 2: Categories of cold chain

Objectives

1. To examine the trade trends in perishable cargo.
2. To examine the perishable cargo handling in terms of Stuffing and Destuffing
3. To analyse the inter-linkages between trade procedures and perishable cargo handling
4. To provide suggestions for handling the perishable cargo.

CHAPTER 2
LITERATURE REVIEW

2.1 Review of Literature

The current chapter provides the review of literature and research design of the study. It has been presented under two sections. The first section deals about the studies related to perishable cargo handling and the research design discussed in second section.

‘The Study on Efficient Cold Chain Logistics’ (2018), by Zhang Yu School of Economics and Management, Chang’an University, Xi’an, China; Ma Tianshan School of Economics and Management, Chang’an University, Xi’an, China; Syed Abdul Rehman Khan School of Economics and Management, Tsinghua University, Beijing, China; and Arshian Sharif Othman Yeop, Abdullah Graduate School of Business, Universiti Utara Malaysia says In the supply chain, cold chain is a small part, usually cold chain are using for frozen foods, medical supplies, and fragile items such as, meat, medicines, ice cream, fish etc. The concept of RFID (radio frequency identification device) is tracking products/containers. This technology widely used in the cold supply chain for tracing trucks and their temperature. On the other hand, sensors and RFID is new technology, which also boost to the field of cold chain logistics. This research conducted to find the usage of sensors and RFID and their advantages. The system has many advantages to apply it and it experiences low cost of overhead. For the consideration of differentiated marketing strategy, it is a good strategy to apply this guaranteed cold chain. The LTE-A, the future of GPS and 3G technologies combined with the concept of extranet and intranet make it more transparent for the customers so that the customer can believe the products certainly. A broad and detailed standard of that system needs to be advised in detail so that the suppliers, customers, and vendors can follow it bitterly and can more collaborative on the behalf of this system.

Improved Reefer Container for Fresh Fish (2013) by Iceland food and Biotech R&D analyses the possibilities for transporting fish without giving a chance for deterioration of cargo. The study shows that temperature control during container sea transport may be improved by simple design improvements changes in operation procedures and conditional temperature settings of the reefer. It is noted that after production fresh fish should be stored at a temperature close to the desired transport temperature but not in a freezer storage as is commonly done. Loading cargo at temperatures above the desired transport temperature should be avoided and the loading should preferably take place in a temperature-controlled environment or at least under

a shelter during the summertime. While temperature was found to be stable through the sea freight, the land transport and transport of the reefers from the dock to shipping is less controlled. Improvements at loading facilities when moving and loading containers are needed. The negligence of truck drivers also leads to the rise of temperatures which can be rectified by giving proper instructions to the driver and also making the drivers aware about the consequences and the losses made by silly negligence. Temperatures and temperature fluctuations were generally found to be the greatest at the reefer's door end area and the design improvement results showed that by forcing air flow to the area temperature control can be improved. The cargo should also be spaced from the reefer walls to allow for air flow from the refrigeration unit to counteract heat gain from the ambience.

'Reefer Cargo Market in South America East Coast: A Competitive Analysis'(2010) by GALVAO, Cassia B. Sao Paulo Catholic University analyses reefer cargo maritime shipping characteristics and recent development in South American East Coast ports. The study says that reefer market is a profitable niche market spite of higher operation costs. The analysis explains that reefer cargo has several trades, flows and transportation requirements, which characterises it as a very specific market niche operated by specialists. The risk of transporting reefer goods is much larger than the general cargo and therefore shipping lines involved have to be more dedicated and specialized, resulting in a more concentrated market. The study also analyses that especially in Brazil, the containerization process is coming to its end, and carrier's efforts are concentrated in their strategic share in the reefer container business. As it was demonstrated, South American reefer market has passed by an important concentration process, leading carriers, and shippers to different and more balanced bargain power in their operations.

'Bengaluru airport to get its first perishable cargo facility' an article published in Business Standard Newspaper (March 2, 2015) by Praveen Bose says about the setting up of new perishable cargo facility. Air India SATS Airport Services, a joint venture between Air India and Singapore Airport Terminal Services, will have a 40,000-tonne per annum capacity perishable cargo handling centre 'AISATS Coolport' up and running at the Kempegowda International Airport (KIA) in the next 12 months. The joint venture between Air India and the Singapore Airport Terminal Services (SATS), broke ground for Bengaluru's first fully dedicated perishable cargo Handling centre, spread over 60,000 square feet the 'AISATS

Coolport'. This is a facility, with a provision of about 135 kilo Volt Ampere (KVA) power supply for its operations through solar energy, a first for an air freight terminal in India. This facility will cater to a wide range of commodities such as pharmaceutical products, fruits, vegetables, and flowers. The facility will be equipped with a drug controller lab testing facility, separate ripening zone, land- side truck-docks, warehousing and re-distribution centres, cold room facilities with different temperature zones and testing facility according to the plant quarantine requirements for European Union and US-bound shipments. The new facility will be also living humidity-control and temperature monitoring facilities.

'Freight Forwarders: New regulations complicate the "cold chain"' By Patrick Burnson, Executive Editor May 01, 2015. Forwarders who specialize in the controlled temperature marketplace are facing more regulations now than ever. But by bringing new technology into the fore, they can quickly meet compliance standards and differentiate their service While shippers typically rely on forwarders to help them with quality specifications and export documentation, the challenge is far more daunting when it comes to the movement of perishable goods. Food, beverage, bio-med, and pharmaceuticals are among the most vulnerable to supply chain risk; however, a capable middleman will not only mitigate risk, but prevail over the various challenges of the "cold chain."

'Using Sensor Information to Reduce the Carbon Footprint of Perishable Goods' by Alexander Ilic, Switzerland. Sensor technology Can significantly improve the management of perishable goods. Studies show that even though sensors introduce additional costs, they help to increase supply chain efficiency and thus profits. However, the application of the technology also leads to additional greenhouse gas emissions. This study investigates the value of sensor-based replenishment configurations with respect to profit and emission levels. The results show that profit-optimal solutions can also lead to significant reductions in emission levels. With an abatement cost analysis, the study explains how to balance the trade-off between profit maximization and emission minimization Sensor technology can help to significantly increase the profits when dealing with perishable goods. Moreover, the technology has the potential for considerably improve the resource efficiency of the related processes. As the results show, emission reductions induced from avoiding waste and reducing the number of shipments more than compensate for the emissions related to the sensor production and usage. The companies

that use the technology not only save money but also lower the carbon footprint of their products.

‘Third Party Logistics Practices: An India Perspective’ by B. S. Sahay and Ramneesh Mohan investigates the various aspects of 3PL logistics, a key rationale for outsourcing of logistics functions is the intensified globalization of businesses. During the last two decades, globalization has emerged as a major force of shaping business strategies, leading firms to develop products designed for a global market and to source components globally (Cooper, 1993). This has led to more complex supply chains requiring larger involvement of managers in logistics functions Lack of specific knowledge of customs, tax regulations and infrastructure of destination countries has forced firms to acquire expertise of third-party logistics service providers. As a result, firms are concentrating their energies on core activities and leaving the rest to specialist firms (Byrne, 1993; Foster and Muller 1990; Trunick, 1989).

CHAPTER 3
INDUSTRY PROFILE

Perishable Cargo Industry

India is one of the fastest growing economies in the world today. This growth is fuelled by the growth in infrastructure, booming manufacturing sector, EXIM trade, retail trade and agriculture-related activities, among others. This in turn has led to increased demand for world-class logistics and warehousing services in India, leading to the growth and transformation of the industry. Cochin port has an export of 176197,704 metric tonnes perishable cargo during the year 2013 alone. It is also clear from the records that the volume of perishable cargo from is having a definite increase in the consecutive years.

