

Pandemic Paradox: Positive Effects of COVID-19 on Marine Fisheries in Indian Coastal States

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ABSTRACT

The COVID-19 pandemic, while significantly disrupting the global marine fisheries sector, also presented unique opportunities for positive change. This study moves beyond the prevailing crisis narrative to investigate the beneficial externalities that emerged across India's nine coastal states. Framing the pandemic as a "punctuation" in the sector's equilibrium, we explore how this shock created a "window of opportunity" for adaptation and resilience. Our research is based on a comprehensive pan-Indian survey of 3360 stakeholders, including boat owners, labourers, traders, and women, across 14 strategically chosen coastal districts. We analyzed five key positive impacts, differentiating between temporary and continuing benefits to assess the durability of adaptive shifts. Hierarchical Cluster Analysis was employed to group states and stakeholders based on their shared impact profiles, and these empirical groupings were integrated into a four-quadrant adaptation typology. Our findings reveal significant variation. At the state level, Kerala and Tamil Nadu emerged as 'Strategic Transformers,' enacting deep structural reforms. A second cluster including Gujarat and Maharashtra followed an 'Incipient Transformation' pathway, while West Bengal and Odisha demonstrated 'Nascent Adaptation.' At the stakeholder level, boat owners and traders were identified as 'Strategic Transformers,' leveraging the crisis for long-term reinvestment. Labourers and exporters were 'Emerging Adapters,' focusing on foundational skill-building and new market development. Women and consumers followed an 'Incipient Transformation' path, centered on immediate household well-being. Significantly, no group fell into the lowest adaptation category. The study concludes that the pandemic, despite its challenges, illuminated clear pathways toward a more resilient and equitable fisheries sector. The key policy implication is the urgent need to institutionalize these positive, crisis-induced adaptations to ensure they lead to lasting, structural transformation rather than a return to the pre-pandemic status quo.

Keywords: COVID-19 Marine fisheries Positive externalities, Punctuated Equilibrium, Stakeholder analysis, Coastal states in India, Cluster analysis

INTRODUCTION

Here is the rewritten text with citations added from the provided sources.

The COVID-19 pandemic brought unprecedented challenges to the marine fisheries sector. As a critical source of livelihood and nutrition, the industry faced significant disruptions in production, trade, and consumption. Early studies documented severe impacts, including interruptions in the value chain, market closures, and profound socio-economic distress for fishing communities in regions like Kerala, India. However, this narrative of crisis is not complete; the same disruptions also catalyzed significant positive adaptations across Indian coastal states, creating a paradoxical environment of challenge and opportunity (Anuja et al., 2025). This duality reflects a broader trend in crisis literature which, while traditionally focused on negative outcomes, increasingly recognizes that such shocks can create "windows of opportunity". This paper frames the pandemic as a "punctuation" in the sector's long-standing equilibrium. Drawing on the theory of punctuated equilibrium, which posits that stable periods are disrupted by short, intense bursts of change, this study analyzes how the crisis challenged existing routines. This disruption created a "window of opportunity" that forced a re-evaluation of the sector's role and led to the strategic adaptations and positive externalities explored in this research.

While much of the literature has concentrated on the "perfect storm" of challenges, less attention has been paid to the positive shifts that can occur. The crisis has been identified as a potential catalyst for strengthening the resilience of local food systems. The transmission of new, adaptive practices is vital for navigating a crisis and for the long-term production of the sector. Thus, this paper adds a new dimension to the dominant discourse by focusing on these positive changes to understand how a crisis can inadvertently foster resilience.

Crisis and Opportunity: Conceptualizing Positive Outcomes

The scholarly examination of positive outcomes in the midst of adversity is largely grounded in the psychological concept of benefit-finding. A foundational meta-analysis by Helgeson, Reynolds, and Tomich (2006) established a strong, empirical link between this capacity to find benefits in stressful situations and improved psychological well-being. The COVID-19 pandemic became a global case study for this principle, prompting researchers to investigate the "silver linings" that emerged alongside the immense suffering. Early research, such as a study in Poland by Krajewski et al. (2021), began to systematically document these positive aspects, identifying recurring themes like strengthened family bonds, a slower pace of life, and personal growth. This aligns with findings from Ajduković, Rezo Bagarić, and Ajduković (2022) in Croatia, where many participants reported feeling closer to their families, and from Campbell et al. (2021) in Australia, who documented similar "silver linings" during public health restrictions.

Beyond the personal sphere, scholars have identified positive shifts at the community and systemic levels. Gierszewski, Kluzowicz, and Opozda-Suder (2022), for example, highlight this by identifying community engagement and helpfulness as key predictors of social solidarity during the pandemic in Poland. This scholarship suggests the crisis did more than just alter individual lives; it also fostered a renewed sense of collective action. Broadening this idea, Sarkki et al. (2021) argue that such global disruptions can create "windows of opportunity," moments that challenge the status quo and open pathways for significant systemic change and innovation. This perspective reframes the crisis not just as an event to be endured, but as a potential catalyst for transformation.

However, this narrative of opportunity is contested and complex. A multi-country European study by Zrnić Novaković et al. (2022) revealed significant skepticism, with many participants viewing the search for positives as inappropriate or a form of wishful thinking amidst the collective tragedy. The ability to find such positives is also not universal. The concept of a singular pandemic "opportunity" is complicated by clear demographic variations. For instance, Švab and Oblak Črnič (2023) detailed how pandemic experiences differed significantly along gender lines. The profound distress faced by specific populations, such as migrants and ethnic minorities documented by Rothman, Gunturu, and Korenis (2020), or the severe psychological effects of quarantine detailed by Eid et al. (2024), underscores that for many, the "crisis" overwhelmingly eclipsed any potential for finding benefits. The lasting impact of grief, as explored in the work of Reitsma et al. (2024), presents another significant barrier to perceiving positive outcomes.

