Sustainable Supply Chain by Optimizing Warehouse Capacity Utilization - A Blockchain Solution

Prasanta Kumar Gupta and Dr. Mohd Imran Khan

Lovely Professional University, Punjab

pkgupta0111@yahoo.com

Abstract

In India supply chain is effective but not efficient. Warehouse being one of the integral components of supply chain and constitutes about 15%-35% of logistics cost, its importance is significantly high in the efficiency improvement of supply chain. Logistics cost in India is 14% of GDP compared to 8% in USA. As per NITI Aayog, if India achieves its goal of reducing logistics cost to 10%, it can save INR 10,000 billion during 2022-2025. Indian warehouse sector is expected to grow from INR 1501.2 billion in 2019 to INR 2821 billion by 2024 at a CAGR of 13.57%. The highest growth is envisaged in agriculture warehouse from INR 145.82 billion in 2019 to INR 365.75 billion by 2024.

Indian cold storage industry is confined mostly in 6 states. 90% cold storages are controlled by unorganized sector where most of the warehouses are less than 10000 square feet in size, not energy efficient/environment friendly and suffer underutilized causing high operating cost to the owner. During ongoing vaccination drive, Government realized the inadequacy of cold storages across the country and initiated infrastructure development for future readiness. As per Indian Agricultural Research Institute (IARI), 30%-40% of the vegetable & fruits and almost 10% of the agricultural produce go to waste which would have doubled the productivity and income of farmers. IARI invented a solar refrigerator which can preserve 2 Tons fruits, vegetables and flowers.

Connecting the agriculture warehouses and cold stores across India in Hyperledger Fabric blockchain will improve capacity utilization and help the farmers to directly reach out to cold stores/warehouses bypassing the mediators.

Keywords: *Sustainable, Warehouse, Cold stores, Capacity, Optimize, Blockchain, Hyperledger.*

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1. Introduction

Let us first of all understand, why higher capacity utilization of warehouses is significant for the sustainability of this industry segment in India. Focused approach is paramount important on the following six independent factors for operation of warehouses sustainably addressing triple bottom line of business.

1.1 Capacity utilization: In India, generally average cost of warehouse construction ranges between Rs. 900 - Rs. 1200 per square feet (source: Sanjay-Shaha-1). Considering return on investment (ROI) 12%, the average breakeven period works out to be 10-12 years. Underutilization of the capacity may defer the breakeven period further making the business unviable.

Cold storages (cold warehouses) are more capital intensive in nature, but as the rental premium is 3-4 times higher than the conventional warehouses, the recovery would ideally be faster. Here efficiency of process, technology, equipment and optimum capacity utilization play key role in making the business profitable. Average capacity utilization of cold storages in India is 75% (Source: Ministry of Food Processing Industries, CII & Yes Bank report).

1.2 Operational accuracy: The well-known 7R of supply chain is supreme crucial in enhancing operational accuracy. The right material/item needs to be stored at the right location at right climate, the right item needs to reach to the right intended place at the right time of the right condition/quality, with the right quantity at right cost.

1.3 Cost optimization: Minimizing the wastes drives the cost optimization be it be in the areas of storage space, storage condition, labour utilization, energy, equipment, logistics or any other resources.

1.4 Compliances: All statutory compliances must be in first place as a proactive measure without waiting for CAPA (corrective actions and preventive actions).

1.5 Protections: Protection of goods is a primary condition in warehouse management. The elements of protection could be fire, rain, wind, dust, damage, theft, pest control, climate control and any other anticipated risks.

1.6 Sustainability: Preservation quality standardization by ensuring potency of the goods without any wastage. Energy optimization and exercise of renewable energy management. Usage of energy efficient and environment friendly equipment. Employment generation avoiding social imbalance etc.

The above approaches need even more critical focus in case of cold storages because of the sensitivity of the goods, process, technology, equipment and vulnerability to wastages. Highest capacity utilization of available cold warehouses across the country is the need of the day and priority of the hour.

Top of that the higher dependency of cold storage industry on unorganized sector multiplies the concerns to sustainability. Having such a high growth opportunity of 22% year on year, the cold warehousing industry in India needs to reimagine the digital technology adoption strategy.

How can the utilization of present and upcoming warehouses be maximized with the help of digitalized technology maintaining transparency, trustworthiness, and errorfree transactions?

