

# Navigating the Depths: A Case Study on Post-Pandemic Cold Chain Logistics Transformation in India's Seafood Supply Chain

**Ritika**

Research scholar, Department of Economics, Galgotias, New Delhi, Delhi

Email Id: [ritscool61@gmail.com](mailto:ritscool61@gmail.com)

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**Abstract:** This study examines the transformation of cold chain logistics in India's seafood industry in the post-COVID-19 era, highlighting how the pandemic exposed structural vulnerabilities and accelerated systemic reforms. The seafood sector, heavily dependent on temperature-sensitive logistics, faced severe disruptions due to lockdowns, labor shortages, and transportation bottlenecks, leading to substantial economic losses and supply chain breakdowns. The research adopts a case study approach, focusing on industry responses such as digitalization, decentralized storage infrastructure, and collaborative logistics models. Special emphasis is placed on the adaptive strategies of firms like Avanti Feeds Ltd., which leveraged IoT-enabled monitoring systems, cloud-based inventory management, and regional processing hubs to enhance resilience. Government interventions, particularly through schemes like PMMSY, played a critical role in strengthening infrastructure and supporting recovery. The study further explores the integration of sustainability practices, including solar-powered cold storage and green refrigeration technologies. Despite progress, challenges such as fragmented logistics networks, power instability, and skill gaps persist. The findings underline the importance of technological innovation, public-private partnerships, and policy support in building resilient and sustainable supply chains. The research contributes to the broader discourse on supply chain resilience and offers strategic insights for industries dealing with perishable goods in volatile environments.

**Keywords:** *Cold Chain Logistics, Seafood Industry, Supply Chain Resilience, Digital Transformation, Post-Pandemic Recovery, India*

## INTRODUCTION

The COVID-19 pandemic's silver line entailed one of the worst modern-day global disruptions that not only affect the health system but also some of the most crucial economic systems such as supply chains. When nations raced to lockdowns and limits on their movements early in 2020, supply chains failed in all categories, including pharmaceuticals and perishables. One of the worst affected was the Indian seafood industry which is an industry highly dependent on temperature-sensitive cold chain logistics. Sea food has to be harvested, processed and transported within a narrow window of shelf life with stringent regulations on export quality and constant connectivity required in the supply chain spanning the harvesting, processing, storage stages up to a point of destination.

India seafood industry had been slowly achieving global market status before the pandemic and majorly due to shrimp exports to the United States, Europe, Japan, and the Middle East. But the pandemic has highlighted long-standing system fragilities that have been little addressed: poor rural infrastructure, insufficient reefer vehicles, labor intensive processes with little automation, and poor inter-state transport coordination. These issues were worsened by the nationwide lockdown which led to severe operation suspension and financial strain on the exporters, fisher folk, transporters, and ware house operators.

The current case study dwells on the Indian seafood cold chain system during the crisis of the pandemic. It examines the complex, reactive and proactive reaction of the sector and points to the changes that enabled certain firms to recover quicker than others. New technology gained traction in the form of accelerated digitalization, decentralization of cold storage facilities and collaborative logistics models, which have become blueprints and exemplars in the fields of robust supply chain design.

The study relies on secondary sources, which include government reports, industry survey, and company filings, and

scholarly works. It also prints on certain policy interventions like Pradhan Mantri Matsya Sampada Yojana (PMMSY) which will transform the value chain of fisheries over the long-term. Particular attention is paid to the way's companies, such as Avanti Feeds Ltd. availed themselves of technology and decentralization strategies, in order to overcome risk and regain capacity to operate. The wider objective is to draw strategic lessons related to global supply chains that have to deal with volatility, climate risks, and dynamic consumer behavior.

Beyond that, the pandemic itself has thrown critical questions on the future of cold chain logistics: How can the sustainability objectives be reconciled with fact that cold chain logistic is energy intensive process? Is it possible that India can fill its infrastructure gap whilst remaining competitive in the world markets? What are the required institutional frameworks to help integrate micro and small players into a modern logistic systems environment? The study tries to respond to these issues and provides a prospect to the policy planners, as well as the stakeholders in the industry.