Once again, the logistics sector is experiencing growth. An integral category of international cargo - and one that has been the subject of numerous conferences and discussions - is perishable cargo: essentially cargo that requires a temperature-controlled environment from production to consumption. The absence of an end-to-end temperature-controlled environment for such products can render damage to both the quality and efficacy of such cargo, Examples of perishable cargo include fresh fruits and vegetables, frozen foods meat poultry and dairy products; seafood; and pharmaceuticals and vaccines. Time, temperature, and humidity are the three key variables when it comes to shipping perishable cargo.

Importance of Cold Chain

There can be various causes of food losses. World Food Logistics Organization (WFLO) project measured postharvest losses for 26 perishable crops in 4 countries, and documented losses from 30 - 80% due to poor quality packages, poor temperature management, and delays in marketing. The International Institute of Refrigeration (IIR) calculated that 23% of perishable foods are lost in developing countries due to the lack of the use of cold chain³. Since food loss reduction plays a significant role towards sustainably improving food security, it is important to have economically viable, environmentally friendly, and socially acceptable solutions. In such a scenario, a well-integrated cold chain is a perfect fit to the problem. The cold chain integrates activities across the value chain. An efficient cold chain is extremely critical to the growth of the agriculture and food industry.

Major benefits of a well-connected cold chain are:

Availability: India has a wide range of climate and physio-geographical conditions which restrict the availability of fruits and vegetables all over the year. An efficient cold chain ensures delivery of produce throughout the year. Agriculture is a seasonal activity which results in surplus production in peak season whereas a lacuna in offseason. The presence of temperature-controlled environment facilitates storage of the processed and fresh products, the products are processed/packed in bulk during peak season and stored in the controlled atmosphere so as to supply in the off-season.

Perishable foods, like fruits, vegetables, meat, poultry and dairy, require an uninterrupted cold chain. Moderating parameters like temperature, humidity, and atmospheric composition, along with utilizing proper handling procedures, cold chain can significantly increase the product life of fresh foods for days, weeks or even months. These services allow fresh products to hold their value longer, increasing their transportability and providing opportunities that expand their market reach.

Affordability: Vegetable and fruits production in the country has increased over the years but still the prices are not normal across the country. Normalizing price of the crops throughout the year and locations is possible through the holistic development of integrated cold chain. It holds the key to reducing post-harvest losses, ensuring uninterrupted supply, and thereby minimizing food inflation.

Accessibility: Availability across various parts of the country can be guaranteed if the crop produced can be supplied to areas where it is not cultivated. The cold chain will considerably help farmers to reach far away markets. It empowers them with the ability to capture a larger buyer base and helps to bring their harvest to more valuable end use. Also, the consumer will now have access to the products of his choice and at desirable time and place. In the proposed Vision 2022 “for doubling farmers income, the components to strengthen agricultural supply chains is an important aspect. Extending the cold chain network is one of the key solutions to bridge the existing gap and strengthen these supply chains.

Quality: Cold chain maintains the quality of perishable foods by slowing down the respiration rate, reducing transpiration, lowering microbial activity etc.

Social importance: A major part of an efficient cold chain lies in having an equivalently good backward integration. This, in turn, is a potential source of generating growth opportunities in

rural areas, improve living standards and reducing migration to urban areas. It will also substantially increase the employability in the rural areas offering tremendous opportunities for both men and women in this sector.

These goods demand special handling as even the slightest temperature excursions can negatively affect the quality of the goods - especially in the case of ultra-sensitive Cargo, such as pharmaceuticals and vaccines, where there is no margin for error. Improper handling at point in the supply chain can cause physical damage to the consignments' contents, or even make it unusable. These cargos are also often subjected to numerous temperature excursions because of inadequate supply chain infrastructure, and/or the lack of awareness among supply chain partners about the right storage and/or handling techniques.

The Time and Temperature Sensitive label is a shipment label, specific to the healthcare industry, that must be affixed to all shipments booked as time and temperature sensitive cargo. Articles of perishable nature which are liable to deteriorate or perish due to changes in climate, temperature, altitude, or other normal exposure inherent to carriage of cargo by air, or length of time in transit will be accepted provided that it is reasonably certain they will reach their destination in good condition. Advance arrangements should be made, and packages and documents should be boldly marked 'Perishable'. A special "Perishable" IATA standard label shall be affixed on each package; where applicable "This Way Up" label shall be used, when the contents are liquid in nature.

Reefer Container

An important use of refrigerated hold type Ships was for the transport of bananas and frozen meat, but most of these vessels have been mounted in part by refrigerated containers, the refrigeration systems with the rear end of the vessel have changed. While on a ship this container into an electrical outlet (typically 440V AC), which put the ship ties in power generation. Since many merchant vessels now have diesel-electric propulsion units installed providing power to individual units is mostly a wiring job. Refrigerated container ships are not limited by the number of refrigeration containers they can carry unlike other container ships which may be limited in their number of refrigeration outlets or have insufficient generator capacity. Each refrigerated container unit is typically formed with an independent electrical circuit, and a separate circuit breaker that allows it connected and disconnected as required. In principle, each device could be repaired while the ship is still in progress.



Figure 1: A Refrigerated/Reefer Container

Refrigerated cargo is an important part of the income for some shipping companies. On multi-purpose vessels, reefers are usually carried out on deck, as they must be checked for proper operation. Also, a major part of the refrigeration system (such as a compressor) may fail, which would have to be replaced or unplugged quickly in the event of a fire. Modern container vessels stow the reefer containers in cell guides with adjacent inspection walkways that enable reefer containers to be carried in the holds as well as on the deck. Modern refrigerated container vessels are designed to incorporate a water-cooling system for containers stowed under deck. This does not replace the refrigeration system but facilitates cooling down of the external machinery. Containers stowed on the exposed upper deck are air-cooled, while those under deck are water-cooled systems. The water-cooling design allows capacity loads of refrigerated containers under deck as it enables the dissipation of the high amount of heat they generate. This system draws fresh water from the ship's water supply, which in turn transfers the heat through heat exchangers to the abundantly available sea water.

There are also cooling systems that have two compressors for very precise and low-temperature operation, such as the transport of a container full of blood to a war zone. Loads of shrimp, asparagus, caviar, and blood considered among the most expensive chilled products. Bananas, fruit, and meat were the main cargo of reefers in the past.

Warehousing

A warehousing is a commercial building for storage of goods. Warehouses are by manufacturers, importers, exporters, wholesalers, transport companies, customs, etc. They are usually large plain buildings used in industrial areas of cities and towns. You come equipped with loading ramps for loading and unloading trucks; or sometimes loaded directly from railways, airports, seaports.

They often use cranes and forklifts for moving goods that are placed in pallets loaded racks. Some halls usually on ISO standard pallets fully automated, with no workers inside. The pallets and product are moved with a system of automated conveyors and automated storage and retrieval machines coordinated by programmable logic controllers and computers running logistics automation software. These systems are often installed in refrigerated warehouses where temperatures are kept very cold to keep the product from spoiling, and also where land is expensive, as automated storage systems can use vertical space efficiently. These high-bay storage areas are often more than 10 meters high, with some over 20 meters high. The direction and tracking of materials in the warehouse is coordinated by the WMS, or warehouse management system, a database driven computer program. The WMS is used by logistics personnel to improve the efficiency of the warehouse by directing movement and to maintain accurate in inventory by recording warehouse transactions for a warehouse to function efficiently, the facility must be properly slotted. Effective slotting addresses which storage medium product will be picked from (pallet rack or carton flow), and how they will be picked (pick-to-light, pick-to-voice, or pick-to-paper). With a proper slotting plan, a warehouse can improve its inventory rotation requirements such as FIFO (First in First Out) and LIFO (Last in First Out)-control labour costs and increase productivity.