Success lies in the selection of digitalization tools & technology, effective rolling out of SOP and implementation of the same among the stakeholders, continuous efficiency measurement and prompt addressal of the modification needs. As the challenges are much more in effective capacity utilization of cold warehouses, we focus mainly on cold warehouses in this study.

“A relatively new technology that might meet these criteria is the blockchain technology”, (Loop, 2018).

2. Literature Review

2.1 Cold Storage Facilities in the Country:

https://pib.gov.in/PressReleasePage.aspx?PRID=1658114

As per the report of ‘Ministry of Agriculture and Farmers Welfare’, Government of India dated 23rd September 2020, there are 8186 number of cold storages in India with capacity of 374.25 Lakh MT for storing perishable horticulture produce like fruits and vegetables. 75% of the same are suitable for single commodity mainly potato and tomato. State/Union Territory wise details of cold storage are mentioned in the next page:

Sr. No.	Name of the State	No.	Capacity (MT)
1	Andaman & Nicobar Islands (UT)	3	810
2	Andhra Pradesh & Telangana	405	1567664
3	Arunachal Pradesh	2	6000
4	Assam	39	178096
5	Bihar	311	1479122
6	Chandigarh (UT)	7	12462
7	Chhattisgarh	99	487292
8	Delhi	97	129857
9	Goa	29	7705
10	Gujarat	969	3822112
11	Haryana	359	819809

12	Himachal Pradesh	76	146769
13	Jammu & Kashmir	69	250169
14	Jharkhand	58	236680
15	Karnataka	223	676832
16	Kerala	199	81705
17	Lakshadweep (UT)	1	15
18	Madhya Pradesh	302	1293574
19	Maharashtra	619	1009693
20	Manipur	2	4500
21	Meghalaya	4	8200
22	Mizoram	3	4001
23	Nagaland	3	7150
24	Orissa	179	572966
25	Pondicherry (UT)	3	85
26	Punjab	697	2315096
27	Rajasthan	180	611831
28	Sikkim	2	2100
29	Tamil Nadu	183	382683
30	Telangana	74	410905
31	Tripura	14	46354
32	Uttar Pradesh	2406	14714235
33	Uttarakhand	55	191314
34	West Bengal	514	5947311
	Total	**8186**	**37425097**

The information regarding capacity utilization, real time data regarding availability, cost etc on cold storage facilities for farmers and traders etc. are not centrally maintained by the Ministry. There is no real-time monitoring System. The union Government is promoting following schemes to develop cold warehouse infrastructure and employment generation across the country.

2.2 Mission for Integrated Development of Horticulture (MIDH):

https://midh.gov.in/#:~:text=About%20US&text=Mission%20for%20Integrated%20Development%20of%20Horticulture%20(MIDH)%20is%20a%20Centrally,%2C%20cashew%2C%20cocoa%20and%20bamboo.

This is a Union Government Programme for the overall growth of horticulture sector in India covering vegetables, fruits, flowers, mushrooms, coconut, spices, cashew, bamboo etc. Central Government contributes 60% of the total developmental cost and remaining 40% is borne by the respective State Governments except North Eastern and Himalayan states where Central Government contributes 90% cost. In some very special initiatives like National Horticulture Board (NHB), Central Institute for Horticulture (CIH), Coconut Development Board (CDB), National Level Agencies (NLA), 100% cost is borne Government of India.

Surprisingly, only seven states so far have taken advantage of the MIDH scheme. Most of the states and union territories have not shown interest in this beautiful Farmar friendly scheme because of the undisclosed reason. Government of India must pay attention to this poor participation and identify the root cause for initiating corrective measures. Whether inadequate cold warehouses/cold supply chain infrastructure in the region could be a reason.

(Source: Directorate of Marketing and Inspection (DMI) upto 2009, National Horticulture Board (NHB), National Horticulture Mission (NHM), Horticulture Mission for North East & Himalayan (HMNEH) & Ministry of Food Processing Industries (MoFPI))

2.3 Pradhan Mantri Kisan SAMPADA Yojana (PMKSY):

https://static.pib.gov.in/WriteReadData/specificdocs/documents/2021/dec/doc2021121721.pdf

PMKSY is a wide-ranging envelope which will result in establishing innovative infrastructure including efficient supply chain management from farm gate to retail outlet. It will not only provide a big boost to the growth of food processing sector in the country but also help in providing better returns to farmers and is a big step towards doubling of farmers income. This will create massive employment opportunities especially in the rural areas and reduce wastage of agricultural produce. Increase in processing level and enhancement of export of the processed foods.4 will be the end result.