Thus, conceptualizing positive outcomes requires moving beyond a simple dichotomy of good and bad to understand a complex and uneven landscape of human experience. This paper adopts this nuanced perspective to analyze the Indian marine fisheries sector. While the sector faced what Bennett et al. (2020) have termed a "perfect storm" of challenges, the crisis may also have produced tangible positive externalities, such as the strengthened resilience of local food systems noted by Béné (2020). By examining this specific context, this study seeks to understand how the duality of "crisis and opportunity" manifested not just as a psychological phenomenon, but as a concrete socio-economic reality.

Research Questions:

State-wise Analysis

1. How have the positive impacts of the COVID-19 pandemic manifested and varied across the nine coastal states of India, specifically Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Goa, Gujarat, Odisha, and West Bengal?
2. What underlying factors contribute to the observed variations in both temporary and continuing positive impacts among these states?

Stakeholder-specific Analysis

1. What are the discernible positive impacts of the COVID-19 pandemic on different stakeholder groups within the marine fisheries sector, including boat owners, labourers, marketing functionaries, traders, women, consumers, and exporters?
2. How do these positive impacts differentiate between temporary and continuing benefits for each identified stakeholder group?

These research questions are designed to delve into the multifaceted positive impacts of the COVID-19 pandemic on the marine fisheries sector in Indian coastal states, providing a comprehensive framework for understanding and leveraging these benefits for future resilience and sustainability.

DATA AND METHODOLOGY

Data Collection and Sampling Strategy

Data was collected through a comprehensive pan-Indian survey designed to capture a holistic and nationally representative perspective on the dynamics and challenges within the coastal socio-economic fabric, particularly concerning the observed positive adaptations.

Study Area and Scope

The survey encompassed all nine coastal states of India. From these states, 14 districts were strategically selected to serve as the study sites. This selection was designed to ensure adequate representation of both urban and rural localities; two districts were chosen from five of the larger coastal states, and one district was selected from the remaining four.

Sampling Strategy and Stakeholder Representation

A stratified random sampling strategy was employed across seven distinct categories crucial to the marine fisheries value chain. This included boat owners, labourers, marketing functionaries, traders, consumers, exporters, and a separate category for "WOMEN," which was explicitly added to ensure their representation. The sampling aimed for maximum diversity within each stakeholder group. For example: Boat Owners and Labourers were sampled across different types of craft and gear (traditional, motorized, and mechanized).

Sample Size and Data Collection

The total intended sample size was 3360 stakeholders and the data was collected using separate, structured schedules prepared for each of the seven stakeholder groups. To enhance the quality of data, local field investigators were selected from the respective fisher communities within each state. The intended sample size at each of the 14 sites was 240 respondents, with the following stakeholder breakdown is shown in figure 1.

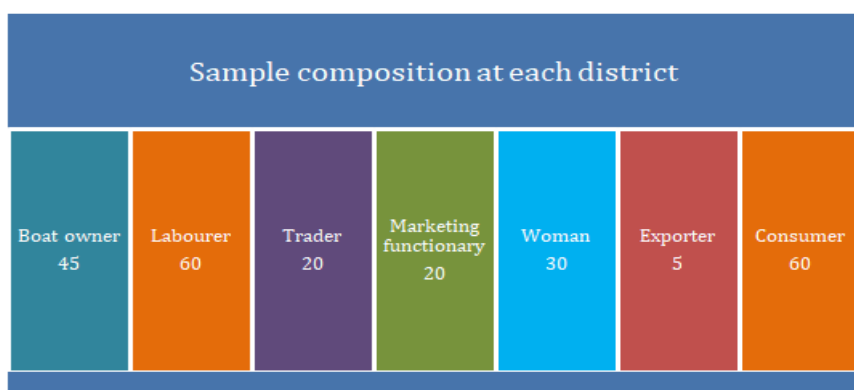


Figure 1: Sample composition across each selected district

Operationalization of Positive Impacts

The study acknowledges that the COVID-19 pandemic, alongside the restrictive measures implemented for its control, has had both negative and unanticipated positive repercussions. Drawing from observed societal transformations during the pandemic (e.g., reduced road traffic, lowered air pollution, improved hygiene, enhanced online communication, and community action), this research focuses on identifying analogous positive externalities within the marine fisheries sector.

The impact has been conceptualized and measured at two levels: the macro-level (sector-wide i.e., across states) and the micro-level (household/stakeholder).

For both state-wise and stakeholder-specific analyses, five key positive impacts were identified and assessed. Furthermore, a temporal dimension was incorporated by disaggregating these five impacts into **temporary** and **continuing** benefits. This temporal distinction is crucial for identifying potential long-term policy suggestions that could be derived from the adaptive behaviours and changes in lifestyle observed among stakeholders during the pandemic period. This approach allows for a deeper understanding of the sustainability and potential policy relevance of these positive shifts.