List of Perishable Goods

Foodstuffs

- Plant Products (fresh, chilled, frozen)
- Fruits and vegetables
- Other crops and crop products

Animal products

- Meat and meat products (fresh, chilled, frozen, cooked)
- Bovine meat products
- Porcine meat products
- Poultry meat products
- Lamb/Sheep and goat meat products
- Horse meat products
- Other meat products
- Aquatic animals and aquatic animal products (fresh, chilled, frozen, cooked)
- Fish, crustacean, molluscs, and cephalopods
- Other aquatic animal products
- Dairy and dairy products (fresh, chilled, frozen, pasteurized)
- Egg and egg products (fresh, chilled, frozen, cooked)

Non-Foodstuffs

- Plant Products
- Cut fresh or chilled flowers
- Live ornamental plants
- Live aquatic plants
- Other plant parts (e.g., for propagation or research)
- Animal Products
- Offal
- Viscera (organs)
- Carcass
- Blood
- Skin and hide

- Hatching eggs

Medical and Veterinary Items refrigerated and frozen

- Blood, blood plasma, and serum
- Vaccines
- Biological laboratory reagents
- Pathological, biological and serological materials for research and diagnostic purpose

Live Animals

- Cattle and Buffalo
- Sheep and Goats
- Pigs and Rabbits
- Birds
- Horses
- Aquatic Animals
- Pets (e.g., dogs and cats)
- Laboratory Animals
- Animals for Public Entertainment
- Zoo Animals
- Silkworms
- Bees
- Other Live Animals

CHAPTER 4
ANALYSIS

Components of Cold Chain across value chain

Constituents of Cold Chain

A typical cold chain starts at the farm gate level or the production centre. The primary stage of cold chain is sorting, grading, and pre-cooling; subsequently, the products pass through various processing, storage phases, and other infrastructure to reach the end consumer. Various components involved in the integrated cold chain are:

- Packing and cooling fresh food products (immediately after harvest or collection),
- Food processing (i.e. ripening, chilling, or freezing of processed foods),
- Refrigerated transportation (cold transport and temporary warehousing under temperature-controlled conditions)
- Cold storage (short- or long-term warehousing of chilled or frozen foods),
- Retail (refrigerated or freezer storage and displays at wholesale markets, retail markets and foodservice outlets)

Packing & Pre-cooling:

Pack-houses are facilities where established systems for sorting, grading, washing, drying, weighing, packaging, pre-cooling and staging are present. Pre-cooling refers to reducing the field temperature of fresh horticultural produce soon after harvest and the target temperature depends upon the type of produce. Modern pack-houses are the first step in organized post-harvest management for horticulture and are in effect the first mile sourcing points for this sector.¹⁰ They are used to prepare and pre-condition the fresh farm produce for subsequent logistics connectivity in the cold-chain. The activities at pack house depend on the type of produce and market. Nearby markets generally need only sorting and packing, while for distant markets, additional operations are needed. When immediate transport is available, storage may not be necessary.

Food processing

Cold chain processing plays a significant role in increasing the shelf life, henceforth utility of the product. Processing can be done through ripening, chilling and freezing of the produce having its own implications on the shelf life.

Ripening Chambers are enclosures engineered to simulate ripening process without altering the taste or freshness of fruits. A ripening chamber comprises of following components:

- Air tight room with insulation
- Temperature control for cooling and heating
- Air circulation and ventilation system
- Humidity control system
- Electric control system
- Ethylene gas injection system

Chilled products: The temperature range required for storing chilled products could be from 0 to 10°C extending the shelf life of the products from 2 - 10 days.

Frozen products: Freezing is the drastic reduction of processed food temperature to below -18°C with the conversion of water into ice. Blast freezing speeds freezing by rapidly passing cold air over packages as they move through a tunnel or when they are stacked on racks in cold rooms. The freezing process can be sped up even further by using a free flow freezing process to achieve Individually Quick Frozen (IQF) product pieces. Methods that produce quick freezing (IQF via immersion or liquid nitrogen sprays) result in better quality food products than do methods that provide slow freezing (traditional freezer room racking).

Refrigerated transportation

Refrigerated transport plays a key role in a seamless cold chain ensuring smooth movement of the materials to various locations. Transportation between farm to processing units and processing units to the retailer is very essential to maintain an unbroken cold chain. Vehicles equipped with active refrigeration designed for environment-controlled carriage of products can be broadly classified as:

1. Reefer Trucks: The refrigeration trucks are powered by integrated diesel driven motors, independent of the main truck engine, acting as cold rooms on wheels. Smaller vehicles can also be used to serve the same purpose, by utilizing direct drive systems that are linked to the vehicle engine or battery powered refrigeration units. New age reefer trucks are also incorporated with GPS based location tracking system and data logging temperature and humidity sensors that help in continuous monitoring.

2. Reefer Containers: Reefer containers are multi-modal containers with integrated refrigeration equipment, normally used for multi-modal activities where rail-road-sea-air movements are involved in the logistics chain. It sources electric power from a separate generator (power-pack) which is independent of the reefer container. It has temperature control range of -25 to +20°C.

3. Reefer Vessels/Ships: Cargo vessel specializing in carriage of goods which are required to be maintained at below ambient temperatures. Each cargo carrying space is lined by layers of insulation material. Furthermore, the floor is double skinned to allow even circulation of the cooling air. Usually, perforated wooden/plastic gratings are utilized so as to allow uniform percolation of the cold air. Reefer vessels can carry any frozen or cooled cargo including fruits, vegetables, meat, and fish. Depending on the type of cargo a temperature range of -30 to +12°C can be maintained.

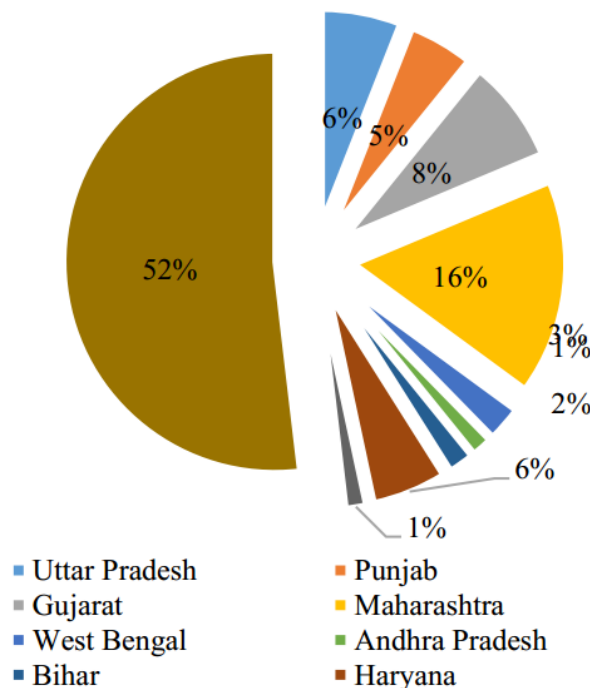


Figure 2: State-Wise number of Reefer Vehicles provided under various schemes

In cold chain, it is very essential to maintain the link and ensure that the chain is not broken. One crucial aspect to ensure this is to have a seamless refrigerated transportation network.

