

## Problems and Management Techniques in Distribution of Perishable Goods:A Critical Review

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**ABSTRACT:** This paper describes traditional management of supply chain for fruits and vegetables at mandi level and its problems associated. New practices adopted by the private firms and regulators in order to make the supply chain efficient providing benefits to farmers and final consumers. Degradation patterns and different temperature requirements of perishable items are also discussed for efficient management of goods. Important aspects related to the challenges in managing distribution by companies, such as those dealing in airline catering services and milk based products are illustrated.

**Keywords:** Perishable items, Distribution management, shelf life.

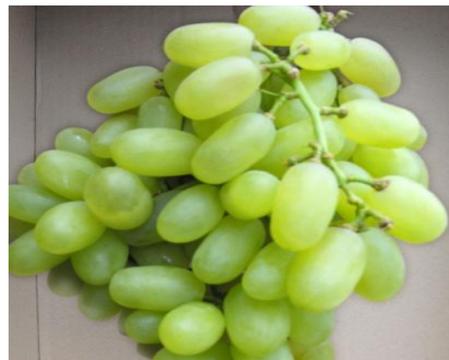
### 1. INTRODUCTION

In a typical supply chain the time taken for materials to move from one end to the other can be quite long, depending upon the type of industry. This is usually understood and accepted when the item is not perishable. Perishable items, however, become decayed, damaged, expired or deteriorate through time. Hence, the length of supply chain becomes critical for such items. Examples of perishable goods include fast food, meat, vegetable, fruit, medicine, flower or ready mix concrete. Perishable items can be broadly divided into two classes: (1) items with a fixed shelf life such as medicine, blood or ready-mix concrete; (2) items with continuous decay, such as food, vegetable, flower, milk, meat and so on (Nahmias, 1982; Raafat, 1991). Depending on the perishability characteristics of the item, the length of supply chain can vary. For example, items like blood, radioactive medicines; or ready mix concrete require much faster delivery than fruits and vegetables.

### OBJECTIVE OF THE STUDY

Fruits & Vegetables are one of the most significant and thrust sector of the economy of India. The entire supply chain of F&V in India is laden with the major issue of post-harvest losses and wastages due to various factors. Since the identification of the issues and challenges may pave a path for planning and implementation of effective mitigation strategies.

1. To identify the factors affecting supply chain of Fruits & Vegetables sector in India.
2. To suggest mitigation strategies for the identified challenges in Supply Chain of Fruits & Vegetables sector in India



Grapes



Apple



Banana  
Figure No: 1 Perishable Fruits

As in any other supply chain, the supply chain for perishable items like fruits and vegetable (F & V) also begins with the production of fruits and vegetables at the farm followed by transportation to procurement facilities, finally to retailers for consumer purchase passing through distribution channels and centres along the way. In addition to control of cost and prompt customer service, F & V supply chain is more concerned with ensuring quality of items and continuity of supply. Table 1 represents the degradation pattern of some F&V items.

Table 1 Segmentation of deteriorating goods- Shelf Life of Food

Perishable goods	Life span without Cold Storage	Life in Cold Storage
Potatoes	1 week	One year
Onions	4-5 week	One year
Tomatoes	4-5 days	8-10 days
Green leafy vegetable	1 day	3-4 days in air tight container
Meat	2-3hrs	2-3 days at -20 C
Milk	5-8 hrs	4-5 days refrigerated 3 months
Apple	2 weeks	
Grapes	3-4 days	1 week

Source:

<http://whatscookingamerica.net/Information/FreezerChart.htm>

## 2. REVIEW OF LITERATURE

Feame and Hughes (1999) point out that initially the supply chain was more concentrated on logistics and the reduction of lead time and inventory levels, reducing uncertainty to make better use of production capacity and underutilized resources. The objective of the supply chain is to ensure that highest and appropriate quality of product is available for customers and to simultaneously ensuring remunerative price to formers and to serve the

population with value added food. Gupta et al. (2001) point out some items experience age dependent perishability, leading to physical decay. These include flowers, plants, green vegetables, dairy products, poultry products, medicines, vaccine, and chemicals etc. Some medicines and vaccines can be safe only at the 2-8 degree Celsius temperature. These types of perishables need a cold chain system. The term cold chain refers to keeping the products at their proper temperature and maintaining that temperature through all the stages in the supply chain until it reaches the consumer.

