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Navigating Cold Chain Challenges with AI Solutions

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Artificial intelligence (AI) is playing a key role in driving the growth of the ever-demanding cold chain logistics sector, which caters to both the pharmaceutical and healthcare industries. The role of AI in enabling real-time temperature tracking and anomaly alerts, reducing spoilage and degradation of sensitive goods, optimising routing, scheduling, and load planning, leading to more efficient delivery and fuel savings, is noteworthy. Both the cold chain and AI players are optimistic about the future growth with a rising demand for life sciences products.

Pharmaceutical cold chain logistics has been instrumental in delivering life-saving drugs across the length and breadth of the world. It may be noted that temperature-sensitive pharma products need safety and efficacy at the highest standards.

Artificial intelligence (AI) is aiding pharma cold chain logistics in a big way. Real-time IoT monitoring, AI-powered predictive analytics, expanded cryogenic infrastructure etc, have added more benefits to pharma companies to securely transfer products from one place to another. And pharma logistics players are innovating themselves with the help of AI to help pharma companies in a large way.

Role of AI

Vaccines, biologics and cell and gene therapy drugs need constant temperature monitoring throughout production, distribution and transportation. With India's cold chain logistics supporting a rapidly expanding pharmaceuticals sector, projected at $130 billion by 2030, it is touted as an ever-growing industry.

By enabling real-time temperature monitoring, predictive maintenance, and route optimisation, AI is helping reduce spoilage, minimise delays, and build stronger compliance and trust for brands with their customers. AI is being used in very practical ways across the cold chain.

There have been instances of inefficient route plans, natural calamities, power supply issues etc. that lead to damage or degradation of almost 20 per cent of temperature-sensitive pharma products. This is where AI has gained prominence.

AI is helping pharma companies forecast demand better and schedule equipment maintenance before breakdowns occur, cutting down on delays and losses. IoT sensors can track temperature and humidity in real time, while blockchain is making it easier to verify authenticity and compliance.

Electric vehicles (EVs) with built-in cooling, and even 5G-enabled systems for faster alerts, are gradually becoming part of operations. Moreover, Alâ??driven warehouse systems employ machine learning and robotics to automate tasks like slotting, smart picking, and predictive demand forecasting, making operations faster, more accurate, and more efficient. All of this is helping the industry run smarter, more reliably, and with a lighter environmental footprint.

AI players in pharma cold chain logistics

Navi Mumbai-based Celsius Logistics, recently launched Celcius+, a specialised logistics arm dedicated exclusively to the seamless management of the pharmaceutical supply chain. The company aims to invest Rs 50 crore to create a dedicated pharma fleet and support infrastructure, with a goal of achieving Rs 100 crore in Annual Recurring Revenue (ARR) from this segment within the next 18 months. Of this, Rs 35 crore will be allocated towards deploying 100 new reefer vehicles for Celcius+ along key pharmaceutical corridors across India. A further Rs 10–15 crore is being earmarked to build a robust pharma courier system tailored to serve high-demand urban and semi-urban markets. Celcius+ will deliver tech-enabled supply chain solutions tailored for pharmaceutical and healthcare clients.

Says **Swarup Bose, Founder and CEO, Celcius Logistics**, "AI is fundamentally transforming the cold chain logistics sector. Predictive analytics, for example, are helping companies forecast demand better and schedule equipment maintenance before breakdowns occur, cutting down on delays and losses. IoT sensors now track temperature and humidity in real time, while blockchain is making it easier to verify authenticity and compliance. Alâ??driven warehouse systems employ machine learning and robotics to automate tasks like slotting, smart picking, and predictive demand forecasting, making operations faster, more accurate, and more efficient."

Gurgaon-based AWL India specialises in offering high-tech and advanced cold chain logistics. The company uses tools that are designed to collect real-time information of goods received, expired, damaged and delivered in one-go with just one click. Custom fleet management software has centralised supply chain management software, GPS tracking software for shipments and tailor-made reporting and tracking tools. According to the company, the advanced software offers software solutions for supply chain management, real-time visibility into the inventory, automated and streamlined operations, improved shipment efficiency, reduced operational, maintenance and transportation costs, logistic software development etc.

Another Gurgaon-based Binary Semantics' Fleet Robo is offering a cold chain logistics solution for managing the fleet of refrigerated vehicles. The company offers real-time visibility, geo fencing, route optimisation, driver and assets delivery,

analytics, detailed report and ensures on-time delivery.