SAMPADA (Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters) was approved by the Cabinet Committee on Economic Affairs (CCEA) in 2017. This umbrella scheme has now been renamed as the "Pradhan Mantri Kisan Sampada Yojana (PMKSY)" to be implemented by Ministry of Food Processing Industries (MoFPI).

OBJECTIVES OF PM KISAN SAMPADA YOJANA

- Creation of modern infrastructure for food processing mega food parks/ clusters and individual units
- To create effective backward and forward linkages - linking farmers, processors and markets
- To create robust supply chain infrastructure for perishables
- The objective of the Scheme of Cold Chain, Value Addition and Preservation Infrastructure is to provide integrated cold chain and preservation infrastructure facilities, without any break, from the farm gate to the consumer. It covers creation of infrastructure facility along the entire supply chain viz. pre-cooling, weighing, sorting, grading, waxing facilities at farm level, multi product/ multi temperature cold storage, CA storage, packing facility, IQF, blast freezing in the distribution hub and reefer vans, mobile cooling units for facilitating distribution of horticulture, organic produce, marine, dairy, meat and poultry etc. The scheme allows flexibility in project planning with special emphasis on creation of cold chain infrastructure at farm level.
- The integrated cold chain project is set up by Partnership / Proprietorship Firms, Companies, Corporations, Cooperatives, Self Help Groups (SHGs), Farmer Producer Organizations (FPOs), NGOs, Central / State PSUs, etc. subject to fulfilment of eligibility conditions of scheme guidelines.

2.4 **How agri-tech can use data to build customised risk-mitigation solutions**

The access to data-driven, digitally enabled agriculture ecosystems are leading to a transformation in the agri-fintech segment. The use of farm management software, drones, smart irrigation systems, predictive data analytics, integrated warehousing and marketplace platforms are addressing some of the key challenges faced by growers, financers, and governments. Today, micro-questions of a farmer on what crop to grow, getting a fair price for produce, seasonal risks, are being answered through a macro approach backed by weather and crop patterns, soil content, historical crop cutting methods, among other such parameters. Actuarially-backed risk-protection methods are enabling smart farming decisions. The convergence of technologies like AI, ML, Analytics, applied to data, are reducing risks, helping institutional agri-finance, planning recovery pipelines, and improving claim settlements.

2.5 Relationship between food waste, diet quality, and environmental sustainability: https://doi.org/10.1371/journal.pone.0195405.g005

This article discusses the improving diet quality while simultaneously reducing environmental impact is a critical focus globally. Metrics linking diet quality and sustainability have typically focused on a limited suite of indicators and have not included food waste. To address this important research gap, we examine the relationship between food waste, diet quality, nutrient waste, and multiple measures of sustainability: use of cropland, irrigation water, pesticides, and fertilizers. Data on food intake, food waste, and application rates of agricultural amendments were collected from diverse US government sources. Diet quality was assessed using the Healthy Eating Index-2015. A biophysical simulation model was used to estimate the amount of cropland associated with wasted food. This analysis finds that US consumers wasted 422g of food per person daily, with 30 million acres of cropland used to produce this food every year. This accounts for 30% of daily calories available for consumption, one-quarter of daily food (by weight) available for consumption, and 7% of annual cropland acreage.

Higher quality diets were associated with greater amounts of food waste and greater amounts of wasted irrigation water and pesticides, but less cropland waste. This is largely due to fruits and vegetables, which are health-promoting and require small amounts of cropland, but require substantial amounts of agricultural inputs. These results suggest that simultaneous efforts to improve diet quality and reduce food waste are necessary. Increasing consumers' knowledge about how to prepare and store fruits and vegetables will be one of the practical solutions to reducing food waste.

2.6 How Warehouse Management System (WMS) supports warehouses for circular economy businesses: https://warehousenews.co.uk/2020/12/how-wms-supports-warehouses-for-circular-economy-businesses

According to a recent Accenture study, 99% of chief executives mentioned sustainability as a critical success factor and expressed importance of circular economy. It could transform sectors like fashion and homewares, but actually, every industry can consider adopting circular business models to reduce their environmental impacts. Many retailers are giving customers the chance to sell pre-loved items back to them in exchange for store credit, which means they can benefit from the resale process too. Ikea launched a Buy back scheme recently to reduce waste going into landfill and sellers are rewarded with vouchers. Luxury clothing manufacturers are quickly entering into circular economy. Circular economy logistics models are rather like processing customer returns on a vast scale and the same principles apply. Goods need to be booked in and accounted for, quality checked, listed for sale as quickly as possible and dispatched to the customer. In addition to processing returns, there are other ways a WMS can improve circular economy warehouses:

Store more stock in the same space

A WMS enables up to 30% more inventory to be stored in any warehouse using dynamic location setting. A WMS directs operatives to wherever there is a slot available and guides pickers to where the stock is held for efficient order processing.