Ferguson and Ketzenberg (2006) addressed the benefits of information sharing on retailers profit in a supply chain in case of perishable items. Hobbs and Young (2000) point out that the quality and price of the perishable products vary with time. The price uncertainty results, largely because of deteriorating quality of the product as the prices are tied to quality. Some chemicals and medicines can be protected for a long time but they require particular temperature, humidity and pressure. Zhang and Chen (2014) addressed the vehicle routing problem of cold chain logistic system. Bryant (2005) points out that the cold chain makes a lot of difference in the quality of the product. A\_hya (2006) in their study explains that restructuring the fresh produce sector will improve productivity and a better deal for the customers. Sengupta (2008) discussed the emergence of organized food retail sector in India and the drivers of evaluation. Negi and Anand (2015a) discuss the current status of infrastructure for F&V sector in India and opportunities for cold chain. Further, Negi and Anand (2015b) reviewed the challenges and issues in F&V supply chain and suggested strategies to overcome the identified issues.

Distribution of ready-mix concrete as a perishable item has also drawn the interest of some researchers (Feng et al., 2004; Naso et al., 2007; Durbin and Hoffman, 2008; Schmid et al., 2009).Naso et al. (2007) addressed the supply chain for the just-in-time production and transportation of ready-mixed concrete and considered the coordination between the two activities to guarantee timely delivery.

## 3. CASE STUDIES IN COLD CHAIN LOGISTICS:-

Cold chain logistics plays a very important role in managing perishable items. According to Ray (2010), the perishable food market is estimated as Rs. 3,50,000 Crore and 20 % of this gets wasted due to lack of storage and transportation facility. Cold chain logistics helps to reduce wastage by providing the suitable storage and transportation

facility for perishable food items. It offers several temperature levels for maintaining food safety such as frozen, cold chill and medium chill etc.

### 3.1 Case 1: Airline Catering Services

Consider the case of a company providing catering services to airlines. Being in a catering service industry, the company needs to deal with perishable items on daily (or, hourly) basis. Since some of these items have a very short life span, they need proper care in terms of time and temperature management. The main issue faced by the company is transportation of these perishable items along with adhering to food safety regulations. The most sensitive perishable item that is used in the company's kitchen is Chicken. Suppose our catering company "A" buys chicken from another company "B". Chicken is produced in Mumbai and then distributed to various locations eg. Delhi, Kolkata, Chennai etc. Besides supply to airline kitchens, company B also supplies chicken to various hotels. Chicken is a perishable item which is very sensitive to bacterial growth. Hence it requires a high level of temperature management. Chicken is frozen at  $-18^{\circ}$  to  $-20^{\circ}$  which is considered a safe temperature and transported to various locations at the same temperature. If this temperature increases to  $-10^{\circ}$  due to various handling issues, bacterial population increases 10 times with every consecutive issue (increase in temperature). This is because, once the population of bacteria increases, this will not decrease even when the temperature is brought back to  $-20^{\circ}$ . With this poor management of temperature, chicken become unsafe for consumption.

Often, a third party logistics company is hired for transporting chicken to various locations. Company A can resolve the problem of temperature abuse and food safety in two ways:

#### i) Spoilage during Transport:

1. Trucks being used to deliver the perishable items are required to possess a tamper-proof recorder which helps the company A to track the temperature changes throughout transit.
2. Loading and unloading of items in temperature-proof room, as it takes 4-5 hours.

#### ii) Quarantine Procedure:

Company 'A' does not mix their inventory stock with new received orders. When a new order is received, they are quarantined and a sample is first taken for testing. The sample is sent to the pathology for testing the bacterial growth. If the food passes the quality check, then it is mixed

with the stock in the inventory. A batching certificate is also received from the vendor which provides the batch no. with manufacturing date, which helps the company in making decision about the life of the item.

### Kitchen to Flight

Managing transportation from kitchen to flights is not an easy task. There are many challenges and conflicts of requirement faced by the company on a daily basis. These challenges can be delay in flight arrival or additional passengers. For supplying food from the airline kitchen to the flights, a cold chain is maintained using 40 trucks. Trucks are the most expensive component of the chain and then the manpower. Trucks cannot stand on the bay for longer duration as traffic congestion is another big problem at the airport. In order to manage the kitchen to flight transportation, a detailed chart is prepared with flight arrival times and which vehicle is assigned to which flight. This chart contains all the information with complete flight details (arrival, departure, number of meals, loading unloading time, and travel time for truck, waiting time at bay, etc). Variation in number of passengers due to additional passengers is another big challenge. To overcome this problem if vendor produces extra meal as safety stock for every flight, then a huge cost will be incurred. To overcome this situation, service providers keep their menu simple /common. They also have additional crew sandwiches as a safety stock, which is cost effective. Also, for the last minute delivery changes in flights, they also have manage the logistics. Seventy percent of the company trucks are utilized on a regular basis. The company also keeps small vans as stand by for urgent deliveries for last minute changes in meal requirements.

