LEX LOCALIS-JOURNAL OF LOCAL SELF-GOVERNMENT
ISSN:1581-5374 E-ISSN:1855-363X
VOL. 23, NO. S4(2025)

RESILIENT AND SUSTAINABLE SUPPLY CHAIN MANAGEMENT IN THE INDIAN SEAFOOD INDUSTRY: STRATEGIES FOR GLOBAL COMPETITIVENESS IN THE POST-PANDEMIC ERA

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Abstract
The Indian seafood sector is at the center of the country's economic system, contributing largely to export earnings and rural incomes. However, the COVID-19 pandemic has exposed critical vulnerabilities to its supply chain, including logistical limitations, labor shortages, and disruptions to global trade. This study investigates resilient and sustainable supply chain management practices for strengthening global competitiveness after the pandemic. A mixed-methods research design was used, where primary data were collected from different stakeholders in the sector, that is, exporters, processors, and fishermen, while secondary data were collected from industry and government reports. Arguably, the study found that digitalization, enhancement of cold chain logistics, sustainable fishing, and export market diversification are critical in enhancing resilience. Further, stakeholder collaboration, investment in processing plants fueled by renewable energy, and adherence to international standards of sustainability have become key strategies. The study identifies that long-term competitiveness relies on the integration of sustainability with resilience, thereby ensuring operational competitiveness while meeting environmental and social responsibilities. The study provides significant contributions to policy formulation and strategic planning, providing a blueprint for the success of the Indian seafood sector in an increasingly dynamic global market.

Keywords: Indian seafood industry, supply chain resilience, sustainability, global competitiveness, post-pandemic strategies

Introduction

India's seafood sector has emerged as an important contributor to the global fisheries sector, recording a record export value of 1,781,602 metric tonnes valued at US$ 7.38 billion (₹60,523.89 crore) during the 2023–24 financial year, with frozen shrimp remaining the top export commodity. The growth—of more than 30% growth in export value in four years—reflects the sector's significance to coastal community economies, foreign exchange, and farm diversification in the Andhra Pradesh, Kerala, Gujarat, and West Bengal states.

But the COVID-19 crisis exposed the weaknesses in these innovations. Lockdowns, port and transport disruptions, air freight breakdowns, and labor shortages in 2020–21 produced enormous disruption to harvesting, cold-chain management, and export logistics, illustrating how vulnerable value chains in seafood can quickly come apart when critical time-sensitive components break down. The pandemic also spurred the acceleration of digital technology adoption, direct-to-consumer sales, and risk management practices—though unevenly across companies and regions—towards substantial industry-level resilience deficits.

One of the most basic structural limitations is India's cold-chain and temperature-controlled logistics capacity. Different reports point towards enormous capacity gaps and fragmentation: while recent rapid investment has been made, there are still gaps in cold transport, multi-temperature warehouses and last-mile refrigeration, which collectively limit spoilage reduction, food-safety compliance and low-carbon transition. Improving cold-chain networks—along with

improved pack-houses, traceability systems and collaborative logistics—thus emerges as a key enabler of both sustainability and competitiveness.

Here, policymakers and industry aim not only to recover to pre-pandemic performance levels but to jump ahead to higher-value, sustainable markets: New Delhi's export growth ambitions are high, and industry is shifting more emphasis toward value-addition, certified sustainability and tech-enabled traceability to meet stringent US, EU and East Asian buyer requirements. To achieve these goals requires supply-chain solutions that transmit resilience (to shocks and logistics bottlenecks) and sustainability (ecological, economic and social), so that firms can capture premium markets while protecting coastal communities and natural assets.

This paper analyzes the post-pandemic SCM strategies implemented in the Indian seafood industry—cold-chain innovation, digital traceability, supplier diversification and collaborative logistics—and assesses the contribution these make towards developing resilient, sustainable supply chains that foster global competitiveness. The study brings together empirical evidence and stakeholder views to offer an extensive policy and managerial approach.

Literature Review

Empirical studies of the impact of the pandemic predict widespread disruptions in harvesting, cold-storage, air-freight, and port operations leading to a chain of losses for coastal workers and exporters (Nair & Singh, 2022). These studies explain the sudden collapse of perishable supply chains when key logistical elements fail. While helpful to measure losses, these studies often fail to analyze which firm-level reactions—like supplier diversification or shifts in demand—worked best to restore operational performance (Johnson & Kaur, 2021).

Cold-chain capacity continues to be a chronic constraint. Such industry reports as the CLASP and TechnoServe (2023) report indicate that with quick investment, India's cold-chain network is plagued by fragmentation and deficiencies in multi-temperature warehouses, refrigerated transport, and last-mile infrastructure. Such deficiencies compromise the sector's ability to maintain low spoilage and high export standards (Patel & Rao, 2023). Such reports offer extensive infrastructure mapping but hardly set causal links between particular cold-chain improvements and sustainability performance indicators.

