

Transforming Cold Chain

A Steamy 'Hot' Affair

The Indian cold chain market size grew to Rs1,81,490 crore in 2022, and it is expected to reach Rs3,79,870 crore by 2028, exhibiting a CAGR of 12.3% during 2023-2028, per the recent estimates by Imarc. As experts unequivocally emphasize that India's cold supply chain faces a pivotal juncture between innovation and adaptation, trends shaping this year set the stage for a stronger industry dynamic. In coming years, stakeholders aim to adopt technological advancements, sustainable practices, collaborative efforts across the supply chain and focus on skill development to meet the evolving needs of this vibrant market. The Special Report traces the changing paradigms of cold chain segment and presents the wish lists of user companies from 3PLs to strike the right equilibrium...

THE global cold storage sector has expanded rapidly in the past decade, growing from around 550 million cubic metres in 2014 to an estimated 785 million cubic metres by 2022. This reflects a 4.5% compound annual growth rate (CAGR). Assuming this same CAGR, the market will grow to more than 1.1 billion cubic metres by 2030. Despite strong potential growth, this is arguably a conservative estimate. A JLL research stated that rising interest in the cold storage sector is underpinned by the structural growth drivers of the market. Global disruptions highlighted the importance of resilient supply chains, and the vital role cold storage real estate plays in these networks. Changing consumption patterns and the movement towards e-commerce has led to a surge in the need for efficient cold chain logistics and more cold storage real estate. These factors have and will continue to have long-term demand implications for the

amount of cold storage space needed, how they are designed and operated, and where they are located.

Our Q&A with experts from various industry domains brought forth intriguing insights into the transformational cold chain landscape. Here's what they highlight...

How is the cold chain segment performing over the years?

Preeti Saluja, Pharma Cold Chain Expert and Consultant: While the cold chain market was always growing, it came into limelight and especially the pharma cold chain, when Covid-19 hit us and the rest is really the history. More so, the growth of the pharmaceutical cold chain market can be directly proportional to the increasing demand of therapeutic modalities, such as biologics, more than 85% of which require cold chain management. Great number of biologics are currently being tested in clinical trials. Cell and gene therapy is another segment requiring cold chain

among other biological segments. Therefore, the anticipated success of these drugs is likely to act as an impetus to the growth of market. Moreover, the need for importing / exporting goods (food, pharmaceuticals, and chemicals) from / to other geographical regions has emerged as the major driving force for the cold chain transportation industry segment. As a result, the cold chain market is expected to grow considerably in the coming years.

Further, the cold chain market is benefiting greatly from the integration of internet of things, artificial intelligence, and real-time temperature monitoring devices, which aid in ensuring the safety and quality of pharmaceutical products in transit. The only from here is the growth path.

Kartik Jalan, Founder & CEO, Indicol: As per industry estimates, the Indian cold chain market size reached Rs2,052.7 billion in 2023. Looking forward, the burgeoning Indian cold

Kartik Jalan, Founder & CEO, Indicol

In India, the cold chain industry is poised for significant growth, driven by factors like increasing investments in infrastructure, government initiatives to get nutritious food to consumers, and the adoption of advanced technologies. The global warming phenomenon presents both challenges and opportunities for the cold chain sector, as rising temperatures necessitate more stringent temperature control measures while also creating greater demand for cold storage and transportation services. Indicol's mission aligns with addressing these challenges by providing sustainable and technologically advanced cold chain solutions to meet the evolving needs of the market. The future of the cold chain industry through our lens will likely see continued investments in warehouse automation, such as automated storage systems and robotic picking technologies, to further enhance operational efficiency and meet growing demand.



chain market is expected to reach Rs5,596.9 billion by 2032. The cold chain segment in India has demonstrated remarkable growth in recent years, with the market size expanding at a CAGR of around 14-15% annually. This growth is propelled by various factors including increasing consumer demand for fresh and frozen foods, rapid urbanization, and the expansion of organized retail and e-commerce sectors. To meet these demands, a range of cold chain solutions have emerged, such as refrigerated transportation, cold storage warehouses, and advanced temperature-controlled packaging. Additionally, warehouse automation is set to play a crucial role in optimizing cold chain operations going forward, with technologies like robotic palletizing, automated storage and retrieval systems (AS/RS), and conveyor systems streamlining inventory management and order fulfilment processes.