By so doing, this case study will add to the existing research on supply chain resilience because it places light on an industry that remains underexplored in global management discussion but is essential to food security, livelihoods, and international trade. The story of the Indian seafood industry throughout the pandemic gives us valuable lessons in resilience, collaboration and transformation during a pinch.

## Background of the Indian Seafood Industry

India has also had considerable competitive advantage over seafood production having been rated among the first three fish producing nations in the world. India has an impressive coastline of 8,000 kilometers along the sea, a large inland waters area and favorable climatic conditions; conditions that facilitate a robust fisheries industry in India. Marine Products Export Development Authority (MPEDA) has experienced steady growth during the last 20 years in the export of seafood mainly because of the demand of farmed shrimp and value-added fish products. Prior to the pandemic, the industry exported a total of above 1.4 million metric tons of seafood that earns more than USD 6 billion of foreign exchange every year (MPEDA, 2021).

The supply chain of the Indian seafood is large and quite intricate. This starts with the coastal or inland aquaculture ponds where the fish and the shrimp are collected to the landing centers or collection points. The produce is either transported to large processing units or are pre-processed close to its source. The last step entails cold storage, packaging and quality check on their items and exportation, most often through main seaports such as Chennai, Visakhapatnam, Kochi, and Kolkata. Temperature control is a major parameter that determines the freshness of the product, the reduction of microbial contamination and matches the global safety standards of foods at every step.

Although India enjoys a global reputation, the Indian seafood industry has traditionally come up against a few systemic challenges. First, it has a large gap in possible production areas and cold chain infrastructures. A large number of aquaculture regions across Odisha, Andhra Pradesh and Tamil Nadu do not have sufficient cold storages or ice plants. Second, the industry is extremely fragmented since over 70 percent of industry activities are motivated by small-scale cluster manufacturers and informal laborers. Such actors are usually not able to access capitals, modernized facilities and institutional support.

The seafood industry is also highly stressed in terms of logistics. Refrigerated trucks are mainly spread in urban centers, which makes aquaculture regions in the rural areas underserved. Power stability, particularly in eastern and north eastern India, is also low, resulting in excessive use of diesel driven generator to keep refrigerated items in cold, which is very costly and not environmentally friendly. The quality risks are further threatened by manual handling practice and poor hygienic practices especially in small processing units.

Besides that, the path of the supply chain before the pandemic was mostly concentrated on exports, and they did not pay much attention to the development of the local market. Such reliance on foreign demand exposed the industry to international trade shocks, currency volatilities and flightiness of policies of importing countries. An example is the US anti-dumping tariffs and European Union strict quality checks which have in the past resulted in bottlenecks in the exports.

The modernization of the cold chain had been an industry analyst recommendation long before 2020. Nonetheless, the pandemic catalyzed the necessity to address it as its effects on profitability were linked not only to food security and rural job market demands. A lesson of the pandemic was also an alarm to invest in resilience, automation, and sustainability that can make the sector resilient against comparable global interruptions in the future.

This backdrop of prior frailty was the starting point where a bewilderingly extensive nest of upheavals in the course of COVID-19 would emerge as presented in the subsequent sections. However, it also led to a flood of innovations that are currently putting India in a position to revise its approach to its cold chain in the post-pandemic world.

## Pandemic-Induced Disruptions in Cold Chain Logistics

The COVID-19 pandemic caused a high magnitude of disruption in seafood logistics network in India. At the very time of national lockdown announcement in March 2020, the whole seafood value chain including coastal aquaculture ponds and export terminals were halted. Already in the first quarter, the level of exports decreased by more than 30 percent compared to the same period last year, and almost 70 percent of the small-scale exporters shared the experiences of spoilages caused by storage and transportation problems (Kumar et al., 2021).

The major constraint was related to mobility constraint. Movement between districts and among the states was strictly controlled and special permissions had to be taken, which most of the times were cumbersome to be issued. Truckers left the vehicles in the middle of the road either because they ran out of food and/or they feared contracting the disease. Trading was halted in the sea where fishing activity was stopped and the auction markets were closed as controls on crowd control were exercised. This resulted in huge backlogs at landing centers and there was no immediate cover with regard to temporary cold storage.