Pick route optimisation and planning

A WMS automatically evaluates the possible routes available to pick a stock item and will direct operatives to fulfil their order pick instructions using the most efficient travel path based on location.

Perpetual inventory (PI) stock counting

A daily PI or cyclical counting process supported by a WMS means warehouse managers can eliminate routine stock counts. It is the most effective way to maintain high inventory accuracy, minimise shrinkage and ensures business as usual whilst counting is in progress.

All manufacturers and retailers should consider how to incorporate circular economy principles into their business. Whether they opt for rental, re-commerce or subscription services, efficient logistics, run by a warehouse management software system, will be essential for maximising profits.

2.7 The pain after the gain: grocery deliverers reshuffle after lockdown boom

https://economictimes.indiatimes.com/tech/technology/the-pain-after-the-gain-grocery-deliverers-reshuffle-after-lockdown-boom/articleshow/92088651.cms

The grocery delivery industry that erupted in the depths of lockdown is facing a painful period of adjustment that investors say is likely to see only a handful of firms survive in each market - and then, in very different shape. As the Covid-19 pandemic kept consumers behind closed doors, investors poured billions into "quick commerce" grocery firms that pledged to deliver products from pasta to soap powder within 15 minutes from bespoke hubs known as dark stores. But with lockdowns easing, consumers struggling with soaring costs of living, and profitability still elusive, that flood of capital has slowed to a trickle, and firms have shifted from expansion to retrenchment.

2.8 India grows more food, wastes more, while more go hungry:

https://www.indiatoday.in/india/story/india-grows-more-food-wastes-more-while-more-go-hungry-1752107-2020-12-22

This article highlights the food wastage in India. In one side farmers' protests citing cries of no proper remuneration for the food grain produces and on the other side the annual farm products wastage in India is estimated close to rupees one lakh crore. India stands at 103rd position in the Global Hunger Index (GHI) is a shocking reality in contrary to its' 2nd global position in farm produce in a year. Statistics says, if India spends almost Rs 1.5 lakh crore on discounted and free food grain each year, a study in 2016 estimated that Rs 92,651 crore is lost annually in farm produce wastage

2.9 Fast Tracking Freight in India: A Roadmap for Clean and Cost-effective Goods Transport

By RMI India, NITI Aayog, RMI

https://rmi.org/insight/fast-tracking-freight-in-india-a-roadmap-for-clean-and-cost-effective-goods-transport/

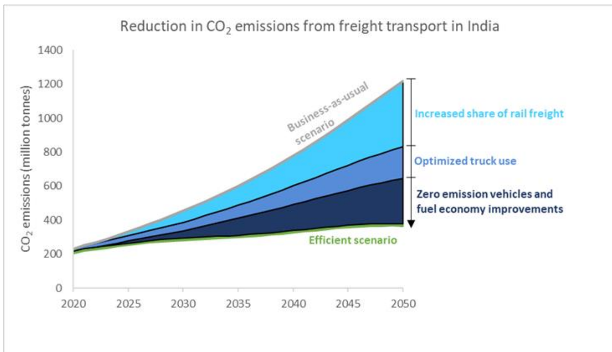
Freight transportation plays a crucial role in supporting the economic development of a nation, boosting its logistics and industrial competitiveness, and satisfying the daily needs of its citizens. Due to the rising demand for goods and services, India's freight transport demand has been growing at 5 percent since 2015 and is expected to grow rapidly over the next three decades. Although freight transport is an important pillar of the Indian economy, it can also have negative consequences such as high logistics costs, rising CO_2 emissions, and worsening air quality leading to poor public health.

India can address these negative impacts through three main opportunity areas:

1. Improve share of rail freight transport
2. Optimize truck use
3. Increase the uptake of zero-emissions vehicles and fuel economy improvement technologies

In this report, NITI Aayog and RMI outline solutions for the opportunity areas mentioned above. These solutions can enable the freight transport ecosystem in India to become more cost-effective, optimized, and cleaner.