Mandar Kulkarni, Head - Warehouse & Logistics, Sun Pharma:

The "Cold Chain" in Pharmaceutical Industry is the end-to-end system of manufacturing of vaccines, transporting, storing and distribution till end user often within the temperature range of 35°F (2°C) to 45°F (8°C). The cold chain in the Pharma industry has been on a steady incline in recent years. The global cold chain market for pharmaceuticals is estimated to be worth \$6 billion in 2023 and expected to grow at 9% CAGR and may go up to \$11 billion the forecast period 2023-2027. The continuous R&D

in pharma sector along with launch of the National Health Protection Scheme (NHPS) in India in 2018, with the objective of extending healthcare insurance, is adding into the growth in demand for pharmaceutical products in India. Also, the growing consolidation in the global healthcare logistics market will facilitate the global pharmaceutical cold chain logistics market for pharmaceutical industry growth. Hence to cater the larger volume requirements, the pharma/end user companies will look for designing and building the efficient warehousing, transportation and distribution specialized in cold-chain healthcare logistics services. Apart from this, the pharma establishments and related service providers will use market consolidation as a strategic tool for overall business expansions. This market consolidation strategy will adopt the regional technologies developed from regional players and expanding their market presence in the competitive market. These factors will increase the cold chain logistics for pharmaceuticals market growth during the forecast period.

Tushar Ghai, Senior Manager - Supply Planning & Operations, Bira 91

The India Cold Chain Logistics Market size is estimated at US\$10.30 billion in 2024, and is expected to reach US\$13.58 billion by 2029, growing at a CAGR of 5.67% during the forecast period (2024-2029). The rising demand for perishable goods has been propelling

market growth. Furthermore, a shift in consumer behavior is driving the market tremendously. The India cold chain logistics market is a fragmented market consisting of a large number of local players to cater to the growing demand. Companies investing in streamlining the supply chain and having advanced technology have an edge in getting a good share of the market. Global players can partner with local companies to invest in the market and gain profits.

What are the challenges in managing cold chain?

Preeti Saluja: There are many challenges. If we look deeper into the figures of the damage and wastage of pharma product due to broken cold chain, numbers are quite alarming. Alarming enough to swing into action to ensure to provide correct ambience for temperature control management. Challenges in broader terms could be categorized as challenges related to correct packaging and cold chain storage, which could include disrupted temperature control, risk of contamination and damage. The very fact that broken cold chain in pharmaceuticals could lead to ineffectiveness and loss of efficacy, more so, poses a risk of it becoming fatal for humans. There have been instances when people have lost their lives due to ignorance in the matter and therefore it cannot be overstressed.

While we may think that we can control 100% of the cold chain journey, in reality, we cannot. Simple reason is the many links in the cold chain journey and at times, there could be

anticipated challenges and there could be unanticipated challenges like equipment breakdown, incorrect storage of the samples, mix ups, incorrect handling of the packages containing temperature control products and sometimes when you try to control all other aspects, tarmac happens.

Kartik Jalan: Challenges within the cold chain industry include maintaining consistent temperature control throughout the supply chain, managing operational costs, adhering to stringent regulatory requirements, handling the complexities of international shipments, and minimizing the environmental impact of cold chain operations. To address these challenges, various solutions are implemented. Automation technologies, such as IoT sensors and automated monitoring systems, enable real-time data collection and temperature monitoring, ensuring compliance with regulatory standards and minimizing product spoilage. Additionally, advanced warehouse automation solutions, such as robotic palletizing and automated storage and retrieval systems (AS/RS), streamline inventory management and order fulfilment processes, reducing operational costs and improving efficiency. Furthermore, investments in greener technologies for refrigeration and packaging contribute to minimizing the environmental footprint of cold chain operations, aligning with sustainability goals. Overall, the integration of these solutions helps overcome challenges and ensures the reliability and efficiency of the cold chain process.