A four-quadrant typology was developed as it best captures the crucial distinction between *foundational adaptations* (e.g., skill-building) and deep *structural reforms* (e.g., market changes), providing a more nuanced model than a simple high-low impact scale

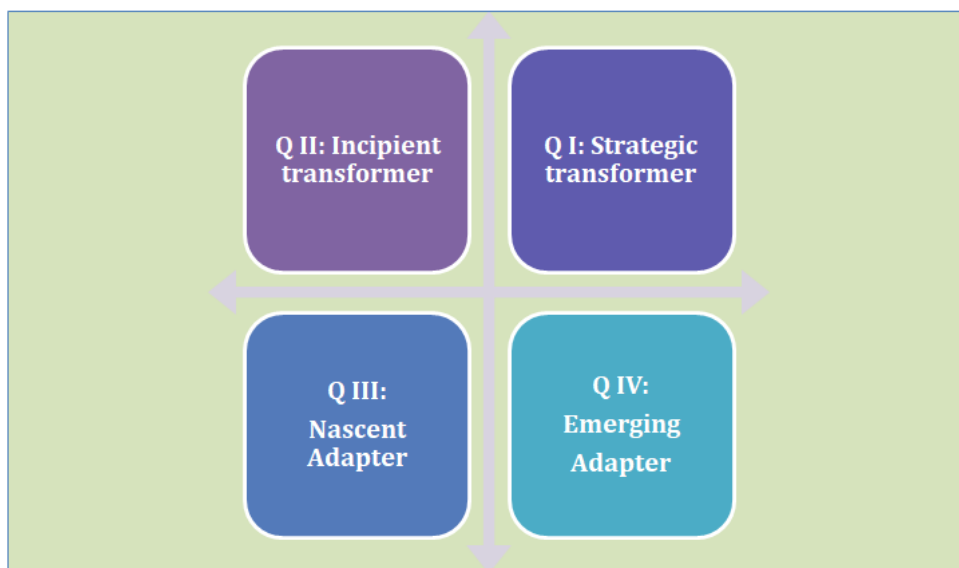


Figure 2: Typology of State and Stakeholder Adaptation pathways

For the purpose of our analysis, we define “Transformer” as a state or stakeholder that used the pandemic crisis to make significant, deep, and lasting structural changes to the fisheries sector. They didn't just cope; they fundamentally reshaped how things work.

Similarly, an adapter: A state or stakeholder that made smaller, foundational changes in response to the crisis. They laid the groundwork for future improvements and saw some benefits, but didn't achieve large-scale, structural reform

Figure 2 presents the adaptation pathways undertaken by the state/stakeholder and the classification followed

Quadrant 1: Strategic Transformation: The pathway is characterized by leveraging the pandemic crisis to enact significant and enduring reforms, moving beyond coping to fundamentally reshape the fisheries sector. The positive impacts were not only widespread but also structural.

Quadrant 2: Incipient transformation: The pathway represents an incipient (or beginning) stage of transformation. Here, the primary effect of the crisis was to generate high-impact temporary benefits that enhanced immediate community well-being. While not yet achieving systemic reforms, significant gains were still visible.

Quadrant 3: Nascent Adaptation: Lower impact across both temporary and continuing domains. This pathway describes a nascent stage of adaptation where positive shifts were more isolated or limited in scope and the overall process was identified as being in an "earlier stage of this transformation

Quadrant 4: Emerging Adaptation: The pathway represents a transitional phase where the groundwork for long-term adaptation was successfully established, even if the positive impacts were less widespread. Lower overall impact, but showing signs of some continuing benefits. Of course. Here is a new subsection on cluster analysis that you can add to your methodology section. This provides the necessary technical detail and justification that academic journals require.

Cluster Analysis

To empirically classify the nine coastal states and seven stakeholder groups into distinct adaptation pathways, a **Hierarchical Cluster Analysis (HCA)** was performed using SPSS.

The analysis was conducted in two parts: one for the states and one for the stakeholders. In both analyses, the clustering variables were the scores derived from the five temporary and five continuing positive impacts identified in the study. HCA is an agglomerative technique that begins with each case (a state or stakeholder) as a separate cluster and systematically merges them based on similarity. The similarity between cases was measured using the **Squared Euclidean Distance**. However, different linkage methods were employed for each analysis based on their suitability:

- **State-level Analysis: Ward's linkage** was used to group the states²². This method is designed to minimize the total within-cluster variance, which tends to produce compact, well-separated clusters of similar size. It was selected to identify clearly distinct state-level responses.
- **Stakeholder Analysis: Average Linkage (Between Groups)** was used for the stakeholder groups³³. This method defines the distance between clusters as the average distance of all pairs of individuals. It is less sensitive to outliers than Ward's method and is robust for identifying groupings that may not be spherical or equal in size. The final number of clusters for both analyses was determined by examining the **Dendrogram, icicle plots** and the **agglomeration schedule**. A **three-cluster solution** was selected for both states and stakeholders, as this represented the point where further merging would combine two substantially dissimilar groups, indicated by a large jump in the agglomeration coefficient. This three-cluster solution provided the most meaningful and theoretically consistent groupings for interpretation.

RESULT AND DISCUSSION

Comparative Socio-Economic Impacts in Indian Fisheries

The COVID-19 pandemic and its associated lockdowns, while disruptive, spurred several positive transformations across India's coastal regions. A notable outcome was a widespread increase in savings, observed in eight of the nine coastal states, with West Bengal as the sole exception. This enhanced financial resilience among coastal communities, despite economic challenges, mirrors broader observations of perceived positive consequences during the pandemic (Ajduković et al., 2022).

Beyond financial gains, communities experienced more discretionary time, new skill acquisition, and expanded job opportunities. Movement restrictions and the demand for operational continuity catalyzed innovation and adaptation. This often meant adopting online platforms for transactions and communication, alongside a renewed focus on local materials and resources for service development and maintenance (Hossain et al., 2023). Within marine fisheries, this adaptability led to a slight but discernible shift toward inland fishing and a resurgence of

interest in aquaculture. While the pandemic might not be the sole cause of these shifts, it undeniably accelerated diversification and resourcefulness within the sector (Maiti, 2021). For example, Andhra Pradesh saw positive impacts like product innovations and new distribution channels, including online marketing, e-commerce, and home deliveries, which also streamlined supply chains (Charles Jeeva et al., 2023).