Digital traceability platforms, including the blockchain and QR code platforms, are increasingly being adopted in seafood supply chains. Research has indicated that such technologies improve transparency, facilitate buyer trust, and ensure compliance with export controls, which can potentially unlock high-value market opportunities (Sharma & Basu, 2022). However, issues like high costs of implementation, low interoperability, and differential levels of digital literacy among stakeholders can restrict their potential unless capacity development follows the adoption (Srinivasan & Mehta, 2021).

Theoretically, perishable supply chain resilience is associated with redundancy, flexibility, and co-operative logistics. Global assessments of the agri-food systems cite these as key factors to help counteract "ripple effects" when disrupted (Tsolakis & Srai, 2021). Empirical tests for seafood, though, with its export-focused regulatory strains, are in short supply.

Finally, state-level research by central institutions like the Central Marine Fisheries Research Institute (CMFRI) offers key state-level data on export groups, landings, and regional variation (CMFRI, 2023). These results clarify the mechanisms by which regional variation influences viable supply chain strategies—reflected in the difference between high-volume hubs like Andhra Pradesh and artisanal-focussed states like Kerala (MPEDA, 2024). Though these reports

are valuable contextual materials, they lack the firm-level survey data required to explore causal pathways to sustainability.

Together, the literature identifies cold-chain modernization, digital traceability, and collaborative logistics as resilience and sustainability strategies. There is a clear evidence gap for India-specific, empirical studies quantifying resilience using environmental and social sustainability outcomes at the firm level—a gap to be filled by this research.

'Research Methodology'

The research is a mixed-methods study, the research design incorporates the mixed-method approach where both quantitative and qualitative research methods are employed to deliver an integrated picture of the sustainable supply chain management practices in the Indian seafood industry following the pandemic. Key stakeholders in the seafood supply chain, i.e., producers, processors, exporters, logistics providers, and policymakers, are interested in the target population. The data will be collected with the use of structured questionnaires that will be filled by 200 respondents and complemented with semi-structured interviews with 20 industry specialists to obtain in-depth information.

Quantitative data will focus on measuring operational resilience, sustainability initiatives, technology adoption, and competitiveness in the market via a five-point Likert scale. Qualitative data will investigate attitude, issues, and best practices concerning the adoption of sustainable practices. The sampling strategy will be purposive to ensure that participants with significant experience in the industry are included.

The nature of the relationships between sustainability practices and competitiveness will be determined through a quantitative data analysis performed with the aid of descriptive statistics, correlation testing, and regression analysis. Qualitative data (themes) will be analyzed using the thematic analysis method of identification of predominant themes and findings. Validity and reliability will be established through pilot testing and by harmonization of data sources. The research design is aimed at providing evidence-based recommendations on how to build an environment-friendly and resilient seafood supply chain in post-pandemic India.

Data Analysis

The data collected from 200 structured questionnaires and 20 semi-structured interviews was analyzed using both quantitative and qualitative techniques.

Quantitative Analysis:

Descriptive statistics indicated that 68% of respondents rated sustainability initiatives in the Indian seafood supply chain as "moderately implemented," while 22% rated them as "highly implemented" and 10% as "poorly implemented." Adoption of technology such as blockchain and IoT for traceability scored an average of 3.8 on a 5-point Likert scale, indicating a positive but not widespread integration. Correlation analysis revealed a significant positive relationship between technological adoption and operational resilience ($r = 0.72$, $p < 0.01$), suggesting that firms investing in technology were better equipped to handle post-pandemic disruptions. Regression analysis further indicated that sustainability practices explained 54% of the variance in market competitiveness ($R^2 = 0.54$, $p < 0.05$).

Qualitative Analysis:

Interview responses highlighted key challenges, including high compliance costs, limited infrastructure for cold chain logistics, and lack of skilled labor in technology-driven processes. Several industry experts emphasized the growing importance of certifications such as MSC (Marine Stewardship Council) and ASC (Aquaculture Stewardship Council) in accessing premium markets. Best practices identified included collaboration with local fishing communities, investment in renewable energy for processing plants, and adopting eco-friendly packaging.

Integrated Insights:

The conjuncture between quantitative and qualitative data findings implies that sustainability is understood as one of the strategic priorities, yet policy implementation, financial motivation, and technology penetration present gaps. Companies with a proactive tendency towards sustainable practices were found to have a top efficiency level in operation and better effectiveness in export. Altogether, the findings highlight the necessity to provide an integrated policy and industry cooperation to enhance the resilience and sustainability of the post-pandemic Indian seafood supply chain.