Mandar Kulkarni: The Cold chain begins when vaccine gets manufactured, moves through to the state or national distribution centres and ends with the local immunization provider. Since the vaccines are consumed by human beings, each stakeholder involved in handling the temperature controlled condition (avoiding temperature excursions) and preserve the potency at each and every step during storage transportation. The altered potency and integrity of vaccines is irreversible & can affect the quality and its effectiveness if not controlled within the prescribed temperature range (on either side of temperature range-up/down). The Cold chain involves several complex challenges under distribution,

technology, warehousing, packaging solutions, standardization in packing, process oriented, business challenges, quality and temperature excursion challenges. Distribution challenges can be haul capacity utilization, reefer vehicle load formation, PTL shipments facing airline connectivity issues, packaging issues may include proper shipper material & sizes along with right type of gel packs, business challenges due to demand fluctuations, process & technology challenges may involve visibility & monitoring system. The challenges/risk areas can be addressed through proper storage/transport, effective communication & co-ordination among several stakeholders involved in supply chain, vehicle quality, addressing power failure/breakdown issues, etc. There is need to monitor the movement and temperature of plug in the cargo transport unit throughout its journey. The vaccines/pharma cold chain products are very expensive and hence needs proper control on all parameters to prevent losses.

Tushar Ghai: Cold chain logistics in India is growing rapidly and is currently the most focused area in the supply chain management industry. A few common gaps currently in the ecosystem include:

Limited Tech Integration: Several cold chain logistics facilities still rely on manual temperature monitoring and inventory management processes. This lack of tech integration leads to data inaccuracies and delays in decision-making, increasing the risk of product spoilage. It directly impacts the safety, quality and profitability of temperature-sensitive goods. However, the introduction of artificial intelligence, the Internet of Things, and machine learning are accessible, and it is ideal to incorporate these technologies into the cold chain management structure.

Inefficient Infrastructure: The cold chain infrastructure in India is still developing and needs to improve its efficiency. Many regions, particularly remote and rural areas, need proper storage facilities and transportation networks for a seamless cold chain. This infrastructure needs to be improved to enable seamless distribution of temperature-sensitive goods, which is otherwise hindering its reach till the end

consumers.

No Cost Efficiency: Business operations with cold chain logistics are capital-intensive, and energy costs comprise a significant portion of the total expenses. Inefficient refrigeration systems and a lack of cost-effective energy solutions certainly increase operational costs, making it challenging for businesses to maintain a profitable cold chain.

Unorganized Industry: Despite growing rapidly, India's cold chain logistics remains largely distorted and unorganized. Several small players operate independently, generally needing more standardized practices and quality controls.

Scope of Human Error: While most of the cold chain facilities in India function manually, the scope of human error remains a significant concern. From incorrect temperature settings to mishandling of products during transportation, the potential for error is high.

What are the wish lists of user companies in managing temperature sensitive goods?