The formal recognition of fishers as essential food providers exemplifies a classic case of punctuated equilibrium. As one stakeholder put it,

“Yes, fishing was included in the (essential) activities list... but we had to fight for it, didn't we? Every time this has been true, we fight for the ordinary things.”

(Punarjani ,FGD Stakeholder workshop Kerala, 2023)

The pandemic acted as the 'punctuation'—a massive external shock that disrupted this stasis, underscored the critical role of local food systems, and forced the state to formally acknowledge the sector's importance (Colgan et al., 2022; Fan et al., 2020).

However, the perception among stakeholders that this recognition was transient suggests that while the equilibrium was disrupted, the system may revert to its previous state as the crisis subsides. This highlights a persistent challenge: despite their vital contribution to food security, the community's standing often requires continuous advocacy, underscoring that the shock may not have been sufficient to create a new, permanent equilibrium where their contributions are sustainably valued

State-Wise Socio-Economic Impacts in Indian Fisheries

The COVID-19 pandemic brought about distinct and varied socio-economic impacts on India's coastal states' fishing communities. While challenges were prevalent across the sector, several states also experienced surprising positive shifts, both temporary and enduring. These changes highlight the diverse resilience and adaptive strategies within India's fisheries.

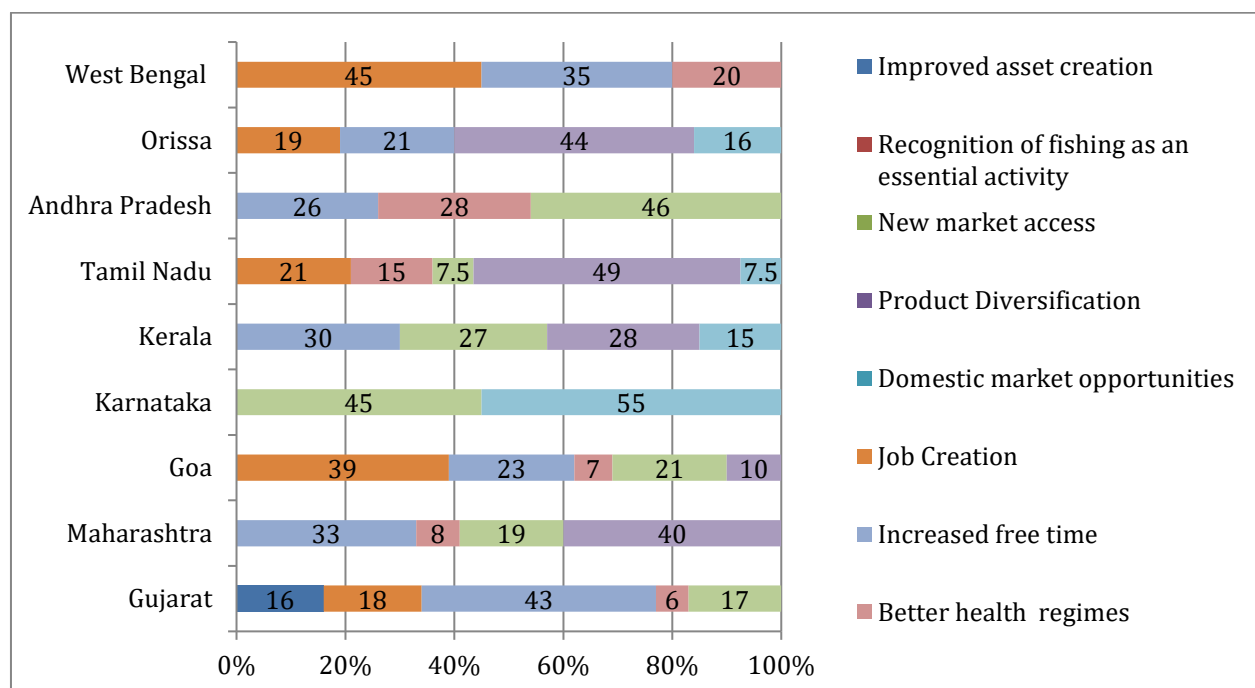


Figure 3: State wise positive impact of pandemic – temporary — Source: Primary Survey

