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State of Art Information & Communication Technology (ICT) in Cold Store Management

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Abstract: ***"A Cold Store is a Specialised Area to Minimize the respiration rate and increase the life span of the product for future use. "***

This paper includes the cold storage capacity of India and the condition of cold storage. There are many Gaps are found in cold storage management. Due to improper cold storage management, the loss of Agricultural produce takes place. "Cold storage is an integral component of the postharvest management of the Fruits and Vegetables. According to a United Report International Development Program, about 40% of India's total production is lost on consumer-oriented travel or it's broken." [10] "The report provides an overview of the cold storage areas in India including current storage strengths, styles, and Government programs such as initiation, growth potential, challenges, and key achievements of the industry. The role of the Information & Communication Technologies (ICT) is very helpful in cold storage management. This paper is focused on improving the cold storage sector in India." [10] The ICT technology provides greater visibility and control over the entire Cold Chain network running daily. Using real-time data, ICT element technology called the Internet of Things (IoT) will allow faster, more efficient, and more informed decisions. [16] This literature review is created by reviewing a good number of papers published in peer-reviewed journals and online sources using second-hand data obtained. The purpose of the study is to explain the application of ICT applications to the Cold Chain System and to obtain research opportunities. [16]

Keywords: *- Cold Store Management, Role of Information & Communication Technology (ICT), Implementation of software, Role of IOT, Reduce Food Loss, Government Schemes.*

Introduction

India is now a fast-growing economy and the largest producer of agricultural produce. "India is the second-largest producer of the fruits and vegetables after China ranks the first in the fruits and vegetable production."[11] According to the 2019-2020 report the production the fruits are about 97.97 MT and the production the vegetables is around 183.17 MT. [2] Now the total production of both fruits and vegetables is about 313.35 Million tonnes which is greater than 2018-19 was estimated to be 310.74 MT. [2] But now the only production of the fruits and vegetables are not sufficient. Nowadays, the main issue is not the production but it's to store the of agricultural produce in the cold store.

A cold store is a sophisticated area where the temperature, pressure, moisture-controlled to store perishable products like fruits and vegetables are the common ones. The conditions inside the cold store are different for different food products that are stored. For example, the potato is stored at temperature ranges 2-8℃ while milk is stored at 3-4℃. The ideal function of the cold store is to keep the freshness and quality of the perishable food. There are different types of the cold store are present in India like Bulk storage, Multipurpose storage, Frozen storage and Mini-storage, etc. The worldwide capacity of the cold storage warehouse is about 719 million cubic meters according to the Global Cold Chain Allowance Report. According to the All India Cold-chain Infrastructure Capacity India has the 8186-cold storage or India has the 150 million cubic meters area has covered by the cold store. But after the presence of the cold store, the wastage of perishable food products is increasing every year. The production of the fruits is about 97.97 million tonnes and vegetables are about 183.17 million tonnes in 2019-2020 [2]. About 40% is wasted due to lack of improper management or availability of the cold store. [10] "91% of all cold storage is meant to store the only potato because India is the second-largest producer of the potato after China." [10]

Nowadays the problems that occur in the store are the Availability of skilled workers, Improper handling of the perishable products, lacking Standards and protocols, traceability of the products in-store, Recordkeeping and documentation work, etc. are the problems that occur in the cold store these days. The technologies used in the cold store that are range from small-scale cold stores to large refrigerated warehouses. The basic key components of the cold store technology are flooring, insulated room, temperature monitor equipment, refrigeration system, and lighting. Most of the cold store owners are used 1970's technologies. The cooling methods are room cooling, use of ice, vacuum cooling, air-force cooling, hydro cooling, etc. are some methods used in cold stores. But these all technologies or methods are very electricity consuming. Recently many private cold store owners like or a private company like Viking cold are focusing on solar-based energy to minimize the cost of the electricity that is used. After installation of the solar energy to the refrigeration reduce 40% of the cost [3].