Power crisis turned out to be a serious concern because the workers who ran generators and refrigeration machines could not show up at the workplace. In most instances, the sea food products that were yet to be processed could not undergo proper preservation and either went to waste or were sold at distress rates. Big exporters such as Falcon Marine and Devi Seafoods experienced huge losses in terms of money since the international buyers mostly had just-in-time contracts with a short span of delivery deadlines.

Lack of reefer containers was another crunch situation. As international shipping companies repurposed their shipping containers on more lucrative shipping case or on other necessities such as prescription drugs and PPE, seafood exporters quickly came to the bottom of the shipping priority chain. Port also had to operate with very few people that resulted in ships clearing with shipping windows. The average wait time of seafood containers at Visakhapatnam Port increased by 2 days in the lockdown to over 5 days at peak since the wait before the pandemic took an average of 1.5 days.

These compounding disruptions underscored the fragility of India's cold chain infrastructure and the urgency to modernize it—not just for economic gain but for socio-economic resilience. The next sections detail how various stakeholders responded to this crisis, setting the stage for a more robust and future-ready supply chain model.

## Strategic Responses and Sectoral Adaptations

### Adoption of Digital Technologies

Several leading exporters adopted IoT-based monitoring systems for cold chain management. These systems allowed for real-time temperature tracking and predictive maintenance alerts. Cloud-based Enterprise Resource Planning (ERP) solutions facilitated remote management of inventory, billing, and shipment schedules. The use of mobile apps for fisherfolk to upload catch data and receive pricing updates also gained traction (Chandrakandan et al., 2022). These tools improved transparency and helped reduce spoilage due to better coordination between harvesting and processing units.

### Infrastructure Investments

Both public and private sectors-initiated investments in enhancing cold chain infrastructure. The Government of India, through the Pradhan Mantri Matsya Sampada Yojana (PMMSY), allocated Rs. 20,050 crores for strengthening fisheries infrastructure, including cold storage, ice plants, and refrigerated vehicles (MoFPI, 2020). Private players like Avanti Feeds Ltd., Falcon Marine, and Devi Seafoods began building decentralized mini-cold storage hubs closer to landing sites to reduce dependence on central facilities. These hubs, often powered by solar energy, provided temporary storage until transportation was arranged.

### Workforce and Process Resilience

Labor shortages forced companies to redesign operational workflows. Automation was introduced in grading and packing processes to reduce human dependency. To attract labor back, firms provided transport, housing, and COVID insurance. Training programs were launched for upskilling local workers in hygiene and cold chain handling. According to George and Prakash (2021), companies that retained part of their workforce through such incentives were able to restore normal operations quicker than those that did not.

### Case Focus: Avanti Feeds Ltd.

Avanti Feeds consists of one of the leading companies in the aquaculture industry in India; the company can be a good example of adaptive resilience in the context of the COVID-19 pandemic. The company is based in Hyderabad and is one of the largest manufacturers and exporters of the shrimp feed and processed shrimp that have a major presence in the United States, Japan, and European Union among others. When the pandemic started taking shape at the beginning of 2020, Avanti was one of the most affected companies by the global trade disruption, lockdown measures, and saturated logistics system. During the early days, the firm faced some serious challenges, which were eminent in terms of port congestion, escalating demurrage expenses on account of late clearances or late orders on exports translating to a key challenge of canceled export orders related to irregular delivery schedules. To it were added domestic disruptions: labor shortage arising out of reverse migration, stuck supply chains, and intermittent power to cold storage facilities, particularly in rural areas. These downturns stressed the vulnerability in the centralized processing systems.

Avanti made a strategic shift to a decentralized processing model establishing a number of relatively small-scale pre-processing units in places such as Odisha and Tamil Nadu. The regional hubs helped in becoming a center of aggregation and initial freezing facilities where it lessened the dependence on the main processing plant in Andhra Pradesh. The action curtailed not only logistics but also reduced the risk of transport where states were under lockdown.