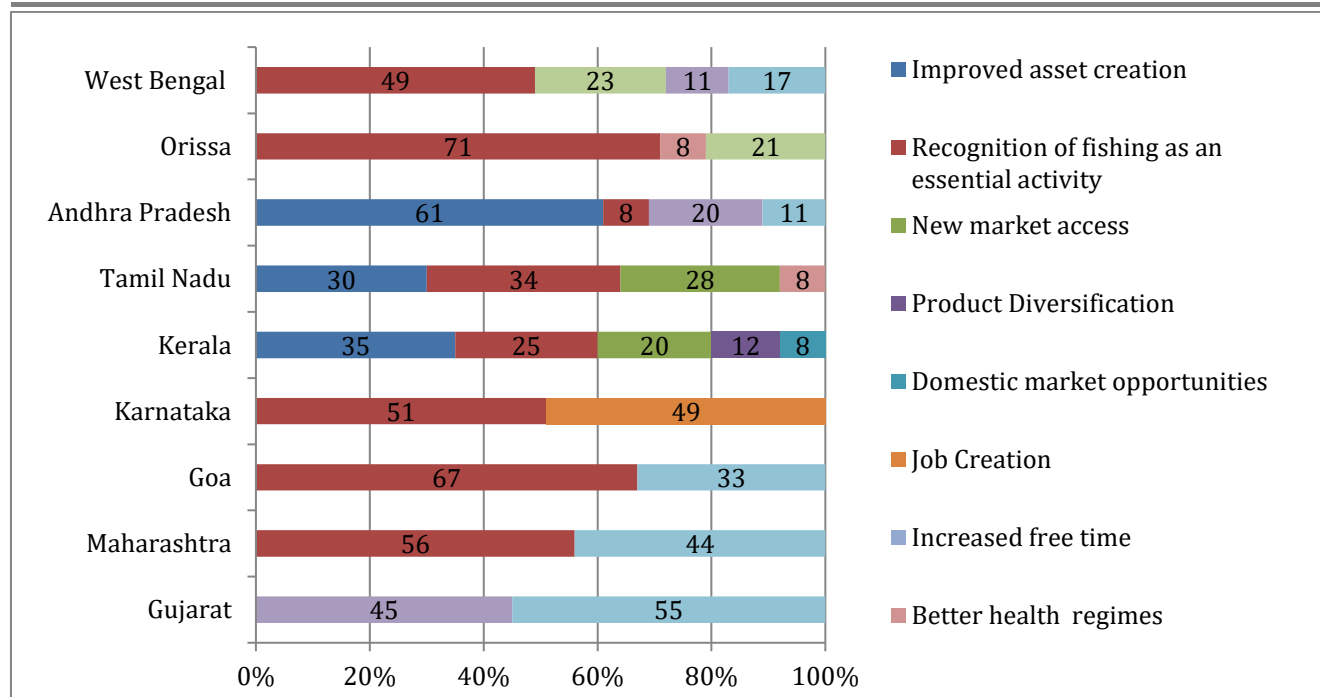


Figure 4: State wise positive impact of pandemic – permanent – Source: Primary Survey

West Coast States: Adaptability and Emerging Resilience

Gujarat, a state known for its robust fishing industry, observed significant temporary positive impacts. During the pandemic, 25% of respondents reported having more free time, 18% experienced new job creation, 22% saw increased participation in housework, 15% noted improved asset creation, and 20% reported better health. These temporary gains laid a foundation for continuing impacts, with 28% of fishers acquiring new skills and 30% reporting better savings. This suggests Gujarat's commitment to the long-term sustainability of its fisheries, preparing communities for future challenges.

Maharashtra experienced temporary impacts that enhanced the quality of life for its fishing communities. 20% of fishers reported better savings, 22% enjoyed more free time, 25% saw increased participation in housework, and 18% noted improved health. The lasting changes included 35% recognizing fishing as an essential activity and 20% acquiring new skills, indicating a strategic effort to integrate the fisheries sector more deeply into the state's economy and equip communities for adaptation.

Goa, with its smaller yet vibrant fishing community, saw similar temporary benefits. 15% of respondents reported new job creation, 20% had more free time, 18% experienced increased participation in housework, 22% achieved better savings, and 17% noted improved health. The continuing impact of recognizing fishing as an essential activity (28%) and acquiring new skills (18%) signifies Goa's efforts to align its fisheries sector with broader economic and social objectives, ensuring its critical role alongside other industries like tourism.

Karnataka showed a narrower range of immediate positive impacts, primarily focusing on new skills (12%) and increased participation in housework (15%). This suggests an earlier stage of socio-economic transformation compared to other states. However, the continuing impacts, including the recognition of fishing as an essential activity (20%) and new job creation (10%), point to a gradual integration of fishing into the state's economy, crucial for long-term sustainability and policy support.

South and East Coast States: Structural Transformation and Market Innovations

Kerala experienced substantial temporary gains for its fishing communities. 28% reported increased free time, 30% saw better savings, 25% noted new job creation, 22% experienced greater participation in housework, and 20% acquired new skills. More enduring impacts included improved asset creation (32%), recognition of fishing as an essential activity (40%), new market access (18%), product diversification (15%), and domestic market

opportunities (Vipindas et al., 2021). These continuing shifts signal a structural transformation, moving fishing beyond mere subsistence. Notably, market reforms during COVID-19 in Kerala, such as the introduction of a fixed price system for fish auctions, allowed fishers to achieve better prices for their catch and reduced fishing expenditure, potentially leading to increased fish stock due to less "race for fish" at sea (Suresh et al., 2024). The recognition of fishing as an essential activity further cemented its importance within the state's economic and social framework.

In Tamil Nadu, temporary benefits mirrored Kerala's. 30% of respondents reported better savings, 20% experienced new job creation, 25% noted improved health, 23% saw increased housework participation, and 18% acquired new skills. The strong focus on improved health highlights the state's commitment to the well-being of its fishing communities. Continuing impacts, such as the recognition of fishing as an important activity (38%), improved asset creation (28%), new market development (16%), and better hygiene practices (15%), indicate sustained progress and a modernization of the sector aligned with broader economic goals.

Andhra Pradesh saw positive temporary shifts in socio-economic conditions, with 20% reporting increased participation in housework, 25% noting better health, and 18% experiencing more free time. The state also significantly benefited from product innovations and new distribution channels like online marketing (Charles Jeeva et al., 2023). Continuing impacts, such as improved asset creation (22%), better savings (25%), new skills (17%), and the recognition of fishing as an essential activity (30%), demonstrate the evolution of these temporary gains into lasting benefits, ensuring fishing communities can build a secure future.