CloudTrack, with its offices in Mumbai and Bengaluru, offers IoT Sensors, real-time data transmission, cloud-based software, alerts, monitoring and analytics.

Lytus BLOD is Lytus Health's AI-first medical logistics platform that covers blood components, vaccines, biologics, and other temperature-sensitive medicines with different cold-chain needs. Lytus BLOD uses a mix of AI and ML techniques that are constantly being refined. It uses forecasting models to predict temperature risks and avoid false alarms, reinforcement learning to improve dispatch timings and reduce delays, route optimisation tools that balance cost, quality, and even carbon emissions, computer vision and OCR to help with compliance checks, time stamping and audit trails.

Sai Guna Ranjan Puranam, COO, Lytus Healthtech, says, "AI is shifting cold chain logistics from reactive tracking to predict-and-prevent operations. In the coming decade, AI-driven medical logistics will be as vital to public health as highways and power grids were to earlier generations."

New Delhi-headquartered Snowman Logistics offers 5PL (fifth-party logistics) solutions and a suite of services including warehousing, customised supply chain management, transportation, and consultancy. The company offers SNOWPRESERVE warehousing from +25°C to -25°C, including blast freezing in key locations. The vehicles are equipped with both GPS and data logging.

Talking about the benefits of AI in today's pharma cold chain logistics sector, **Jeevan Upreti, Business Development Head, North Region, Snowman Logistics**, says, "AI will automate compliance record keeping and generate auditable logs automatically, allowing for transparent, tamper-proof tracking of product conditions throughout the supply chain. Regulators will likely rely more on continuous digital monitoring and data-driven inspections rather than manual record checks. The shift will reduce audit time, minimise paperwork, and provide real-time access to historical shipment data for rapid verification."

Startups like Tagbox, CloudTrack, Pickrr, Roanbee etc., offer IoT sensors combined with AI and machine learning to dynamically track pharmaceutical shipments in real time.

Challenges

Challenges like AI false alerts are known to plague the pharma cold chain logistics. The likely causes can be AI algorithms being overly sensitive to data anomalies, sensor inaccuracies, or environmental noise etc. These alerts often arise from sensor calibration issues, poor network connectivity, or inconsistent data inputs. Variations in external temperature, vibration during transport, or incorrect thresholds set in the AI system can also cause unnecessary alerts. Regular system updates and validation help reduce these errors.

False alerts also happen because AI learns from limited or local contexts. This can cause errors in reading, interpreting, or projecting results. Common reasons include calibration gaps, poor sampling, or misinterpretation of short-lived temperature spikes.

Other challenges include sensor calibration drift or hardware malfunctions that lead to unreliable readings, as well as environmental factors—such as temperature fluctuations in delivery vehicles—that may not actually affect product stability but still trigger alerts. In addition, poor data quality and the lack of standardisation in sensor network integration can result in fragmented information and the misinterpretation of data patterns as potential threats. Finally, overly sensitive thresholds in anomaly detection algorithms often generate excessive false alarms, creating unnecessary notifications and reducing trust in the system.

Sustainability

AI in cold chain logistics doesn't just make operations smarter but it makes them greener. By helping optimise routes, cutting fuel use and reducing wastage of perishable goods, AI indirectly lowers the sector's carbon footprint. Many platforms are now cloud-based, which means companies don't need heavy infrastructure to get started. As the technology matures, these tools are proving to be both environmentally and financially sustainable in the long run.

Many cold chain logistics players are adopting AI tools to enhance their productivity and overcome challenges. AI is also helping in adopting sustainability measures. The focus is on using reusable materials instead of single use, planning routes

that reduce emissions while ensuring safety, creating demand-surplus matching workflows etc.

Affordability and costs

Pricing of AI tools depends on deployment scale, integration needs, and service models (SaaS, on-premise, hybrid).

AI-driven cold chain solutions can reduce operational costs by 10–15 per cent through lower fuel consumption, reduced waste, and streamlined labour. Many AI tools are offered on a subscription (OPEX) basis, making adoption more affordable for SMEs, while larger implementations by global logistics firms require a higher initial investment but deliver significant long-term savings.

The future seems optimistic for the pharma cold chain logistics sector. And AI is only going to enhance growth. Using AI tools in the right way and avoiding false alerts will be a win-win situation both for AI and logistics players.

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