Currently, this sector is ignored in the industry as very few players are equipped to provide the temperature-controlled logistics service. This sector is highly fragmented and dominated by the private players.

Indian market comprises of around 250 major and minor reefer transport service providers with ~ 9000 controlled temperature vans having a capacity of 4.2 million tons.

Figure 2 shows state wise refrigerated transport infrastructure created under various government schemes. Though almost every state is facing shortage in terms of reefer transport, it is evident from the pie chart that Maharashtra, Gujrat, and Haryana are better off.

Most of the infrastructure sponsored under the current schemes consist of reefer vehicles with large capacities of approx. 20 tons, which do not cater to the need of transportation at farm end.

The states like UP, West Bengal and Punjab are leading in terms of number of cold stores, but they are considerably lagging behind in transportation network.

NCCD in collaboration with Mahindra Logistics has come up with a unique service proposition of Reefer Vehicle Call-in Centre. It is 24/7 call-in facility for registered transport drivers to help them with on road concerns regarding extortion, transit bottlenecks or any other issues.

Use of Radio Frequency Identification Device

Architecture

Cold Chain has four stages refrigeration processing, refrigeration distribution refrigeration storage and refrigeration sale. And in every stage, there are standard operation procedures to ensure the safety and quality of the foods from the processing till to customers or consumers. The system perspective in each stage is addressed in the following subdivisions.

1. Refrigerated Storage and Processing Stag

The RFID sensor on the package case will be initiated at the starting moment of processing level or stage. And from this situation, the sensor with RFID will record the temperature and timestamp in the memory of that RFID and will send this data towards the RFID (reader) of

the processing centre. It is noticeable that human-being cannot live in the very cold temperature like -18 degree, so it is very important for the operator to start and process the raw material under low temperature, but it should be greater than -18 degree within a limited duration. For every batch operation, one EPC code is generated and traced by the sensor with RFIDs EPC code. In the frozen (very cold temperature) processing centre, the sensed timestamp and data will be sent out periodically basis to the RFID reader in this centre. And all the data will be conveyed to the database server. In that scenario, the database server will judge if there are any time of abnormal condition, situation according to the rule of temperature of processing centre. The concept of this refrigerated storage and processing centre is shown in figure 3.

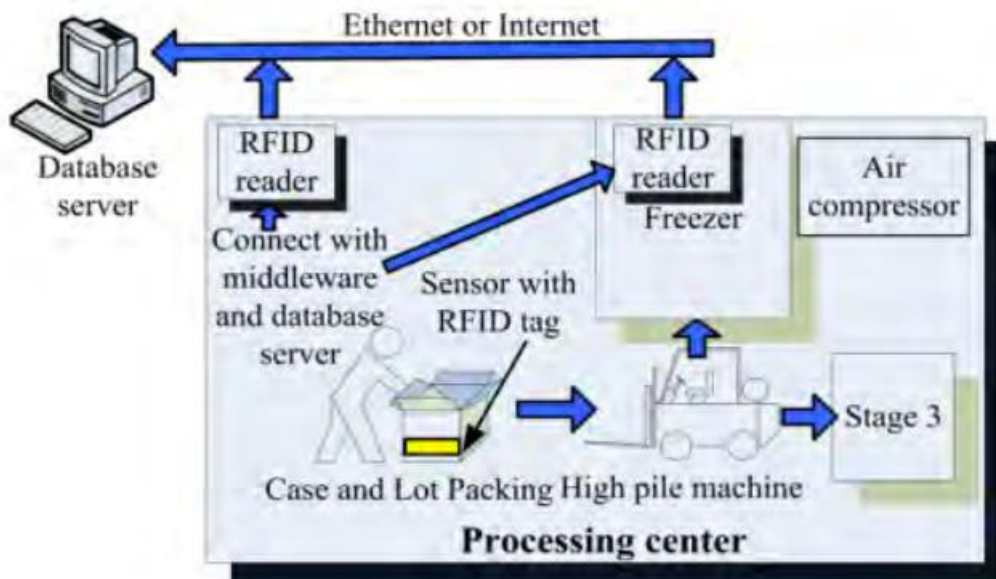


Figure 3: Concept of this refrigerated storage and processing centre

2. Sale and Transportation Stage

One time if the cold chain foods have been dispatch from the frozen storage or processing centre, these foods will be sent to the truck by a high pill machine or transportation line. The transportation line can be walk to the truck or a mechanical line. But there will be RFID reader attached and involved on this line. Whenever the lot packs dispatch out by the line in the range of induction, the RFID reader will alarm and send the EPC of this vehicle number, lot pack to the database server to clue their relationship. One time when the customer log in the web server

and make a query regarding the condition of their ordered foods, all the details will be shown in detail, including the frozen conditions. The customer's server of database can receive this data stream to monitor the foods quality in any place and at any time. Therefore, one time the cold chain foods are received, the maintain quality of those foods has been determined by the customer's database server. The server can place very strict rules on this data stream, and if any violations occur, the customer can reject or cancel the foods' order before arrival of those foods. On the same time, the supplier's database server will also make an event notice to the supervisor, and the RFID reader over the truck can also occur warning message to the truck's driver if the air compression over that truck is out of order. This innovation can provide to the customers' guaranteed quality. And it is also a best marketing strategy to make a differentiation from competitor's cold chain logistics.

Cold storage

Cold Stores are buildings or chambers that achieve controlled storage environment using appropriate thermal insulation and an efficient refrigeration system. Its objective is to properly handle and store fresh produce under appropriate temperature and humidity conditions for maintaining quality and extending shelf life. Fresh produce cold stores are designed to control respiration and prevent discoloration, sprouting, dehydration and decay. The cold stores/warehouses can be classified as follows:

1. **Bulk Cold Stores:** Environment controlled warehousing space intended for the bulk storage of perishable produce are known as bulk cold stores. It is designed for long duration storage of produce so as to build an inventory buffer which will serve to smoothen the episodic production by stabilizing & sustaining the supply lines. These are normally constructed in areas close to producing areas (farm-gate) to facilitate quick access to producers for a selective set of crops only. Generally used for storage of a single commodity, which mostly operates on a seasonal basis e.g. stores for Potato, Chilies, and Apples etc.
2. **Multipurpose Cold Stores:** Warehousing space with multiple temperature zones for functioning as a distribution hub. It is designed for short-term handling of products so as to serve as a distribution logistics platform for market ready packaged produce and ready to retail products. They are designed for storage of a variety of commodities which operate, round the year. The products stored in these types of cold stores are seasonal fruits, vegetables, dry fruits, spices, pulses, milk products etc.

3. Small cold stores with precooling facilities for fresh fruits and vegetables, mainly, for export-oriented items like Grapes etc. The major concentration of these units is in Maharashtra, but the trend is now picking up in other states like Karnataka, Andhra, and Gujarat etc.

4. Frozen food stores with or without processing and freezing facility for fish, meat, poultry, dairy products and processed fruits and vegetables. These units have helped the promotion and the growth of frozen foods sector, both in the domestic and the export markets.

5. Controlled Atmosphere (CA) Stores: These are cold store fitted with technology that can alter the atmospheric gaseous contents, in addition to controlling the temperature. For certain fruits/ vegetables like apples, pears, cherries.

6. Mini units / Walk-in cold stores located at hotels, restaurants, malls, supermarkets etc.

The Task Force on Cold-chain Projects (TFCP-2014) reported that 31.82 million metric tons of cold stores have been created in the country, out of these, a total of 10.58 million tons in cold storage size were created in the last decade, through Central Government Assistance.