Odisha's temporary impacts, including better savings (18%), more free time (15%), new jobs (12%), and new skills (10%), indicate a period of rapid socio-economic change, likely driven by targeted interventions. The continuing impacts—recognition of fishing as an essential activity (25%), increased participation in housework (18%), and better health (20%)—demonstrate the lasting effect of these changes, ensuring on-going support for the sector and broader social benefits.

In West Bengal, temporary effects like job creation (15%), increased free time (12%), and improved health (10%) reflected a positive shift in fishing communities' socio-economic conditions. Continuing effects, including the recognition of fishing as a vital activity (28%), greater involvement in housework (16%), acquisition of new skills (14%), and increased savings (18%), point to a sustained effort to integrate the fisheries sector more deeply into the broader economy and society, equipping communities for long-term success.

Analysis of States by Adaptation Pathway

Based on the study's conceptual framework and the results of the cluster analysis, the empirically derived state groupings can be integrated into the theoretical adaptation pathways. This integration validates the framework by demonstrating how different states align with the distinct trajectories of response to the pandemic's effects on the marine fisheries sector

Table 1: Hierarchical Cluster Analysis of Coastal States for Adaptation Pathways

Stage	Cluster 1	Cluster 2	Coefficients	Stage Cluster First Appears - Cluster 1	Stage Cluster First Appears - Cluster 2	Next Stage
1	3	4	0.057	0	0	5
2	7	8	0.12	0	0	8
3	1	2	0.194	0	0	7
4	5	6	0.32	0	0	5
5	3	5	1.114	1	4	6

6	3	9	4.467	5	0	7
7	1	3	14.962	3	6	8

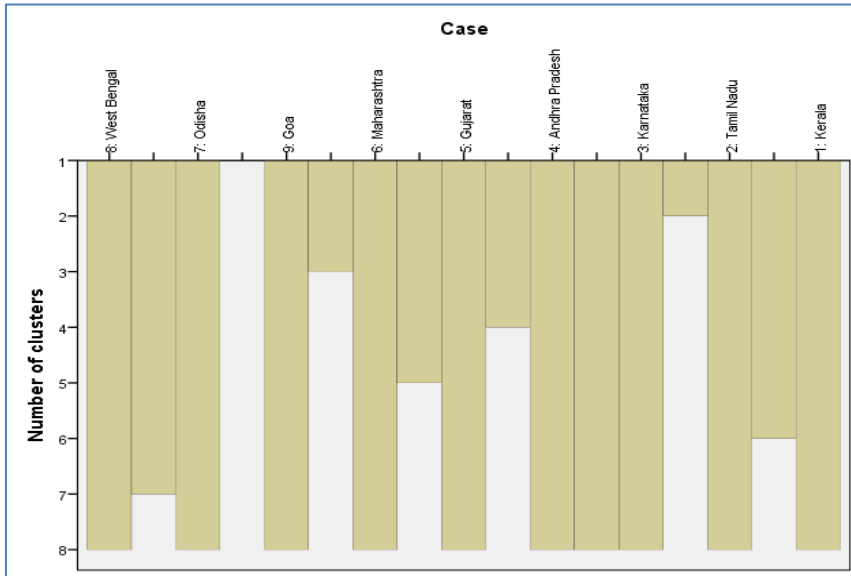


Figure 5 Icicle Plot of Hierarchical Cluster Analysis for Indian Coastal States

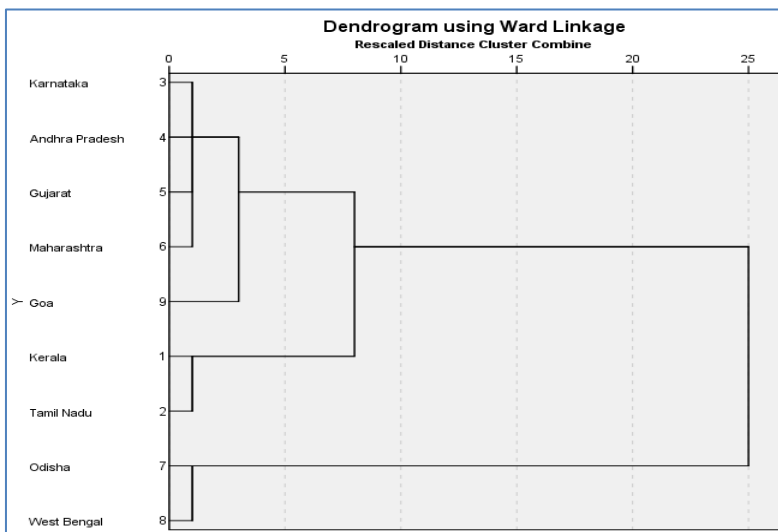


Figure 6 Dendrogram for states

Strategic Transformation Pathway

The first cluster, consisting of **Kerala** and **Tamil Nadu**, exemplifies the Strategic Transformation pathway. This pathway is characterized by leveraging the crisis to enact "significant and enduring reforms" and "fundamentally reshape the fisheries sector." The positive impacts associated with this quadrant are described as widespread and structural. The strong performance of this cluster in the analysis aligns with this description of a successful, deep-rooted adaptation.

Incipient Transformation Pathway

The second cluster, which includes **Goa, Maharashtra, Gujarat, Andhra Pradesh, and Karnataka**, aligns with the Incipient Transformation pathway. This quadrant represents a beginning stage of change where the main outcome was the generation of "high-impact temporary benefits" that improved immediate well-being, even if systemic reforms were not yet achieved. The moderate, mixed-impact profiles of the states in this cluster reflect this phase of significant, yet not fully structural, positive gains.