Preeti Saluja: There could be a long list of wish lists:

- ❖ The robust packaging systems, which lasts longer than standard 72/96/120 hrs with minimal external management to manage parcel size shipments.
- ❖ Predictive temperature management for Pharma using AI which enables selection of right packaging for specific routes.
- ❖ AI interference for selecting the shortest and effective routes.
- ❖ Better infrastructure at the airports, no matter how much we boast of having seamless processes and perfect infrastructure, I think at a global level, we are far from achieving the perfection. In case of heavy loads at the airports, ground handling agencies still struggle for the space in their freezers and cold rooms. Better infrastructure across the globe is one of the major wish lists for sure.
- ❖ Managing offloads with the airlines,

Preeti Saluja, Pharma Cold Chain Expert and Consultant

The cold chain market is benefiting greatly from the integration of internet of things, artificial intelligence, and real-time temperature monitoring devices, which aid in ensuring the safety and quality of pharmaceutical products in transit. Sustainable and intelligent packaging solutions are a talk of the town now. Smart packaging which could not only be able to provide the real time tracking but also do predictive analysis based on AI. Technologies like big data, predictive analysis, and AI are ushering significant benefits to the pharma sector's cold supply chain. Real-time temperature-monitoring and control in smart storage warehouses, facilitated by AI, robotics and IoT, are facilitating accurate and consistent temperature-controlled environments, reducing the risk of product spoilage.



not sure, how this could be controlled though.

- ❖ Temperature management at TARMAC would take my biggest vote.
- ❖ When it comes to cold chain sea shipments, the biggest challenge is managing the plug off timings, so better thermal blankets with PCMs could be the answer amongst other solutions.
- ❖ For pallet size shipments, availability of active/passive systems at the remote locations could be an answer to many challenges.
- ❖ Supply chain management through drones for remotest of the locations is another chapter to be read. Understandably some trials are on their way for sure.

Kartik Jalan: Clients managing temperature-sensitive goods seek greater efficiency, reliability, and sustainability in the cold chain process. This includes real-time monitoring, automated systems for temperature control, and environmentally friendly packaging solutions. Indicold, a leading player in the Indian cold chain industry, aligns with this vision by providing end-to-end cold chain solutions with a commitment to sustainability and innovation. Through warehouse automation, Indicold enhances operational efficiency and product integrity, ensuring that temperature-sensitive goods are handled

with precision and care throughout the supply chain.

Mandar Kulkarni: The basic wish lists consist of maintaining temperature condition (NIL temperature excursion cases), timely deliveries to locations wherever urgencies exist for serving cancer patients and addressing critical illnesses. The express delivery solutions at optimum cost, zero missed deliveries are desirable. Other expectations may be for freight cost reduction by optimizing the right packaging solutions for different sizes of packed vaccine shippers. In case there is expected delay in deliveries (> 48 hours) due to any issues like air connectivity, road challenges, etc., then there should be back-up plans for arranging separate facilities/re-packing infrastructure for replacement of gel packs so that the current maintained temperature condition gets extended for few more days. The online tracking of temperature and deliveries, timely alerts through SMS/emails and on time actions could be the requirements. Need to have adhered vehicle checklist points along with data loggers/GPS enabled FTL, Milk run and PTL temperature controlled solutions to ensure that each shipment is shipped in the most optimum mode of transport, increasing its reliability. It's also important to have drivers trained and equipped for quality monitoring, risk management, repairs, sensitivity and escalations through matrix to address any unforeseen issues.

Tushar Ghai: In my view, the most important wish list in managing the

temperature sensitive goods is the adoption of more mature ecosystem to handle temperature sensitive and shelf life sensitive products. Secondly, end to end tracking of vital parameters for maintaining and ensuring the product quality & integrity is crucial. Moreover, there needs to be competitive pricing for maintaining cold chain and transporting temperature sensitive goods in order to ensure high customer satisfaction and great brand execution. Lastly, there is always a challenge of availability of a "Good Fit Vehicle" which should be resolved as part of ecosystem transformation and necessary training sessions.

Are logistics companies preparing to brace the latent demand and do we have state-of-the-art cold chain infrastructure in place to cater to the demand when it comes to cold chain shipments by air?