The use of the ICT will improve the management in the cold chain. To keep the record and data the ICT (information and communication technology) is very helpful these days, which are effective and reliable cold storage monitoring system. It gives wireless sensors to the gas, temperature, pressure, etc. you can easily and continuously 24×7 checked the environment of the cold store using the wireless sensors. Due to this, we can track the product. Many government apps are launched in the agricultural sectors like Pusa Krishi, Kisan suvidha, M-Kisan, Farm-o-Pedia, etc. The main advantages of the ICT are updating data logger, easy to communicate, following of the standard operating procedures, calibration is easy and updated, etc. these are some advantages of the ICT in cold storage management.

We make a software regarding these problems whose we find in the cold store management during the research. Our Software manages all most all the functionalities of the cold storage such as Reduces reports generation time and increases the quality and accuracy of information. It obtains instant up-to-date information regarding the Account and Stock Position at any time, which leads to efficient utilization of time and enhancement services to the customers.

Information regarding the availability of space in various chambers can be obtained at any point of time, just at the click of the mouse. Goods Inward Acknowledgment, Storage agreement, Floor-wise / Commodity-wise Billing Statements, Customer-wise Stock Position & Stock Ledger, Overall Stock Position & Stock Ledger, Balance Sheet, Trail Balance, Profit Loss Statements.

Review of literature

The Indian cold store market reaches INR 1425.49 billion in 2020. [9] Currently, India is still the world's chief producer of milk and the secondary producer of fruits and vegetables. Most of them are temperature-sensitive products and need the proper temperature to stored and transported. This results in the establishment of a very huge cold chain area in the country. "According to the IMARC group expect that the growth of the Indian cold chain market is strong during 2021-2026." [9]

"India's cold chain market is expecting of CAGR of 14% or more during the prediction period of 2020-2025." [9] Most of the cold chain market is unorganized in India as around 70-80% of the cold storage market is unorganized. Now the market is slowly moving towards the organized market due to technological development and focusing on health awareness. Some of the leading cold chain market players are Cold Star Logistics Pvt. Ltd., Gubba Cold Storage Ltd., RK Foodland Pvt. Ltd., etc. The Indian government provides a variety of technical and financial assistance to boost cold -blood production in the agricultural and Agro-food sector. The list of cold storage present in India is given below;

Table 1: List of cold storage facilities in India in 2020. [15]

S.No.	State	No. of cold store	Total capacity in MT
1	Uttar Pradesh	2406	14714235
2	Gujarat	969	3822112
3	Punjab	697	2315096
4	Maharashtra	619	1009693
5	West Bengal	514	5947311
6	Andhra Pradesh & Telangana	405	1567664
7	Haryana	359	819809
8	Bihar	311	1479122
9	Madhya Pradesh	302	1293574
10	Karnataka	223	676832
11	Kerala	199	81705
12	Rajasthan	180	611831
13	Orissa	179	572966
14	Tamil Nadu	183	382683
15	Chhattisgarh	99	487292
16	Delhi	97	129857
17	Himachal Pradesh	76	146769
18	Jammu & Kashmir	69	250169
19	Jharkhand	58	236680
20	Telangana	74	410905
21	Uttarakhand	55	191314
22	Goa	29	7705
23	Assam	39	178096
24	Chandigarh (UT)	7	12462
25	Tripura	14	46354
26	Meghalaya	4	8200
27	Mizoram	3	4001
28	Nagaland	3	7150
29	Andaman & Nicobar Islands (UT)	3	810
30	Pondicherry (UT)	3	85
31	Manipur	2	4500
32	Arunachal Pradesh	2	6000
33	Sikkim	2	2100
34	Lakshadweep (UT)	1	15
	Total	**8186**	**37425097**

"The Global cold chain released the 2020 report of the global cold storage capacity, which details the reach of cold chain supplier worldwide." [9]

The global ability report includes: -

In 2020 the number of refrigerated stores was 719 million cubic meters which is 16.7% greater than in 2018. [8]

The world's largest capacity of 156 million cubic meters, in the United States, followed by 150 million cubic meters in India and 131 million cubic meters in China. [8]

Netherlands, Canada, Brazil, and United States all had a size of 100,000 cubic meters and more. [8]

The top five global players of cold storage are United States cold storage, New cold advanced cold logistics, Lineage Logistics, Agro merchant group, and Americold logistics.