Top 5 states in terms of total installed capacity are

- Uttar Pradesh (13.6 million MT)
- West Bengal (5.9 million MT)
- Gujarat (2.3 million MT)
- Punjab (2.0 million MT)
- Andhra Pradesh (1.6 million MT)

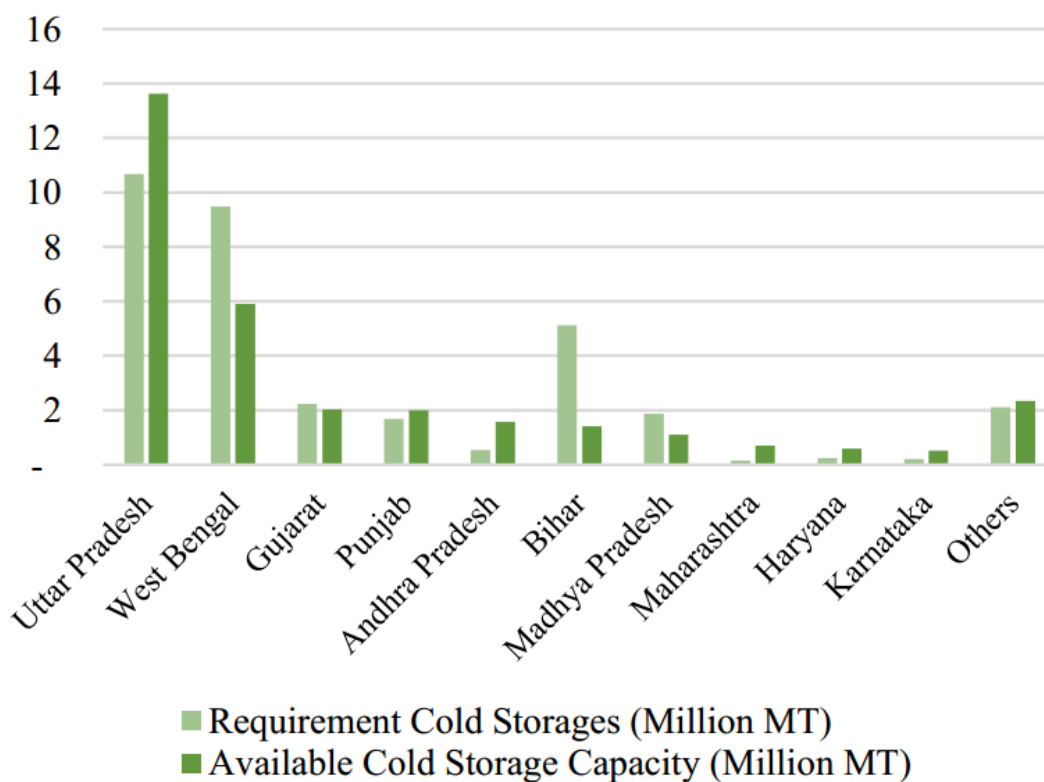


Figure 4: State Wise Cold Storage Distribution in India: 2014-15

It can be observed from Figure 4 that the growth of cold storages in India is not uniform. Some states like UP Andhra Pradesh, Punjab etc. have excess capacity whereas others like Bihar, MP have insufficient facilities.

In UP and West Bengal, majority of cold stores are single purpose storages which are utilized to store potatoes and in case of AP, they are used for storing chilies.

States like West Bengal, UP have high storage capacity with an average storage capacity more than 6000 MT, whereas Karnataka and Maharashtra, though have a high number of cold storages, average storage capacity is less than 2000 MT.

Since the majority of cold stores in India are single purpose warehouses due to the seasonality of produce they remain idle for almost 6 months.

It has also been observed in the NCCD study (2015), that only 75% of installed cold stores is being utilized.

Majority of the warehouses in India are under private ownership. In states like Gujarat, Haryana, UP a number of cold storages are owned on partnership basis, whereas storages in

AP are predominantly owned by private limited companies. In states like Karnataka, proprietorship basis is also prevalent.

Stakeholders and their roles in Cold Chain

The stakeholders in cold chain based on their roles and functions in the chain, include growers associations, farmers producer organizations and co-operatives and association of retailers to companies engaged in manufacture and installation of refrigeration equipment, associations of cold chain owners, chambers of trade, industry and commerce, regulatory and development agencies (NCCD, MoFPI, NHB, WDRA, FSSAI, BIS), PSUs, skill development academic and resource institutions.

- **Producers/Grower Associations and Consolidators:** Farmers in India are small by land holding, yield, volume of crop and are highly fragmented across geographical areas. Typically, a farmer handles cultivation, harvesting and preliminary packaging and transportation to the local mandi or consolidator. Some local entrepreneurs/consolidators provide the collected produce at the predetermined quantity and quality to the traders or processors and responsible for transportation of the produce from field/farmer storage to the trader/processor. The consolidator is accountable for the physical transfer of the product in good quality without injury. In a cold chain both these actors play a crucial role as, the produce is most susceptible to damage after first few hours of harvesting.
- **Traders & Processors:** Small producers with very small orchards take their harvested produce to the market yard and sell it to traders, who in turn will sell them to processor after performing basic pack house operations. Traders are mostly owners of primary collection centres where the fresh produce is stored initially. Usually, they perform both trading and pack house, storage and in some cases ripening activities. They buy the produce from multiple farmers after performing suitable operations sell it to either wholesaler or the retailer. Some traders/ pack houses apart from trading, offer their operations as services, and charge a fixed price for each activity performed.
- **3rd party reefer transporter:** Currently major part of transportation is through roadways via trucks. The products are carried from farm to trader or mandi either in tempo/vans, in case of larger consignment trucks, which are unrefrigerated. Reefer transportation is employed only in the organized trade after surpassing two to three

stages in the value chain. Third party reefer transporters are employed mostly by organized retail marts, food processing companies to meet the shortage of own reefer transportation.

- **Technology Providers:** Technology providers in cold chain sectors comprises companies working in the areas of refrigeration technologies, packaging technologies, IT infrastructure, Post-harvest care, monitoring and control technologies for real time acquisition and reporting data. They play an important role in modernizing the infrastructure by engaging in research and development to improve the efficiency of the cold chain by working on the aspects like energy efficiency, cost reduction, increasing the reach and reducing the environmental impact.
- **Cold Chain Associations:** Various cold chain associations at national and state levels are active in voicing out for necessary policy support. They act as pivotal agents for the sector to collaborate and network with each other for sharing knowledge, lobbying and liaising for government support.
- **Government agencies:** Government agencies play the lead role in designing policies, infrastructure creation, and framing regulations. Agencies like MoFPI, NHB, and APEDA extend their support in infrastructure creation. National Centre for Cold Chain Development (NCCD) is an autonomous agency under the Department of Agriculture, Cooperation and Farmer Welfare, established to promote cold chain sector for the perishables in collaboration with Industry and other stakeholders. It plays a vital role in promoting research, formulation of suitable technical standards and protocols, development of human resources for cold chain infrastructure in the country¹¹.
- **Consumers/Markets:** The premium pricing offered by the consumers for the quality products will determine the demand for quality products in the country which in turn will boost the cold chain sector, encouraging more players to adapt it.

Current status of Cold Chain in India

Cold-Chain Infrastructure: Status

Over the years India has seen a gradual increase in production of perishable products like fruits, vegetables, meat, and poultry products etc. It ranks first in dairy production, second in fruits

and vegetables and 6th in chicken and meat production in the world. Unfortunately, cold-chain infrastructure development has not met this demand, which resulted in absence of mechanisms, for safe handling and storage, transportation of perishable products to markets. A resultant demand supply gap has emerged across these agricultural commodities, frequently contributing to widespread price fluctuations and inflation. This shortage of farm-to-market logistics, also contributed to high food losses in case of perishable foods, further adding to inflationary pressures.