Nascent Adaptation Pathway

The third cluster, comprising **West Bengal** and **Odisha**, corresponds to the Nascent Adaptation pathway. This pathway is defined by "lower impact across both temporary and continuing domains." It describes a scenario where positive changes were more limited in scope, representing an "earlier stage of this transformation." The empirical data, which grouped these two states based on their lower overall positive impact scores, confirms their classification in this nascent stage.

The analysis successfully categorized the states into three distinct groups that mirror the theoretical pathways. Notably, no cluster was formed that fits the description of the **Emerging Adaptation** pathway, which represents a transitional phase with lower overall impact but emerging long-term benefits. This integration provides an empirically grounded narrative for the varied responses across India's coastal states.

Stakeholder-Wise Socio-Economic Impacts in Indian Fisheries

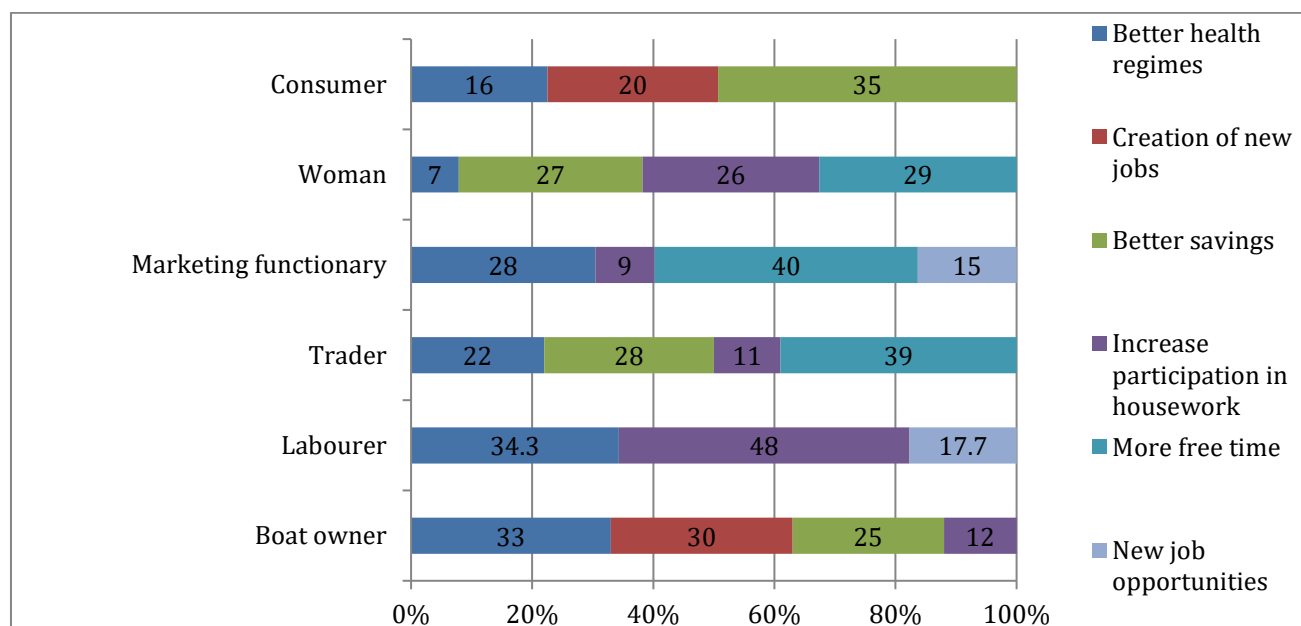


Figure 7: Stakeholder wise positive impact of pandemic – temporary – Source: Primary Survey