The distribution of the refrigeration storage space was uneven in all countries.

Tools and techniques used

After the harvesting, the Agricultural produce is transfer to cold storage. The processes from production to reach to consumer-like transportation, storage, etc. all have come under the tools and techniques.

The transportation of agricultural products like perishable fruits and vegetables is done through temperature-controlled refrigerated vehicles to minimize the respiration processor to remove the field heat. During storage techniques used are: -

Tools	Purpose
Microsoft Visual Studio framework	System Development
Microsoft SQL Server	Database Management
C#	Programming Language
Java Script	Data Validation
Internet Information System (IIS)	Web Server
Windows 10	Operating System
Microsoft Visio	System Modelling
Browser (Any)	User Interface
Cascading Style Sheets (CSS)	Designing Interface

Table 2: Tools used for developing the proposed system

Cooling and storage

The Refrigeration and cool rooms both are Australian inventions.

Refrigeration and Cooling rooms are first used for the storage of the meat then after that fruits and vegetables are started stored in the cooling rooms.

Cooling Rooms

Refrigerator systems: - Refrigerator systems work by pressing the refrigerator, and then allowing it to grow. Gas expansion absorbs the energy, cools and the evaporator coils, indirect, air passes through them. This air supply should be cooler than the temperature set in the room to cool the product & room.

Five major components of the cool rooms are, Compressor whose function to compress the gas, Condenser which cools the gas, Expansion valve whose function is to control the flow of molten gas, "Evaporator coils in which liquid gas expands and boils, Follower or fans, spreading the air on cold evaporator coils, thus cooling the cool room." [12] The air can be dispersed and on top of pipes containing a certain type of liquid antifreeze, which itself has been cooled using an evaporator. [12] "Fans also circulate air around the cooler room to ensure even distribution of cold air and reduce temperature variations inside the room." [12]

Insulation

Airtight containers should be kept dry for proper operation. Proper installation of walls, floors, and roofs improves temperature control and reduces running costs.

Cooling rooms are painted well or rely upon their air holding, usually use polystyrene matrix to eliminate the heat transfer from inside to outside. It is very important to keep the matter dry. If the interior is wet due to thickening, then it will not work properly. All panel rooms should be strong and enough waterproof.

Cooling Methods

Room cooling

Room cooling is when the product suddenly cools down inside a cool room. Temperatures can take hours or days to get closer to a designated area in a room, depending on air circulation and container penetration. Cooling the room reduces recycling. However, cool cooling levels can increase weight loss and cause congestion.

Air force-cooling

During forced cooling, the air is quickly pumped into barrels or vegetable boxes. "This increases the working surface area from that of the barrel or carton to that of the internal product." [12] This increases the cooling rate and avoids congestion.

Hydro-Cooling

Water is a good conductor than air. It can provide rapid cooling if the water chillers are strong sufficient to remove the heat from immersed water. [12] "It is not suitable for all products, and it is important to install a sanitizer to avoid spreading human or plant diseases." [12]

Ice

Ice packing products can provide 'insurance' on the cold habits of cold chains and can be expected by customers for certain products. when it melts it can cause cold damage when used and increase rot and disease. Using ice is an improper way to cool vegetables.

Vacuum Cooling

Vacuum cooling technique based on producing negative pressure inside a closed room. The water present in vegetables turns into steam, absorbs heat energy. [12] The cooling machine works best on products that lose water easily, like bay leaf and lettuce plants. Hydro-vacuum heaters use a misting system to avoid moisture loss from the product. The cooling machine is faster and saves energy. [12]

Role of ICT in cold chain

The use of the ICT will improve the management in the cold chain. It can help to overcome major challenges faces in cold chain logistics like real-time temperature monitoring, tracking of shipment, reduce the loss, providing data insights.