Preeti Saluja: Logistics companies may want to do many things but the reality of the situation is that logistics companies alone cannot do everything as they are also dependent on many other service providers to ensure that cold chain is maintained, to name a few, correct packaging is required to ensure that the qualification time of the box should be enough for it to last for its total transit time, once the shipment is handed over to the airlines, airlines and ground handling agencies must ensure the correct storage of the shipment and ensure to have the least of the tarmac exposure. Some agencies are also introducing cool dollies for this reason. Human Resources at the airlines and

Mandar Kulkarni, Head – Warehouse & Logistics, Sun Pharma

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GHAs must be properly trained to handle temperature sensitive products. After the shipment has successfully reached destination, correct storage is required until the time it is custom cleared and delivered. As for the state of the art cold chain infrastructure, it will be, of course, a wish list for many stakeholders but so far, we have miles to go.

Mandar Kulkarni: It is important to have the stocking of pharma products/vaccines near consumption points to reduce the transit time and meeting on time requirement of hospitals/patients. The planning of right quantum of stocking SKUs against inventory norms at central distribution centres as well as at regional depots can help in addressing this issue. The strategic location of warehouses can be based on market volume demand/needs and also can be supported by inputs on state-wise varied electricity rates. Secondly, there are many 3PL companies coming up with large cold storage facilities and may provide logistical extension too. There are couple of service providers/partners working in collaboration for building large sized upgraded warehouses nearby metro cities with technological advancements. If there is high variation in demand at client end, then if required, such kind of facilities can be availed based on variable cost basis with actual usage per pallet cost basis. There can be an advantage of consolidation and reducing overall supply chain costs. The collaborative approach across several companies within industry would be

the future. There are various innovative initiatives that would play out well in the future such as warehouses near consumption point, multi-temperature modular partitions to reduce electricity consumption and costs (also vehicles with partitions), etc. It is also important how the segmentation within cold room/cool room is done along with modular partitions for reducing electricity costs.

Cold chain solution can have insulated pallet blankets, collapsible pallet storages, or which provides thermal barrier systems cover pallet loads to provide an enclosed thermal environment that passively manage product temperature during storage and transport. Pre-qualified off-the-shelf temperature-sensitive courier shippers designed temperature-sensitive deliveries in specific insulation like PU, EPS, PU polyurethane, Vacuum insulated panels, etc.

How are logistics companies preparing to brace the latent demand and do we have state-of-the-art cold chain infrastructure in place to cater to the demand? What's happening on warehousing front as well in this regard?

Kartik Jalan: In India, the cold chain industry is poised for significant growth, driven by factors like increasing investments in infrastructure, government initiatives to get nutritious food to consumers, and the adoption of advanced technologies. The global warming phenomenon presents both challenges and opportunities for the cold chain sector, as rising temperatures

necessitate more stringent temperature control measures while also creating greater demand for cold storage and transportation services. Indicold's mission aligns with addressing these challenges by providing sustainable and technologically advanced cold chain solutions to meet the evolving needs of the market. The future of the cold chain industry through our lens will likely see continued investments in warehouse automation, such as automated storage systems and robotic picking technologies, to further enhance operational efficiency and meet growing demand.

What are the innovations happening in this space?

Preeti Saluja: There are several innovations happening. Cold chain market stakeholders have started talking about and implementing a lot of newer technologies. The cold chain market is benefiting greatly from the integration of internet of things, artificial intelligence, and real-time temperature monitoring devices, which aid in ensuring the safety and quality of pharmaceutical products in transit. Sustainable and intelligent packaging solutions are a talk of the town now.

Smart packaging which could not only be able to provide the real time tracking but also do predictive analysis based on AI. Technologies like big data, predictive analysis, and AI are ushering significant benefits to the pharma sector's cold supply chain. Real-time temperature-monitoring and control in smart storage warehouses, facilitated

by AI, robotics and IoT, are facilitating accurate and consistent temperature-controlled environments, reducing the risk of product spoilage. There is so much that is being tested at the moment and if I can say so, also being used when the budget and operational requirements meet each other.