Together, these opportunities can unlock 10 gigatons of cumulative CO_2 emission savings between 2020 and 2050. This can help India achieve its goal of reducing the logistics costs from 14 percent of GDP to 10 percent, and will reduce nitrogen oxide and particulate matter emissions by 35 percent and 28 percent respectively until 2050.



2.10 Cargo drone airline DRONAMICS obtains operational licence:

https://www.itln.in/cargo-drones/cargo-drone-airline-dronamics-obtains-operational-licence-1345505?infinitescroll=1

The leading middle-mile cargo drone developer and operator DRONAMICS, proclaimed receiving the EU's Light UAS Operator Certificate (LUC). The LUC is recognised in all EU member countries and offers drone operators with considerable industry prospects across the EU marketplace.

The announcement made during EBACE (European Business Aviation Conference Exhibition) comes at a key moment as the company prepares for the first commercial flights of its flagship Black Swan aircraft later this year. Carrying 350 kg at a distance up to 2,500 km. The Black Swan plans to transform supply chains by reducing cost, time and carbon footprint.

2.11 Skye Air, Aster DM to begin medical drone deliveries in Kerala

https://www.itln.in/cargo-drones/skye-air-aster-dm-to-begin-medical-drone-deliveries-in-kerala-1345632?infinitescroll=1

After the recently concluded Bharat Drone Mahotsav in New Delhi on 28th May 2022, Skye Air Mobility and Aster DM Healthcare have jointly announced the use of drones to deliver vital medicine and lab samples from Aster MIMS Hospital to Aster Mother Hospital Areekode, Kerala, covering a distance of about 32 kilometres with a payload of 5 kgs with single battery charge.

With rapid growth in digital technology in medical supply chain, they committed to invest more and more in drone logistics. This is surely going to be a game changing initiative in supply chain management in India.

2.12 India's warehousing sector checks into the fast lane:

https://www.itln.in/logistics/indias-warehousing-sector-checks-into-the-fast-lane-1345478

Buoyed by the e-commerce sector and the growth of the Indian industry, warehousing in India has undergone a metamorphosis. With technological advancements, consolidation, government support, newer business models, and investment coming into the space post the pandemic, the sector may well be set for a dream run for the next five years. Warehousing is a crucial part of the supply chain for businesses that are engaged in manufacturing, importing, exporting, and transporting of physical goods. From being mere holding places of stock or low-grade godowns, warehouses have metamorphed into smart buildings replete with insulation, ventilation, climate-proofing, surveillance and standard safety procedures, and IT infrastructure. From a largely unorganized, asset-heavy industry, warehousing has also undergone an evolution in India, especially after a multitude of factors like the expansion of pharmaceutical, e-commerce, and manufacturing sectors. Some growth can also be attributed to favorable government policies in recent years and an increase in the spate of institutional investments.

3. Research Gap:

The reviewed literatures talked about the prospect of warehousing business, cold supply chain, inadequacy of cold warehouses in India and the impact of those factors in economy & ecology, but it is silent on how the available and upcoming infrastructures can be optimally utilized adopting digital technology like blockchain.

According to United Nation's Food and Agriculture Organization, post-harvest losses in India amount to around 40 % of the agricultural produce, running into about Rs 1 lakh crore. For a country ranked 101st among 116 nations on the Global Hunger Index, it's a crime of the worst order. These losses can be attributed to inadequate storage facilities and logistical solutions. Farmers growing horticultural crops suffer bigger setbacks because of the limited shelf life of fruits and vegetables. The lack of access to cold storage infrastructure and refrigerated vehicles forces them to sell their produce at disturbingly low prices. Even then, every year they collectively end up losing Rs 63,000 crore due to the wastage. Financial losses aside, it's also a waste of precious resources like water and energy. Harvest losses turns into a disconcerting social condition of food starvation in the families of modest farmers. Furthermore, it promotes social crime and sometimes provokes farmers to commit suicide.

Fruits and vegetables waste impacts sustainability to a great extent because it represents the wastages of resources used to produce those spoiled fruits and vegetables, including harvest land, agro-chemicals like inorganic fertilizers, pesticides, irrigation water, energy, equipment, labour, money etc.

As per the National Centre for Cold Chain Development's (NCCD) estimate, there is a shortfall of 126 lakh metric tons of cold storage capacity in the country. As per the Integrated Cold Chain Availability Platform's estimate, India needs about 125,000 rural packhouses compared to the present availability of 500 numbers.