IoT programs include many RaspberryPi, Intel Edison, Intel Galileo, etc. The gateway is used to communicate with the IoT node through the protocols such as ZigBee, BLE, Z-wave, GPS, Bluetooth, Wi-Fi, and mobile sites. Often, agreements such as CoAP, MQTT and XMPP transmit data from gate to cloud. [16] Cloud infrastructure provides a platform for processing fast, easy and complex events in real-time required to perform High-level sensor data statistics. Cloud computing technology includes a Big Data platform that allows a large amount of data that will be stored in a user location, to ensure easy data access, data protection, and reduce storage costs. Notable cloud platforms are Amazon Web Services, Microsoft Azure, VMWare, and Google Cloud. Cloud Platform provides a set of tools for collecting, processing, and storing data. [16] Real reading and installation software, such as Google Cloud ML, Amazon Machine Learning (AML) and Google ML Kit for Azure Mobile Machine Learning Lab, make it easy to find knowledge and constructive understanding to provide analytical solutions that are essential to improve efficiency and the benefits of energy plants. [16]

Software

These all are the trending technologies but very few of these technologies are used in the cold storage located in the India as compared to the other countries. But our software covers all the processes that are done in the cold storage. Whole application can be move on Online Cloud Base Web Application which can be easily accessible on your all devices easily. Inside online, where you can get access of your application anywhere in the world.

We can give you live temperature screening on your software or website, if you have website version then you may check same anywhere even you are not inside the cold storage. The software contains the two types of the login system, one for the customer login and second for the cold storage. Your customer/supplier/agent having limited access of our online system where they can see they stocked items, Pending invoice, paid invoice etc.

We define functionality where you may import chart of your warehouse department, chambers & racks. If you need to created whole chart at your end then you can easily create chart., If you need to do chart designing from our team then we will guide you on same.

Charting system become very helpful when you are allocating chambers and racks to inward items, you have clear picture on your screen that which is free and used space inside your warehouse. These all functionalities are covered by our software. Some advantages of our software are: -

Temperature Monitoring: - After installation, of the software will enables the monitoring of temperature inside the storage rooms from everywhere. It is the most critical parameter in cold chain logistics. [13] "Sensors can be used in the cold rooms and during transportation to monitor the temperature of the food." [13] Due to this, there is complete regulation over the temperature and

monitoring process. It also minimizes human interventions. If any issue came during the process and transportation will be fixed immediately. "IoT devices are the maximum amount regarding the software as they're regarding the hardware." [13] "The information collected by the IoT devices may be accustomed auto-generate reports by advanced computer science computer code running on these devices." [13] With computer science and machine learning, cold chain supply processes may be improved by analyzing the info collected from IoT devices. Analyzing process-related information will show inefficiencies, if any, within the current supply method, and businesses will build strategic selections to eliminate them. [13]

Tracking of shipment: - A business needs to possess complete information about their shipments. With our software, businesses will monitor their cargo 24*7. they'll build any changes within the provisioning schedule quickly if the chain is moving at a slower pace than planned. This helps scale back the time lost in coming up with and modifying the schedule once the pursuit information isn't simply accessible. Stakeholders will coordinate simply with completely different members of the availability chain and with efficiency manage the system. [13]

Some advantages of this system are, get a timely alert, measure exact temperature, macro-level tracking, react to changes during delay or damage, get previously invisible problems.

Expiration Date Control: -

We can also control the expiration date whether product is fresh or not through this software by checking such as FIFO (first in first out), LIFO (last in first out) and LEFO etc. Flexible lot definitions allow lot codes which can be segmented into components. This allows the user to record several key pieces of data such as expiry and production dates, colors, size, etc. Julian date codes can also be translated into readable dates, therefore speeding up the receiving process as well as minimizing keying errors. Lot components can be treated differently for reporting, billing and stock rotation.

Inventory Accuracy

By using this software, we can maintain the inventory accuracy rate. We can timely check that how much space is left or present in the different chambers of the cold storage. Due to this we can achieve a good accuracy rate.

Catch Weights

Fixed and variable weights can be recorded at either the lot or unit level, as well as being recorded during Receiving and Shipment as appropriate, for example unit Catch Weights for Shipments.

It helps to increase profits: -

The main effect of real-time monitoring is analytical analysis, which further leads to a reduction in operating costs and an increase in profits. In addition, timely renewable energy efficiency will lead to increased profits over time.