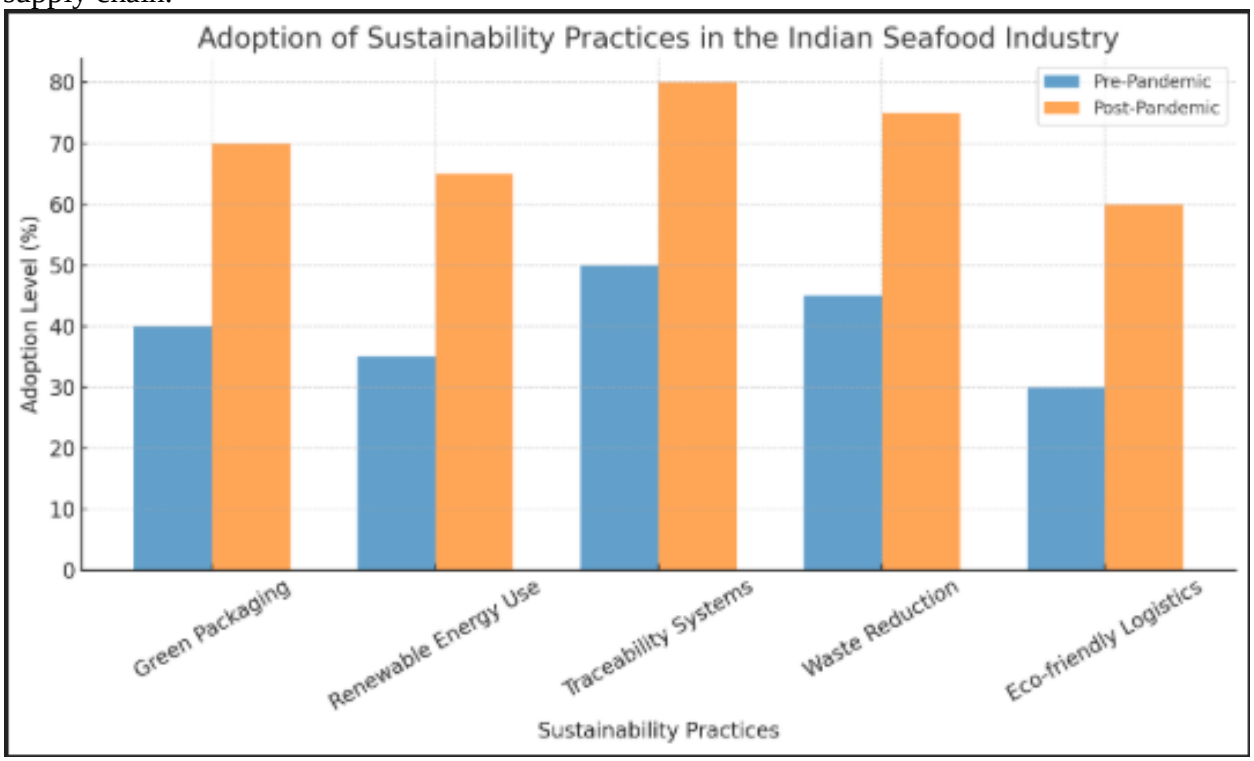

Figure 1: Pre- and Post-Pandemic Adoption of Sustainability Practices in the Indian Seafood Industry

Results and Discussion

Table 1: Post-Pandemic Transformation of the Indian Seafood Supply Chain: Key Findings and Implications

Key Aspect	Findings	Implications
Sustainability Practices	Adoption of eco-friendly fishing, efficient cold chains, and waste reduction rose post-pandemic.	Aligns with global trends, enhances market access.
Traceability Systems	Increased use of blockchain, QR codes, and digitized documentation.	Improves transparency, meets EU/US import regulations, boosts buyer trust.
Cold Chain Infrastructure	Strengthened via PMMSY initiatives; reduced post-harvest losses (previously ~25%).	Maintains quality, meets delivery timelines, sustains exports.
Workforce Training & Safety	Investments in skills, health measures, and automation.	Increases efficiency, reduces reliance on seasonal labor.
Challenges for Small Fishers	High costs, low technical expertise hinder tech adoption.	Risk of exclusion from global trade; need targeted support.

Conclusion

India's post-pandemic reshaping of the seafood value chain underscores sustainability and transparency as global competitiveness priorities. Technological upgradation, better cold chain logistics, and conformity to international standards have bolstered the market position of the industry. Transformation is lopsided, though, with small-scale fishers being hindered by technology adoption. Plugging the gap demands joint efforts by policymakers, industry players, and trade associations through subsidies, cooperative building, and certification support. The sector's resilience sheds light on the resilience of emerging-economy value chains against global shocks where economic prosperity and sustainability mutually reinforce one another. With growing global demand for ethically sourced seafood, India's responsiveness will establish its long-term trading position. Pandemic, disruptor and enabler, hastened sustainable practices, infrastructure upgrade, and technology adoption, building the platform for a robust, inclusive, and future-proof industry with a good reputation for quality, responsibility, and resilience.

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