4. COVID-19 impact analysis:

Lockdown during the pandemic left severe impact on the world economy. The warehousing sector also witnessed a negative impact in its capacity utilization over the first three quarters of 2020 due to a negative impact in production, supply chain disruption and restriction in international trade. The demand for warehousing in India fell by ~11% in the first quarter of 2020, compared to the fourth quarter of 2019. However, with the well-planned vaccination drive and controlled 3rd wave, the warehousing market started reviving and emerged as a promising investment destination for potential investors. A massive increase in the demand for cold chain and pharmaceutical warehousing and growth in the e-commerce / e-retail segments in India are driving the market which is anticipated to continue for at least a decade. Other factors, including technological advancements, such as warehousing automation and robotic mechanization are expected to revolutionize the market. (Source: "Warehousing Market in India 2021" report, ResearchAndMarkets.com.

5. **Problem Statement**

3.1. Supply Chain – Inept Capacity Planning

Inadequate capacity planning is the prime cause of suboptimal storage utilization of available cold warehouses. Restricted visibility of current and future storage availability in cold warehouses adds to the problem. Lack of monitoring for proper storage parameters causes to the resultant mismatch in demand & Supply

3.2. Supply Chain – Logistics constraint

Cold logistics availability in places surrounding the warehouses is a challenge at the moment. Cold warehouse's proximity to the markets & points of produce makes it more complex. Absence of weather forecast options near the produce and the warehouse also plays a vital role in agricultural wastages in light of inadequate infrastructure.

3.3. E-commerce ecosystem and circular economy

Every e-commerce platform needs to maintain their own warehouses and logistics with the mindset of sharing the unutilized capacity with peer group encouraging higher capacity utilization and circular economy. Diversified product portfolio based on local produce, demand & supply analytics and a defined strategy for Tier 3, Tier 4 towns are the need of the day.

3.4. Insurance & Finance-Challenges

Lack of access to insurance for both producers & warehouses and unavailability of affordable financing promotes distress sale by the perishable goods producers.

3.5. Sustainability compliance

Unsustainable practices that increase carbon footprint, tracking and preventing unsafe products, degradation of potency of goods and unexercised eco-friendly waste management are some of the major impactors to the triple bottom-lines of businesses.

6. Magnitude of the problem

6.1 **Span of control**: In Indian cold warehouses is very low because the sector is mainly in the hand of unorganized operators. 10% organized and 90% unorganized.

6.2 **Lack of adequate storage facilities**: As per the National Centre for Cold Chain Development's (NCCD) estimate, there is a shortfall of 126 lakh metric tons of cold storage capacity in the country. As per the Integrated Cold Chain Availability Platform's estimate, India needs about 125,000 rural packhouses compared to the present availability of 500 numbers.

6.3 **Distribution of cold storage is uneven PAN India:** 68.53% of the available cold warehouses in India (total 8186 Numbers) are confined to six states-Andhra Pradesh/Telangana, Gujarat, Maharashtra, Punjab, Uttar Pradesh and West Bengal. 75% of the same are for the single commodity.

6.4 **Government of India rolled out various schemes** on optimal usage of the cold storage facilities under Pradhan Mantri Kisan SAMPADA Yojana (PMKSY). Unfortunately, many a times difference in political ideology of Central and State Governments become a bottleneck in effective implementation of the good schemes across the country, causing unavoidable dent to the economy.

6.5 **CARE ratings peg** growth rate at 13%-15% annually. Drivers are manufacturing, retail, FMCG and E-Commerce, Chemical-Pharma. Major industry houses of the country need to join hands with State and Central Governments to grab the opportunity.

7. Major Stakeholders

7.1 **Warehouses**: The warehouse owners and the departments are the most important stakeholders who created the infrastructures.

7.2 **E-Commerce Players**: This segment of business promoters have revolutionized the concept of buying, encouraging digital transactions and giving impetus to exchequers.

7.3 **Physical Goods Producers**: The farmers, processors, manufacturers etc.

- Perishable Goods: Agriculture Produce, Farm Produce, Dairy, Medicine, Fisheries and Cosmetics.
- Non-Perishable Goods: FMCG Products

7.4 **Warehouse Development and Regulatory Authority (WDRA)**. Being the custodian of Warehousing (Development and Regulation) Act, 2007, they administer warehouse registration and ensure implementation of the provisions of the Act. They also define negotiability of warehouse receipts to promote warehouse business.