According to ICAR study on post-harvest losses of major agricultural and horticultural crops as well as livestock products, the losses in selected fruits and vegetables were found to be in the range of 5.8% - 18.0%, losses in inland and marine fisheries were estimated to be 5.23% and 10.52%, respectively. On board losses were not recorded in case of marine fisheries. The assessed loss in milk sector was only 0.92% whereas losses in meat and poultry sectors were 2.71% and 6.74%, respectively. ¹² To a great extent, these losses could be reduced by utilizing basic cold chain infrastructure.

Pack houses

- Pack-houses and refrigerated transport are important to initiate the vital link of logistics chain from villages to city or distribution hubs (in case of fresh produce).
- As per the NCCD (2015) report, at present the country has about 250 fully equipped functional pack-houses, whereas to fulfil current consumption of urban clusters, India needs about 70,000 pack-houses, each equipped with a pre-cooler and dispatch room for onwards transport links.
- Backward integration in a cold chain has been completely neglected until recent past when the focus has been shifted from building just cold stores to holistic development of integrated cold chain.
- A small concentration of packhouses in Maharashtra has brought global momentum to India's grape sector. Maharashtra is also a leading state in terms of number of packhouses for Mango and Pomegranate, followed by Andhra Pradesh.
- In Uttaranchal customised packhouses have been created to cater to the need of exporting Litchi.
- Another constraint in this sector is that most of the packhouses in India are primarily focused on fruits, there is very little emphasis on vegetable sector. Only few categories of exotic vegetables are handled properly and not much care is extended to others.

- Most of the packhouses created provide only basic operations of grading sorting and are not equipped with latest technology to carry out further value addition.
- Most of the pack houses are established by government. Lack of active participation from private companies is hindering the growth and innovations.

Ripening Chambers

- Generally, ripening can be carried out for fruits like Mangoes, Papayas, Pears, Apricots, Guava, Citrus, Melons, and for reddening of Tomatoes, Green Chilies, but in India ripening chambers are predominantly used only for Mango and Banana.
- Maharashtra and UP are hub of ripening chambers in India. Andhra Pradesh stands 3rd in the country. Majority of the ripening chambers are used for ripening of Mangoes in these states.

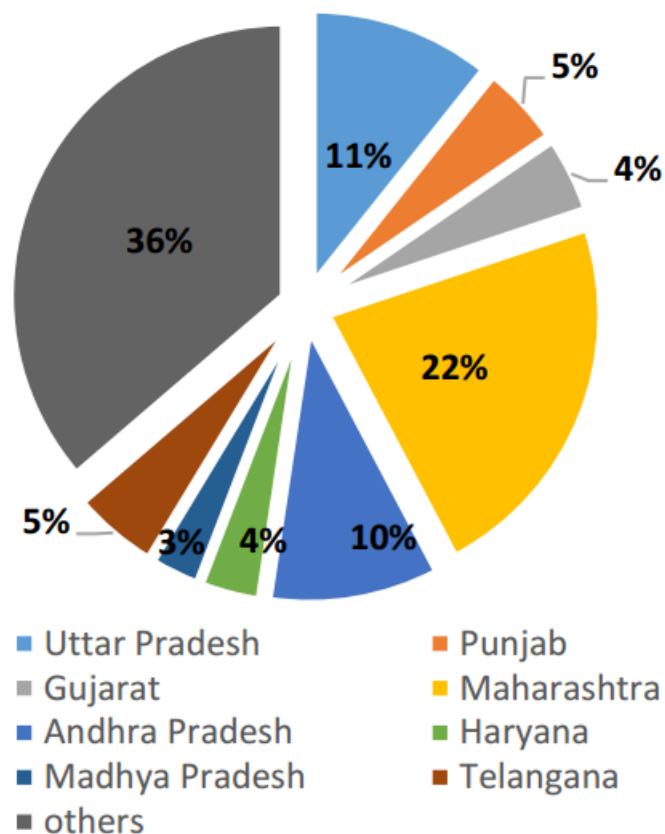


Figure 5: State-Wise Distribution of Ripening Chambers created under various government schemes

Gaps in Indian Cold Chain Infrastructure

As per a recent study by NCCD, there is a shortfall of almost 70,000 pack houses in the country. The gap of 70,000 pack houses indicates an average need for one between for every 10 villages. This evaluation indicates that the cold-chain backend is underdeveloped, and large investment needs to flow into rural India, at grass roots level. The optimal requirement of cold stores in the form of bulk stores and distribution hubs is 35.1 million tons in capacity, as against the existing cold stores capacity of 32.86 million tons from about 7129 units. As per a recent baseline census undertaken, 1219 cold stores of estimated 5 million tons in size, were found permanently closed/not available. The total number of functional cold stores is 5367 amounting to a total storage capacity of 26.85 million tons.

Infrastructure Type	Infrastructure Requirement (A)	Infrastructure Created (B)	All India Gap (A-B)	% share of Gap to Required
Pack house	70,080	249	69,831 nos.	99.60%
Reefer Vehicle	61,826	9,000	52,826 nos.	85%
Cold Storage (Bulk)	341,64,411 MT	318,23,700 MT	32,76,962 MT	10%
Cold Storage (Hub)	9,36,251 MT			
Ripening Chamber	9,131	812	8,319 nos.	91%

Table 3: Gap Analysis of Cold-chain Infrastructure in India

According to the NCCD study, there is an associated requirement of about 62,000 refrigerated transport units (of carrying capacity of 10 tons each) in the form of vehicles or multi-modal containers. Most of the current capacity (actively refrigerated trucks) is deployed for frozen processed foods, pharmaceutical sector, and imported foods, and not for the domestic supply of fruits and vegetables. This is largely because the shortfall of pack houses does not introduce fruits and vegetables into the cold chain in the first place. Although most of the cold storages facilitate transportation of commodities, 79% don't own any transportation facility and there are very few modern pack houses to originate produce into cold chain. An additional 30-40,000 vehicles (non-refrigerated/ Insulated) are estimated to be in use for transporting milk and fresh fish.

The NCCD study also indicates a need to develop an additional 8000 ripening chambers, large numbers of temperature-controlled retail cabinets and city delivery vehicles. The Table 3 shows that India has done reasonably well in terms of creating capacity for cold stores, but

it significantly lags behind in terms of creation of pack houses, reefer vehicles, and ripening chambers.

Investments needed for meeting the gaps

Approximately, 4000 projects are funded through various schemes in India constituting a total subsidy sanctioned of Rs. 3022.5 crores primarily focusing on bulk store capacity development with limited attention on linking other infrastructural components of cold chain which includes pack houses, reefer capacity, ripening chambers, mini storage hubs etc. Further focus needs to be given in supporting development and implementation of upcoming technologies and improvement of cold chain from farm to fork in order to cater the rising demand for quality and quantity, predominantly from urban markets. The table below estimates the total investments required to fulfil the current infrastructural gaps in the cold chain.