The use of technology formed part of their recovery plan. Avanti deployed cloud-based inventory management and active update positioning of its cold chain and resources. This allowed them to monitor the reefer trucks and storage temperatures remotely which minimized spoilage and improved supply chain vision. In collaboration with ColdXpress, a cold chain logistics young company, the company has access to a specific fleet of reefer vehicles that were fitted with IoT devices, which raised immediate alerts over temperature fluctuations.

Furthermore, Avanti has overcome its labor crisis through what is known as semi-automated production lines, and crucial operations took place with minimum human presence. In a bid to protect the health of workers, the company introduced PPE distributions, conducted on-site inoculation programs, and developed zones of isolation in processing departments. The employees were also primed to train on COVID-appropriate behavior, which was presented in local languages, giving more emphasis to employee safety and adherence.

The resilience strategies paid off in terms of money. At the close of FY 202122, Avanti had achieved a 90 percent rebound of functional capacity and better supply schedules, and the consumers of the important foreign markets had developed higher customer confidence. Omitting several details indicating the sustainable profitability, it was pointed out in the Annual Report (2022) that the investments in technological innovations and decentralized infrastructure proved the company to experience the enhanced turnover of inventories, less wastage, and insignificant increases in profit margins despite the rough external environment.

The case of Avanti shows why decentralization, tech-enabled logistics, and the safety of the workforce should be regarded as the main elements of the supply chain strategy in the post-pandemic world. It presents an emulator example of other seafood exporters who move through analogous disruptions in unstable global trading.

## Government and Policy Support

The Indian government played a pivotal role in sustaining and revitalizing the seafood logistics and supply chain sector during and after the COVID-19 pandemic. Recognizing the severe disruptions caused by lockdowns, supply bottlenecks, and export constraints, a series of targeted policy interventions were introduced to ensure both short-term relief and long-term resilience.

One of the cornerstone initiatives was the Pradhan Mantri Matsya Sampada Yojana (PMMSY), under which financial support was extended to various nodes of the seafood supply chain. This included subsidies for cold chain equipment, refrigerated transport vehicles, and modern seafood processing units. These interventions were crucial in minimizing post-harvest losses and maintaining product quality during transit, especially for export-grade seafood.

To streamline export processes and improve port logistics, the Directorate General of Foreign Trade (DGFT) implemented the Turant Customs system. This digital initiative significantly reduced paperwork, enabled faceless assessments, and allowed faster clearances at major ports. For seafood exporters, this was a welcome shift that cut down bureaucratic delays and improved shipment turnaround times—critical in an industry where freshness is key (DGFT, 2021).

At the state level, many governments launched e-market platforms and digital marketplaces that connected local fisherfolk and aquaculture farmers directly with seafood processors and retailers. By facilitating direct transactions, these platforms helped eliminate exploitative middlemen, ensuring better price realization for primary producers and more consistent supply for processors. This move also marked a significant step toward formalizing the sector and increasing transparency in trade practices.

Furthermore, the Ministry of Food Processing Industries (MoFPI) extended the Production Linked Incentive (PLI) scheme to include seafood processing units. This policy shift aimed to attract investments into value-added processing—such as ready-to-eat seafood, IQF (Individually Quick Frozen) products, and packaged meals—which hold strong potential in global markets. By incentivizing domestic players to upgrade their infrastructure and adopt advanced processing technologies, the scheme positioned Indian seafood firms to compete more effectively on the international stage.

Despite these forward-looking measures, several implementation challenges hindered their full potential. Reports by scholars and industry observers (Ranjan & Dey, 2023) pointed to issues like uneven fund disbursement, bureaucratic delays in approvals, and a lack of clarity on eligibility criteria, which disproportionately affected smaller enterprises and fishermen's cooperatives in remote coastal regions. These inefficiencies created bottlenecks that undercut the intended benefits of the policy frameworks.

In response to these hurdles, stakeholder consultations involving industry associations, exporters, logistics companies, and policymakers highlighted the critical need for more robust public-private partnerships (PPPs). These partnerships are essential not only for infrastructure development—such as building integrated cold chains, inland depots, and quality testing labs—but also for skill development and digital literacy programs among coastal communities. A collaborative approach that leverages both state capacity and private sector expertise is seen as a sustainable pathway to modernizing India's seafood logistics ecosystem.