8. Scope of Solution

8.1 Integrating the warehouses, PAN India.

8.2 Categorization of goods and consolidation of the produce, PAN India

8.3 Capturing the warehousing capacity availability in different categories and capacity mapping with requirements.

8.4 Standardized tariff plans PAN India

8.5 Application for real-time update on current and lookahead storage space availability (PAN India location-wise).

8.6 Application for real time booking with reservation and cancellation rule.

8.7 Auto suggesting cost-benefit analysis and comparison while booking warehouse space and location. Auto populated booking updates to all the peers in the network.

8.7 Auto populated booking updates to all the peers in the network.

9. What is Blockchain Technology (BLT)

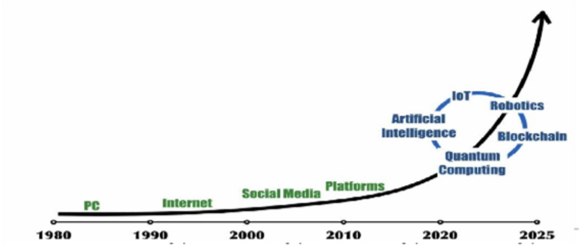
In layman language, BLT is a decentralised distributed ledger that stores all the transactions in particular blocks in a transparent and secure manner. It is immutable in nature and neither any individual node can change the captured data without consensus nor delete any block. In case of consensus or modifications a new block is created. Blockchain technology is a revolutionary new protocol for sharing and updating information by linking ledgers or databases in a decentralised, peer-to-peer, open-access network. Blockchain is designed to ensure the data is stored and updated in a secure, tamper-proof and irreversible way. Despite being in its nascent stages, the blockchain research is developing rapidly in different fields, making it imperative to capture the ethical and sustainability implications of blockchain development and implementation. The circular economy also focuses on enhancing sustainability and social responsibility, alongside economic growth.

10. Opportunity of Blockchain Technology (BLT)?

Global market for Blockchain is expected to grow at US$3 trillion in 2024 and would cross US$5 trillion by end of 2025. According to IDC (International Data Corporation), US$11.7B would be the spent on Blockchain in the year 2022, with a compounding annual growth of 73.2%.

69% of banks across the globe are experimenting, and around 90% of North American Banks and European banks invested in BLT development solutions in 2020 to make their processes seamless, secure, transparent and shortly we would hardly find any bank in the globe without BLT and AI (Artificial Intelligence) supported. Banks and Financial institutions are saving around US$12Billion+ annually by embracing BLT powered decentralized finance solutions.

11. Growth of BLT & AI



Source: https://kambria.io/blog/moocs-for-ai-empowering-individual-learning/

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12. Key features of BLT

12.1 Immutability

12.2 Decentralized database

12.3 Distributed Ledger

12.4 Transparency

12.5 Data protection

12.6 Traceability

12.7 Trustworthiness

13. Pre-Blockchain revenue utilization challenges

13.1 Warehouse market size valued at INR 1501 billion in 2019 and is expected to reach INR 2,821.1 billion by 2024, at a CAGR of ~13.57%. Global property consultancy Knight Frank India in their India Warehousing Market Report 2021 estimated that the annual warehousing transactions for the top eight cities (primary markets) would grow at a CAGR of 19%. In absence of transparency in optimized warehouse utilization, the slippage on growth projection would be unavoidable.

13.2 Funding problem- Farmers to seek loans from banks against NWRs (Negotiable Warehouse Receipts) and gets into distress sales.

13.3 Unorganized warehouse tariff management leading to price inflation

13.4 High amount of underutilized warehouse space

13.5 Missing quality standard leading to revenue losses

13.6 Lack of Modular Warehousing causing revenue loss

13.7 Restricted visibility of warehouse availability

13.8 Transparency and standardization

14. Post-Blockchain revenue & business opportunity

14.1 Visibility of available category wise spaces to the network peers

14.2 Reservation of spaces preventing distress sale by producers

14.3 Providing finance to producers through warehouse receipt by banks

14.4 Prevent fake warehouse receipts and theft of items using IoT enabled monitoring the stock at warehouse

14.5 Insurance for the warehouse and producers would be easy

14.6 Geotag products can be purchased by the users

14.7 Forecast of future requirement of warehouse /cold storage facility

14.8 Managing PAN India network and compliances by a consortium

14.9 Auto evaluation of nodes based on defined parameters and rating

15. Structure of Blockchain Consortium

Figure 1:

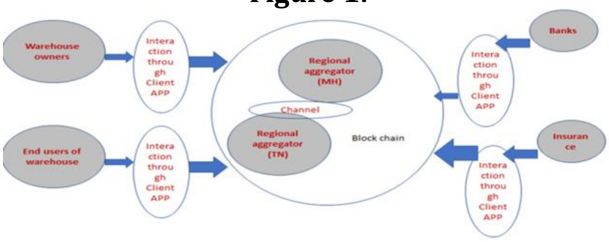
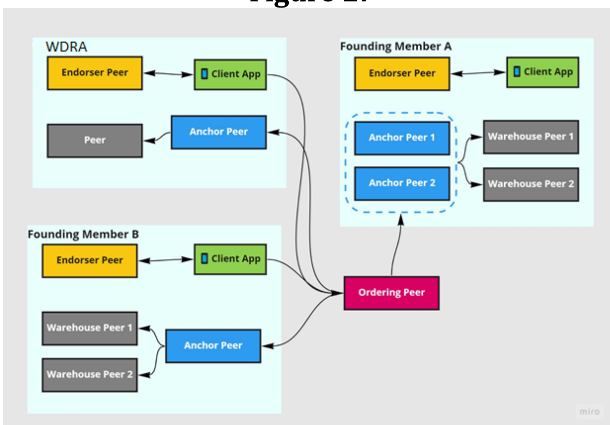


Figure 2:



16. Categorization basis of members into founders, general members & non-voting members

Founding Members	**General Members**	**Non-Voting Members**
Large Warehouse Owner a. 100K square feet or more space b. 50K square feet cold space c. 50K square feet & 100% e-equipment d. 25K square feet modular space & 100% e-equipment	WRD Representative from each Zone Global sustainability rating agency	Smaller Warehouses

17. Basic agreement framework between the nodes

17.1 Majority of founding members must approve for admission of new warehouses

17.2 WRDA must approve the new warehouses

17.3 Assessment by Global sustainability rating agency

17.4 User apps will show the warehouse type, location, availability information both current & futuristic, cost-benefit analysis, best economic options, special offers if any, rating (bronze, silver, gold, platinum) etc.

18. Driving force/s behind the consortium

18.1 Optimum utilization of warehouse spaces with the support of technology

18.2 Better revenue earning (ROI) through transparency

18.3 Reduction of wastages and enhance efficiency

18.4 To make the producers profitable

18.5 Promoting green energy

18.6 Creating job opportunity

18.7 Ensuring product quality avoiding degradation

18.8 Uniformity of policy and governances

18.9 Upgrading Indian warehousing practices to Global standard

18.10 Encouraging innovation like Drone-Unmanned Aerial Vehicles (UAVs) Logistics

18.11 Promoting Circular Economy

19. Circular Economy

A circular economy can simply be explained by the three R:

19.1 Reducing materials and waste

19.2 Reusing products

19.3 Recycling materials. So that products and services can be exchanged in a closed cycle.

Blockchain technology's transparency and traceability can reduce materials consumption and waste in the supply chain. Warehouse space can be optimized which would enable the owners to allot space to the required users. Perishable items' lifespan will be increased and supplied to the end-consumers before it deteriorates. This will enable the users to make intelligent purchase decisions to consume sustainable circular products and services. All the stakeholders will be in a win-win situation as there will be minimum wastage and loss of resources and top to bottom users will get the benefits of this optimized system.

6. Conclusion

The optimum utilizations of cold warehouses have the potential to transform agriculture, making it sustainable and profitable for even small farmers. With healthy storage facilities within an economic radius, including post-harvest management, farmers can selectively focus on high value crops. They will be empowered to exercise selling decision at appropriate time, leading to better price realization of their produce as per demand. This would encourage them to become self-dependent and free from the tight controls of mediators in the supply chain. In fact, state and union Governments' schemes to boost the network of cold storage facilities can play a catalytic role in improving farmers' income. With the impetus from Government of India in promoting Drones more and more for commercial supply chain applications, the supply chain professionals will be inspired to carry out experiments with higher payloads. Once farmers start using drones for warehouse transfers directly from croplands, Blockchain would be the only effective traffic control technology base to ensure safe landing of goods to the intended destination.

Governments are relentlessly trying for development of cold supply chain infrastructure in the country, but optimum capacity utilization of those facilities will be the key to success. A sustainable digital technology which is largely capable of making it possible with transparency, traceability, cost effectiveness and care to ecology & economy is BLOCKCHAIN.

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