Item	Components	Gaps All India	Unit Cost	Investments	Remarks
		Units	Rs. Lakhs	Rs. Crores	
1	Integrated Pack Houses	69,831	95	66339.45	For preconditioning 16 tons a day for cold-chain transit. Includes a pre-cooler and staging cold room with dispatch area for trucks. Facility will handle larger volume of incoming goods to segregate for non-refrigerated local market.
2	Reefer Transport	52,826	30	15847.8	Cost considered for 30 foot vehicles. Vehicle is insulated and refrigerated, capable of full range of temperature (-25 to +15°C).
3	Cold storage Bulk	650	400	2600	Cold store (Bulk) with large chambers for long term storing of certain produce, for periodic sale to markets over months. Average size of 5000 tons is considered.
4	Cold Storage Hub	360	350	1260	Cold store (Hub) with chambers of less than 250 tons each with multiple docks and doors, racking and forklift systems. Average size of 2500 tons is considered.
5	Ripening Chambers	8,319	40	3327.6	Ripening units with daily handling of 10 tons after a 4-day ripening cycle.
Total Investment				89374.85	in Rs Crores

Table 4: Investment requirement for fulfilling the infrastructural gaps in the cold chain

Unit costs taken are as per the normative costs assessed under the MIDH guidelines. Additionally, for modernizing retail end in cold chain (for fruits, vegetables, and processed foods), an investment of Rs. 10,000 - 15,000 crores can be estimated at last mile. The estimation is made assessing the overall storage, processing, and transportation connectivity along with consumption centres store hubs required for overall produce handholding.

Challenges in Indian Cold Chain infrastructure

Operational Challenges

1. **High lifecycle cost:** High real estate prices with an increase of more than 280% in last decade adds up significantly to the total cost, as for building a cold storage with 1 million cubic feet of space which requires an acre of land. Interstate barriers, intercity and state taxes, and bad roads etc. are other factors contributing to the rise in project and operational costs. In the country like the USA, the similar scale of installation cost less than half of the investment required in India
2. **Quality cold warehouse infrastructure:** Nearly 75% of the cold storage infrastructure created in the past is suitable only to store single commodity, rendering them of no use for utilizing for the multi temperature and multi commodity storage.
3. **Standards and protocols in construction and operation of facility:** Technical standards followed in India are mostly unsuitable for Indian conditions, which results in poor performance of a standard refrigerated system
4. **Uneven distribution of cold storage:** Storage facility throughout the supply chain is another major challenge. Majority of cold storage facilities are located at the point of production, creating a lack of efficient supply chain to the downstream operations/markets.
5. **Low awareness:** Cold chain industry consists of multiple players, of which are 85% of unorganized players who are unable to invest much in the technology required to build high quality cold storages along with reefer trucks. 36% of the total players are small players with capacity less than 1000MT and their lower margins further limit their ability to maintain quality standards and invest in growth.
6. **Generic schemes on pan India basis:** Approximately, 4000 projects are funded through various schemes in India constituting a total investment of INR 3022.5 crores.

These schemes are basically volume driven nearly based on parallel parameters throughout the country. Lack of focus can be seen on technologies, capacity variance and customization of policies depending on geographical area requirements

Availability and supply of electricity through-out the country: India currently faces about 9% of peak power deficit, which enforces the use of fuel-based operations leading to a marked increase in operating costs. The majority of electricity deficiency and unavailability could be found in the major agrarian states of the country, having a significant percentage of cold storages.

State / Region	Total cold storage capacity MT	Surplus(+)/ Deficit (-) of electricity as %	
		Energy	Peak
Tamil Nadu	238536	11.2	4.8
Andhra Pradesh	900606	-7.6	-13.8
Maharashtra	546748	7.4	0.7
Bihar	1147041	- 25.2	-18.4
Karnataka	407165	4.6	- 11.2
Gujarat	1267304	4.2	4.2
West Bengal	5682000	- 13.7	- 3.6
Uttar Pradesh	10118000	- 6.4	- 9.7
Odisha	291039	2.2	4
Kerala	58105	4.5	- 6

Table 5: Electricity deficiency and number of cold storage in major agrarian states

Laxity in refer transportation and development of rail and air mode to cold transport:

There is a marginal lag of proportionality between storage to the reefer capacity, leading to 85% shortage of refers in India. Supplementary attention needs to be given to air and rail reefer modes. Rail reefer transport, despite wide coverage of railway network, is still at the nascent stage and calls for a need for drawing better strategy.

Major challenges to reefer transportation are:

- Dearth of adequate in-house facilities for holding consignments.
- Lack of proper handling facilities at intermediary stations.
- Multi temperature and chamber support system for air and rail refers.
- Cost optimization for transit.
- Skilled workforce to understand the product standards.
- Backup support for detaining of refers increasing perishability chances.
- No financial coverage for the losses incurred during vehicle malfunctioning.
- Lack of specific guidelines that set the standard or protocols which need to be maintained for refrigerated transports.

Perishable Cargo Handling Procedure

Perishable goods are such, whose conditions or suitability for its original or prime purpose may deteriorate below its useable condition if exposed to undue changes in temperature and humidity or delayed in transportation (e.g., fresh fruit and vegetables, Bowers, meat and fish shipments, vaccines, medical supplies etc.). All perishable goods other than flowers, meat, seafood or fish (PER) Perishable cargo requiring special attention during flight, e.g. recommended temperatures and/or ventilation shall be entered in the remarks box of the Load and Trim sheet In case of thermograms (shipper owned) being used in temperature sensitive loads the cargo department shall inform the aircraft handling department accordingly.

Loading

Perishable cargo shall be accepted for carriage only if properly packed in order to avoid damage and/or contamination to other loads, ULDs or compartments. Pallets with flowers, fruit or vegetables must not be covered with plastic foils.

Perishable cargo, refrigerated with wet ice or containing fluids or moisture which could leak (e.g. meat, fish, or other sea foods - fresh, salted, smoked or frozen) shall be treated as "Wet Cargo". Perishable cargo refrigerated with dry ice (ICE) shall be handled according to the respective regulations. Care shall be taken when slacking perishable items so that lower layers of the stack are not damaged by the weight of the upper layers.

Foodstuffs (EAT)

Foodstuffs shall not be loaded together with poisons or infectious substances in the same compartment, unless they are loaded in separate ULD's not adjacent to each other, Foodstuffs shall not be loaded in close proximity of live animals and human remains.

Hatching Eggs (HEG)

Hatching eggs shall not be stowed in close proximity of dry ice (ICE) and cryogenic liquids. The temperature in the compartment should remain between 18-20°C.

Vaccines, Medical Supplies and Live Organs (LHO)

Life-saving drugs or live human organs (LHO), which have been requested on short notice, shall principally be loaded in the special collecting net for small cargo items. In special cases, considered justifiable by the station manager or his deputy in relation to given specialties of transportation, these shipments may be given into the care of the crew. In all cases a copy of the request, the delivery document or the telex message showing the description of the drug or human organ, the names of the final recipient and the person collecting it from the aircraft shall be handed to the crew. According to the priority regulation of the "Federal Institute of Traffic Control", precedence is given to a flight carrying lifesaving drugs or live human organs, respectively in a life-saving mission. In such cases, the priority shall be requested by the cockpit crew.

Note: In case of transport without reference to an emergency, the priority regulation does not apply.

Handling in delay situations

To the event of a delay, action shall be taken to prevent a deterioration of the loads, such as- Provision of air condition to the aircraft-Transferring the perishable cargo to a warehouse with adequate facilities, such as air conditioning or cold store.-Offloading and rebooking control and refilling of dry ice supply in initially used for chilling loads)

Flowers Plants (PEF)

Flowers shall be stowed so as to avoid direct contact with the compartment floor or walls. Flowers should not be stowed in the same hold or ULD as fresh fruit and vegetables due to ethylene gas produced by vegetables which may deteriorate flowers.