In conclusion, while government intervention was timely and largely effective in mitigating the immediate impacts of the

pandemic on the seafood sector, the long-term success of these initiatives depends on addressing implementation gaps, fostering transparency, and deepening stakeholder engagement. Continued investment in digital infrastructure, training, and last-mile connectivity will be vital to unlocking the full potential of India's seafood industry in the post-pandemic era.

## Analysis and Strategic Insights

The post-pandemic transition in the Indian seafood supply chain offers valuable insights for global supply chain resilience. The crisis functioned as a catalyst for innovation, decentralization, and sustainable practices.

**Tab 1.** Key Strategic Insights and Their Implications for Cold Chain Resilience in India's Seafood Supply Chain.

Theme	Insight	Strategic Benefit	Reference
7.1 Enhancing Agility and Flexibility	Decentralized storage and processing enabled firms to continue operations despite localized disruptions.	Improved supply continuity and export reliability.	-
7.2 Leveraging Technology	Adoption of IoT, blockchain, and digital procurement tools improved real-time cold chain monitoring and supplier connectivity.	Enabled predictive responses to disruptions and built consumer trust through traceability.	Kamble et al., 2021
7.3 Collaboration and Ecosystem Thinking	Partnerships with logistics startups and infrastructure-sharing reduced capital burden and streamlined operations.	Facilitated efficient scaling for SMEs and optimized resource use across the ecosystem.	-
7.4 Sustainability Integration	Shift towards green technologies like ammonia refrigeration and solar-powered cold storages aligned with environmental goals.	Enhanced long-term cost efficiency and alignment with global sustainability standards (e.g., SDGs).	Patel et al., 2022

## Ongoing Challenges

Even after making such significant strides because of government programs and other investments at different levels by the private sector, there are many challenges that persist with regard to the development of a truly resilient and integrated cold chain in seafood sector in India.

Fragmentation of logistics players, especially remote and rural coastal regions should be seen as one of the most important issues. This split of integration tends to cause inefficiency of coordination, failure to meet delivery time, and unstable maintenance of the cold chain. This is more compounded by lack of power reliability in numerous coastal belts making many more rely on diesel powered generators raising not only the cost of operation but also the carbon emission profile of the sector. These ineffectiveness leads to a reduction in the quality and freshness of seafood- which are very essential parameters in the domestic and export markets.

External risks faced by exporters also come in the form of fluctuation in international trade policies, freight rates and stricter food safety laws across the world. Shipments may be rejected or market trust lost and even fines imposed in some markets i.e. EU and USA, when non compliant.

When it comes to human resource, the need to build its capacity, especially in cold chain operation is urgent. Technical skills in refrigerating devices, quality control, traceability tools and data analysis are nonexistent. The unavailability of uniform training programmes also prevents expansion of best practices in the industry. This problem is more so creating havoc to SMEs who usually run on very limited technical personnel with minimum formal training facility.

The other issue concerning structure is the high rate of informal jobs. Most of the cold chain workers are not registered; they do not have access to social security, safety training, and legal protection. This is detrimental to the welfare of the workforce, and exposes the sector to labour disturbances. Among such efforts is regulation, particularly in terms of worker safety, good wages, and occupational standards that are important in the achievements of long-term sustainability and resilience in the sector.

## CONCLUSION

The COVID-19 pandemic disrupted, but also transformed, the Indian seafood cold chain logistics landscape. While the initial impact was severe, it provided a necessary jolt for modernization. The industry emerged more technologically equipped, decentralized, and sustainability-oriented. Companies like Avanti Feeds Ltd. demonstrated that a combination of digital integration, decentralized infrastructure, and proactive workforce strategies could build operational resilience even under extreme stress.

Looking ahead, the sector must institutionalize the gains made during the crisis by investing in skill development, strengthening public-private collaboration, and ensuring long-term policy support. With these measures, India's seafood supply chain can not only withstand future disruptions but also lead in sustainable global trade.

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