### 3.2 Case 2: Milk and milk product distribution problem

We now consider the case of milk distribution in India. India is one of the largest producers of milk and milk products. Milk supply chain is very crucial to manage and it affects a large proportion of the population. It requires continuous monitoring of time and temperature before it is consumed. A careful monitoring of cold chain logistics for milk and dairy products is important to maintain the quality and freshness of these items for longer duration. Cold chain of milk is required to maintain a temperature of  $0-4^{\circ}\text{C}$  to keep milk at its optimal freshness level and preserve its taste. Every increase of  $2^{\circ}\text{C}$  in the temperature of cold

chain may reduce the life by 50% (BT9. Milk Supply Chain)

Product	Temperature Requirement	Life span
Butter	0°C or Below	1 week
Cheese	-3°C	6 month
Ice cream	18°C	6 month
Paneer	Vacuumed Packed 4-6°C	10-15 days
Butter Milk	8°C or below	1-2 days

(Source: Ray(2010). page 294)

Here we discuss the supply chain of a very large milk and milk manufacturer in India and the challenges faced by them. The company has developed a huge distribution network in India with over half of the millions of retail outlets. Milk is procured from various states: Gujarat, Rajasthan, Punjab, Haryana, Uttar Pradesh, West Bengal, Maharashtra and Madhya Pradesh. The company also has the largest cold chain network in India. Milk is their highest revenue generating product. The company also offers a variety of milk products ghee, butter, cheese, baby milk food, and cold beverages.

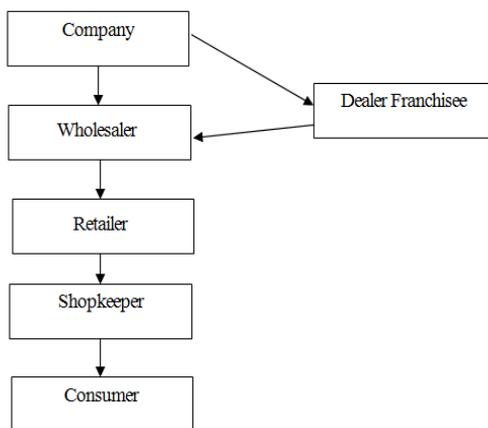


Figure : 2 Distribution Process

District level cooperative societies are formed to collect the milk from fanners or dairy. This is done without any cooling facility. From the cooperative societies, milk is then taken to the processing plant in a temperature controlled environment in tankers. In the plant, milk is processed into various products according to the demand. Since the company has to buy all milk coming to them,

surplus of the milk is converted into milk powder and in other commodities, which can later be combined to manufacture other products. Processed products are sent to the wholesale distributors in temperature controlled trucks of different capacities to be cost effective and from there it is distributed to retailers.

Frozen goods are kept at a temperature of -18°C and dairy wet at -4°C. Transportation from wholesale distributor to retailer is managed by distributors. Company also provide the cooling infrastructure to the distributors and retailers. They put an emphasis to ensure that distributors and retailers should be well equipped with cold storage or refrigeration facility to keep the perishable items in good condition.

The company incurs a huge cost in transportation. It is exploring other options in order to reduce their transportation cost. Currently they transport products in their own trucks but they are planning to collaborate with railways with cooling systems to transport their products to other states. They are also planning to have dedicated trains to transport milk with huge capacity, which can result in reducing the transportation cost significantly.

#### 4. DISCUSSIONS

As is seen from the case studies, there are many challenges when it comes to handing perishable items which are sensitive to time and temperature. Firms are now able to resolve the issue of temperature by creating a temperature controlled environment for perishable items. However, such temperature controlled facility come with a huge addition cost. A major cost component of supply chain is transportation.

Each perishable item discussed above is different in nature and can have a specific deterioration pattern. Chicken has a continuous deterioration rate if it is kept under controlled environment. If temperature increases from the required level, the growth of bacteria is exponential, followed by the exponential deterioration in quality.

Milk is also a temperature and time sensitive product. Milk and milk products also have a tendency of bacterial growth but the speed of bacterial growth in milk is much slower than chicken. Unprocessed milk can be used for up to 6-7 hrs if it is kept at a normal temperature. When refrigerated at life of milk is much longer than that of meat. Unlike food items, it has a fixed shelf life of 2 hrs. Also, unloading of ready mix concrete is restricted by time windows due to site pouring constraints.

## 5. CONCLUSION

Travel times from production place to utility has an important effect on quality and freshness of perishable items. The choice of routes are dependent on the shelf life of the products in order to prevent losses. In order to make transportations activities of such type of network effective and efficient, it is required to decide the optimal routes, schedules of delivery and number vehicles to be used for delivery. To make a strong presence and be competitive in the global market with higher customer service and to reduce the operating cost, it is necessary to integrate their supply chain operations management. To support this, management of supply chain must have to deal with material and information flow within and between supplier, manufacturer and distributors. In this paper four different deterioration patterns of perishable items are discussed. While developing distribution models one must consider appropriate deterioration rate or maximum delivery time depending on product characteristics.

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