Kartik Jalan: The cold storage industry is buzzing with innovation. First off, there's a significant focus on automation, with smart cold storage systems utilizing IoT sensors for real-time monitoring and automated storage and retrieval systems revolutionizing warehouse operations. Energy-efficient refrigeration technologies are also making waves, using variable frequency drives and evaporative cooling to minimize energy consumption. Then, there's the exciting development of traceability solutions like blockchain and RFID tags, ensuring product quality and compliance throughout the cold chain. Lastly, we're seeing advancements in insulation materials like vacuum insulated panels and aerogels, enhancing temperature stability within storage facilities. These innovations collectively drive efficiency, reliability, and sustainability in cold storage operations, marking an exciting evolution in the industry.

What are the regulations in place to enable such a highly specialized cold supply chain?

Preeti Saluja: Maintaining product quality and integrity requires a coordinated effort by stakeholders involved across the supply chain. It requires clear communication of risk mitigation guidelines. GDP (Good Distribution Practices) guidelines are needed to monitor and control pharmaceutical products from manufacturers to end consumers. Major pharmaceutical regulators like US-FDA, WHO, European Union, and PIC/S have issued GDP guidelines in their respective jurisdictions. The Indian regulator - the Central Drugs Standard Control Organization (CDSCO), has developed and issued draft guidelines for Good Distribution Practices (GDP) for pharmaceuticals in 2018 for comments.

What are the emerging trends in cold chain packaging?

Kartik Jalan: From an outsider's perspective, emerging trends in

Traditional warehouses with 40-foot ceiling heights are not conducive to efficient refrigeration because the square footage of the roof introduces heat from solar energy, increasing the load on the refrigeration system. Additionally, there may be an opportunity to increase the pallet capacity of a building footprint by 12% to 25% by raising the clearance height to 11 metres, up from 10 metres.

Source: JLL

cold chain packaging include a focus on sustainability with eco-friendly materials, integration of smart packaging technologies for real-time monitoring, emphasis on convenience and efficiency with lightweight and pre-packaged solutions, and customization to meet specific product and branding needs. These trends are shaping the industry towards sustainability, efficiency, and customer satisfaction. Indicold currently looks to partner with companies to provide such services as and when required by its customers.

What are the conducive policy mechanisms from the government?

Preeti Saluja: For India - National Logistics Policy (NLP) was launched on 17th September 2022 by the Prime Minister, Shri Narendra Modi. The targets of the NLP are to: (i) Reduce cost of logistics in India; (ii) improve the Logistics Performance Index ranking. As per Invest India Forty air cargo ports have been built to increase exports, and thirty airports have been equipped with cold storage facilities. There will soon be 35 multi-modal hubs nationwide, enabling seamless freight movement. The government of India has permitted 100% FDI in warehousing, which is especially needed for developing the growth of state of art cold storage facilities. With the imminent need for specialized equipment and storage solutions to maintain product integrity, FDI also helps accelerate Tech integration, which is a pressing need of the sector.

Funding from the government plus FDI will bridge the gap and empower logistics companies to build cutting-edge infrastructure to upgrade and modernise the cold supply chain.

How is new age technology shaping the cold chain segment?

Kartik Jalan: New age technology is redefining the way goods are being transported, stored and distributed. Blockchain technology is being increasingly adopted to enhance transparency and traceability in the cold chain. Real-Time Monitoring: IoT (Internet of Things) devices and sensors are being integrated into cold storage facilities and transportation vehicles, enabling real-time monitoring of temperature, humidity, and other crucial parameters. Predictive maintenance techniques powered by AI (Artificial Intelligence) are helping cold chain operators anticipate equipment failures before they occur. Innovations in cold energy storage technologies are making cold chain operations more sustainable and environmentally friendly. Automation and robotics are streamlining cold chain operations, reducing dependency on manual labor and minimizing the risk of human error. Drones and autonomous vehicles are being explored for last-mile delivery in the cold chain segment. New-age technology is revolutionizing the cold chain segment, driving increased efficiency, sustainability, and reliability across the entire supply chain. At Indicold,