Meat and Seafood/Fish Shipments (PEM/PES)

Fresh or frozen meat, fish, or seafood with or without dry ice may be carried on passenger aircraft when the special restrictions are observed:

- The structure of the compartment shall be protected by tarpaulins or plastic sheeting and insulating material against direct contact with the load.
- Dry ice for cooling must be considered as dangerous goods. For loads of 100 kg meat no more than 2 kg dry ice shall be used for cooling. For larger quantities of meat, the quantity of dry ice shall be increased in proportion. Note: Experience has proven that 5 kg dry ice per 1,000 kg of meat is normally sufficient.
- The crew is to be informed of the special load in writing.

Loading on Pallets and in Containers

Loading must be performed in the following sequence:

- One layer of plastic foil shall be laid out on the pallet, stabilizer rack or container respectively, to cover the complete meat load. In addition, one layer of absorption sheet shall be used.
- Inside the container, the overlapping edges of the plastic sheets shall be pulled up and fixed to the container walls by tape.
- After loading, all layers of plastic sheets shall be pulled over the meat and secured by tape.
- In case cooling is necessary, boxes containing dry ice shall be placed on top of the covering.

Loading as Bulk Cargo

- The loading shall be prepared in the following sequence:
- The cargo compartment is cleared of all items not required for loading.
- The tie-down rings as required for the load are fitted into the tie-down track in the compartment floor.
- Lashing ropes and/or straps shall be attached to the tie-down rings and laid out along the compartment walls.
- Absorption sheets are laid out on the floor.
- Tarpaulin or plastic sheet shall be laid out and tied to the fastening.
Note: Fastening bolts shall only be used for tying tarpaulins, due to their limited strength; they cannot be used for tying down loads.
- Loading being completed, the tarpaulins are pulled over the load. The open part of the tarpaulin facing the cargo door shall be folded and also pulled over the meat.
- Lashing material (straps or ropes) is accessible now and shall be fastened across the shipment and secured properly.
- Boxes with dry ice shall be suspended from the ceiling outside the tarpaulin covering for cooling the whole compartment.

Disinfection of Loading Equipment

ULDs (Unit Load Device) and loading materials used for shipping of meat shall be cleaned and disinfected immediately after loading/unloading.

Acceptance and Handling of Perishable Cargo

Articles of perishable nature which are liable to deteriorate or perish due to changes in climate, temperature, altitude or other normal exposure inherent to carriage of cargo by air, or length of time in transit will be accepted provided that it is reasonably certain they will reach their destination in good condition. Advance arrangements should be made, and packages and documents should be boldly marked 'Perishable'. A special 'Perishable' IATA standard label shall be affixed on each package; where applicable "This Way Up" label shall be used when the contents are liquid in nature.

ACCEPTANCE

1. Perishable cargo shall only be accepted for carriage when it is certain that it will reach its destination in good condition.
2. The shipper shall provide written instructions as to the maximum acceptable duration of transportation and if any special handling required. These instructions shall be shown on the air waybill and the packages.
3. Prior to acceptance please ensure that the necessary arrangements have been made which may include:
 - That the shipper is advised of the minimum time before flight departure that the carrier will accept the cargo.
 - Making any necessary onward reservations.

Special Procedures Followed During Handling

1. Meat (PEM)

- Meat shall be enclosed in waterproof material and handled as wet cargo.
- Strict hygiene conditions shall be maintained during all stages of handling.
- Meat wrapped in muslin cloth is not acceptable for carriage on certain airlines.

2. Flowers (PEF)

- Flowers shall be stowed so as to avoid direct contact with the compartment floor or walls.
- Flowers should not be stowed in the same hold as fresh fruit and vegetables due to ethylene gas produced by vegetables which may deteriorate flowers. Flowers shall not be left in direct sun.

3. Fresh Fruits and Vegetables (PER)

- When fresh fruit and vegetables are loaded in quantities which require stacking care should be taken to ensure that airspace is available between the packages. This is particularly important with fresh fruit and vegetables having high moisture content.

- Owing to the minimum packing requirements, care should be taken when loading fresh fruits/ vegetables with general cargo.

4. Seafood

Fish shall be completely enclosed in water tight containers and handled as wet cargo.

5. Vaccines and Medical Supplies

Living human organs/ blood and lifesaving drugs vaccines & medical suppliers shall be handled with extreme urgency.

CHAPTER 5
CONCLUSION

From the above information we can find out that a Perishable Cargo is very sensitive cargo which has to be handled with care. Wastages and losses of the goods are highly expected if the goods are not handled with care professionally. minute mistake in the perishable cargo industry would lead to huge loss. Import and Export of perishable goods are much unorganized here in India since there are bad storage systems, poor transport, and congestion at cargo complex not enough equipped cold storages etc. Facilities at the airport are too small and dedicated only to export cargo. In India there is a lack of trained manpower who can understand how to handle perishable cargo. Confusions regarding the temperature to be maintained also arise often, so proper information regarding the perishable cargo should be given with clarity during the transport.

Findings and Suggestions

Maintaining the Temperature:

- Proper awareness regarding the handling of perishable cargo should be given to the operators
- Every small break or gap in the cold chain should be addressed.
- Frequent check on handling conditions.
- Installing automated temperature monitoring equipment which helps to closely monitor the temperature.

Warehouse Facilities:

- Cold rooms operating at the correct temperature for product storage need to be available at all storage sites along the supply chain.
- Routine maintenance and thermometer calibration schedules should be implemented to ensure reliable operation.
- Periodical cleaning is to be maintained during the whole process.
- Proper Racks and Shelves system should be implemented so as to achieve efficient handling in warehouses.

- Controlled temperature loading docks should be used for loading/unloading transport vehicles.
- Controlled temperature bins or modules may be useful for controlled temperature handling of smaller quantities in mixed ponds.

Vehicles:

- Trucks with partitioned load space should use for Transporting mixed temperature loads.
- Equipment has to be installed so that temperatures can be reliably set and maintained in each compartment to allow products to be kept at the correct temperature.
- Vehicle designs and refrigeration equipment need the suitable for the types and quantities of products that are being handled.
- Efficient trucks which are specially designed to perform in severe environmental conditions should be used for transportation.
- In order to ensure reliable performance regular maintenance should be ensured.

Confusions arise while mentioning the temperature of cargo in the documents.

Different countries follow different standards for temperature, such as Degree Celsius and Fahrenheit. While converting the degrees of temperature from one to another the chance for errors is high. So, it would be a great development if all the country agrees to follow a standard measurement for temperature. This will help to avoid errors.

Proper training for manpower:

The manpower involved in the perishable cargo industry should be given proper training on the handling. The labours should be very much aware about the nature of cargo and its importance.

BIBLIOGRAPHY

Books:

‘Textbook of logistics and supply chain management’ by D K Agarwal published by Macmillan Publishers.

Articles & Journals:

- B S Sahay and Ramneesh Mohan (2010), ‘Third Party Logistics Practices: An India Perspective’
- Alexander Ilic (2008). ‘Using Sensor Information to Reduce the Carbon Footprint of Perishable Goods’.
- M.S. Reid (2006), ‘Handling of Cut Flowers for Air Transport’.
- Thomas Miller - UK P&I club (2006), ‘Carefully to Carry’.
- ‘Guide to the Storage Handling of Frozen Foods’ Published by, The British Frozen Food Federation.
- Packaging Perishable Shipments (2013), FedEx Express.
- ‘Reefer Guide’ (2014) published by HamburgSud.
- ‘Study of Logistics in India’ study by DEssence consulting group.
- S.A. Tassou (2008), ‘Food Transport Refrigeration’.

Yash Johri
1905305034
MBA-ITLM