Assists in cold storage management: -

Successfully managing cold storage is not only expensive but also challenging. Temperature fluctuations are a major concern for managers but with the continuous monitoring of IoT in power consumption, broken fluctuations and temperature changes, management becomes much easier.

Provides remote access: -

The best part of the software is that it enables remote access. With this end-to-end process updates can be accessed on the go. Therefore, managers are linked to processes wherever they go.

Future scope

The cold storage business is started around the 1800s but at that time only industry is used to store their raw or finished products. Then now storage of the agricultural produce is coming in the mid-'90s. Now India is the 2nd major producer of Fruits and Vegetables. Storage is the main issue in India Nowadays for Fruits and Vegetables. Now the government is investing in cold storage. "Over the next 4-5 years Rs 21,000 crore will be invested in setting up or upgrading cold storage to address the problem of decaying material collection." [14] There has been an urgent need to upgrade the existing cold storage area with equipment, and technology. [14] A series of well-developed food processors is another issue that needs to be addressed.

Now the government is focusing on the removal of postharvest wastage of agricultural produce. Most of the cold storage space is occupied by the potato. Now the government is focusing on expanding cold storage to minimize the loss.

Some of the possible steps the government may take are listed below:

Provide the necessary assistance such as the low cost of funding to establish cold infrastructure.

"Facilitate a campaign to raise awareness and educate market participants on the importance of cold climates." [4]

National governments are encouraging the establishment of cold storage facilities by providing electricity bills as electricity makes up a significant portion of operating costs. [4]

Promoting better & more effective refrigeration technology to improve the life span of perishable products. [4]

Many government schemes are run to support and expand the cold storage business.

Name of Scheme	Particulars
Pradhan Mantri Kisan Sampada Yojana: Cold Chain Scheme [4]	Assistance The money help (assistance-assistance) beneath the theme is restricted to a most authority ten large integer per project in terms of technical activities and also the relevant business and instrumentality beneath the following: • "For storage infrastructure as well as Pack House and Pre-cooling unit, maturation area and transport infrastructure, grant" [4] @ thirty fifth of the common areas and five hundredth of the Northeast country, the Himalayan Nations, ITDP Areas and Islands, at full price of plants and instrumentality and technical services are going to be provided. • inflated price and process infrastructure as well as ice deep storage / refrigerators area unit related to and integrated with process, help-help @ five hundredth of common areas and @ seventy fifth of the North East Tribes, Himalayan Land, ITDP Areas and Islands, are going to be provided. • Radiation instrumentality are going to be supplied with help @ @ five hundredth of Common places and @ seventy fifth of the Northeast country, the range, ITDP Areas and Islands.
"Small Farmer Agri-Business Consortium (SFAC) assistance to cold storage" [4]	•Setting up cold storage as a {part of} Associate in Nursing integrated worth proposition project they're eligible for support if the cold last part isn't on the market over seventy fifth of the TFO (Total Payments). "facilitate rating as funding for comes is @ twenty fifth capital expense and an oversized roof to INR a pair of.25 crores within the general space and 33% with an oversized roof up to INR four crores just in case of NE, cragged & planned space." [4] "Integrated theme of Agricultural selling (ISAM) - Operational pointers." [4]
NABARD Warehousing Scheme	•Loans are going to be provided for comes that embrace the development of storage infrastructure, with a minimum capability of five,000 MT, for agriculture and integrated merchandise involving the development of Warehouses, Silos, Cold storage, stores controlled by the Controlled Atmosphere (CA), and different cold operations like coffin nail vans, multi-coolers, with individual Frozen units (IQF) units, cold / cold infrastructure, etc. the last existing infrastructure comes are going to be thought-about consequently every suggestion as long because it ends up in a final scientific / further dose.

Conclusion

The objective of this paper is to remove the all Gaps that are present in the management of the cold store and to improve the cold stores. The role of the ICT is very beneficial in the cold chain management. It improves the customer satisfaction and eliminates the risk that comes during the cold chain management. "Also eliminates the loss of the agricultural produce due to the improper or unavailability of

the cold storage facilities." [10] Due to loss of the agricultural produce the hunger and inflation increase in our country. "In this review paper, we highlighted the importance of cold storage and the various systems used by Government of India." [10]

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