Tushar Ghai, Senior Manager – Supply Planning & Operations, Bira 91

Higher quality insights are decisive for refrigerated products, therefore 2024 will see more investments in software that can improve visibility on the whole supply chain. Better tools will need to come in place to effectively monitor temperature-sensitive cargo and create an unbroken cold chain that has real-time visibility on the product conditions using uninterrupted data. Real-time monitoring will become even more precise, with GPS-enabled devices placed in the containers.



we are using data analytics, real time monitoring, predictive maintenance and building unique, state-of-the-art, future ready sustainable cold storage marked by cutting edge technologies.

Tushar Ghai: At present, the industry is undergoing rapid transformation, fueled by technological advancements in packaging materials and monitoring systems. Innovations in insulation, like the use of advanced aerogels and phase change materials, are enabling more efficient and longer-lasting temperature control. Concurrently, the integration of the Internet of Things (IoT)-based monitoring systems in packaging solutions is enhancing the traceability and reliability of the cold chain. These technologies enable real-time tracking of temperature and humidity levels, ensuring product integrity throughout the supply chain. This technological leap is crucial for sectors like pharmaceuticals where the efficacy of temperature-sensitive drugs and vaccines hinges on consistent cold chain management.

How do you foresee the expanse of pharma cold chain in times to come?

Preeti Saluja: Given the inclination of industry stakeholders towards forging strategic alliances focused on the development of cold chain products, we believe that the cold chain market is likely to evolve at a rapid pace in times to come. If I can say so, this is the era of the mergers and acquisitions, many stakeholders are undertaking initiatives to forge alliances with other industry

/ non-industry players and link the activities together to provide seamless cold chain services. Stakeholders are actively engaged in providing multiple services related to the temperature controlled packaging solutions, such as reuse and rental services that involve reusing and leasing of the container / shipper for the transportation of pharmaceutical products. Drug distribution companies are tying knots with specialised logistics companies. Marriage between specialised temperature control packaging systems and logistic companies are proving to be a successful association. Passive and active containers collaborations and many others could be seen. In this era, the expanse of Pharma Cold chain is only going to get bigger and bigger, the aim is clear – expansion of portfolios for respective stakeholders and also their geographical reach.

Kartik Jalan: In the future, the cold chain is set to expand significantly due to globalization, technological advancements, evolving consumer preferences, climate change and regulatory requirements. This growth will be driven by increased demand for perishable goods and the need for more sophisticated infrastructure to meet rising expectations for quality and safety. Tier 1 and 2 cities are more likely to attract significant capital inflow and new capacity creation in the forthcoming years. India's cold supply chain faces a pivotal juncture between innovation and adaptation. Trends shaping this year set the stage for a stronger industry. In coming years, stakeholders aim to adopt technological advancements, sustainable

practices, collaborative efforts across the supply chain and focus on skill development to meet the evolving needs of a dynamic market.

Mandar Kulkarni: The constant market surveys by the teams, predictive analysis, symptom analysis would constantly evolve the distribution pattern of pharma products. Companies are investing in healthcare supply chain and cold chain capabilities by providing cold chain facilities worldwide. They can offer tailored solutions for transport of temperature-controlled healthcare shipments within India to for 6,000+ postal codes. The express logistics (road/air) by consolidation of shipments across whole pharma industry would be key for faster deliveries at optimum cost shared among them. Service partners will be integrating IoT technology for near real-time monitoring, ensuring visibility and product integrity. The growth in pharma industry will be accelerated with digital transformation journey along with innovations backed by data to strengthen the pharma eco-system. Also, the life science companies along with service partners would be proactively working on building the intelligent supply chain, which is customer-centric supported by technology and innovation.

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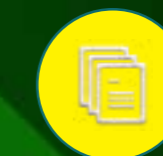
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