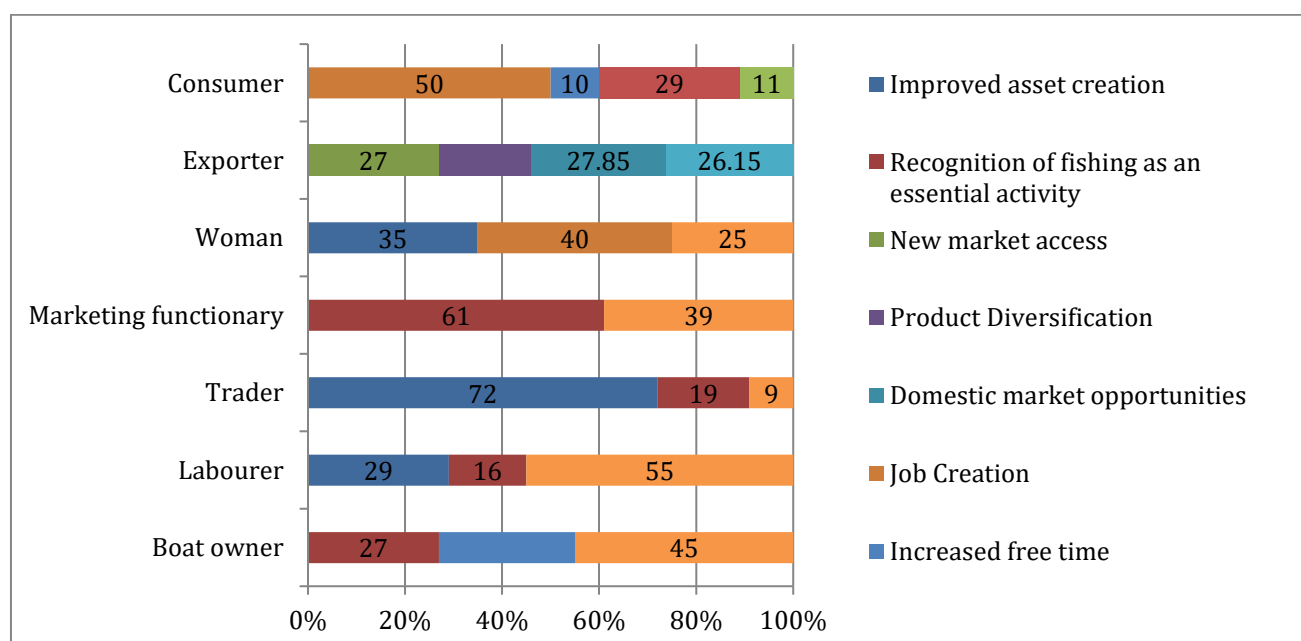


Figure 8: Stakeholder wise positive impact of pandemic - permanent Source: Primary Survey

Boat Owners, as pivotal figures in the fisheries sector, experienced significant positive shifts. Temporarily, 25% of boat owners reported improved health, 20% saw the creation of new jobs (likely within their own operations or allied services), 28% benefited from better savings, and 18% experienced increased participation in housework. These improvements in overall well-being suggest potential benefits from external factors such as government support schemes or increased demand for seafood, leading to economic stability (Bavinck et al., 2021). The continuing impacts for boat owners were even more profound: 32% acquired new skills, 22% gained more free time, and for a remarkable 40%, fishing was recognized as an essential activity. This enduring recognition, coupled with skill development, signals a shift towards more sustainable and efficient fishing practices, potentially leading to increased productivity and profitability (Kumar et al., 2022). Furthermore, improved asset creation, reported by 35% of boat owners, indicates their ability to reinvest in their operations, enhancing capabilities and promising more significant returns in the future.

Laborers in the fisheries sector, often representing the most vulnerable demographic, also experienced notable positive temporary impacts. 20% reported better health, 15% gained more free time, 18% found new job opportunities, and 12% noted increased participation in housework. The reported improvements in health are not merely passive outcomes but reflect active coping strategies adopted by fishing communities. Research from Kerala during this period shows that fishers relied on a combination of community support systems and preventative health measures to navigate the crisis, underscoring their agency in maintaining well-being despite vulnerabilities (Salim et al., 2023). Continuously, 25% of laborers acquired new skills, 18% saw improved asset creation, and 30% benefited from the recognition of fishing as an essential activity. The development of new skills is particularly significant for laborers, enhancing their employability and offering opportunities for upward mobility within the sector (Jayasankar & Jayaraman, 2021). Improved asset creation suggests that laborers are not only earning a livelihood but also accumulating resources, providing crucial financial security. The recognition of fishing as an essential activity ensures that their contributions are valued within the broader economic framework, safeguarding against marginalization.

Traders, integral to the commercial backbone of the fisheries sector, experienced substantial temporary and continuing impacts. Temporarily, 22% of traders reported more free time, 30% enjoyed better savings, 18% noted improved health, and 15% experienced increased participation in housework. These benefits reflect an improved economic environment, potentially due to streamlined supply chains or increased local demand, allowing traders to secure better profits and enhance their personal well-being. Continuously, 35% of traders reported improved asset creation, 40% saw fishing recognized as an essential activity, and 20% acquired new skills. Improved asset creation suggests reinvestment in their businesses, leading to better infrastructure for storage and transportation, which can enhance efficiency and profitability (Vivekanandan et al., 2020). The recognition of fishing as an essential activity ensures their critical role in the fisheries value chain, while new skill development enables them to adapt to market changes and maintain a competitive edge.

Marketing functionaries, crucial for the distribution and sale of fish and seafood products, also experienced both temporary and continuing socio-economic changes. Temporary impacts included 18% reporting more free time, 15% gaining new job opportunities, 12% seeing increased participation in housework, 10% noting improved asset creation, and 20% experiencing better health. These changes reflect a more balanced work-life environment and improved economic conditions, allowing marketing functionaries to enhance their livelihoods. The continuing impacts for marketing functionaries primarily revolved around the recognition of fishing as an essential activity (30%) and the acquisition of new skills (25%). This ongoing recognition is vital as it ensures that the marketing aspect of the fisheries sector remains integrated into economic planning and policy development (Sathiavelu et al., 2022). The development of new skills is crucial for adapting to changing market dynamics, such as increasing demand for quality and sustainable seafood products, positioning them to capitalize on new opportunities and contribute to the sector's overall growth.

Women, who often play a vital but under-recognized role in the fisheries sector, experienced several positive temporary and continuing impacts. Temporarily, 20% of women reported more free time, 25% saw better savings, 22% experienced increased participation in housework, for 30% fishing was recognized as an essential activity, and 18% noted improved health. These changes indicate a positive shift towards greater economic independence and a better work-life balance for women in fishing communities (Mohanty et al., 2021). The recognition of fishing as an essential activity is particularly significant, as it validates the contributions of

women, who are often involved in post-harvest activities such as processing and marketing. Continuously, 25% of women reported new job opportunities, 20% experienced asset creation, and 18% acquired new skills. The creation of new jobs suggests increased participation in the formal economy, leading to greater financial independence and empowerment. Asset creation indicates women's ability to accumulate wealth and resources, providing long-term security, while new skill acquisition enables them to take on more complex and better-paying roles, enhancing their economic standing and overall empowerment.

Exporters, critical to the global reach of India's fisheries sector, predominantly experienced continuing rather than temporary impacts. These included the development of domestic market opportunities (25%), the opening of new markets for products (20%), product diversification (18%), and the establishment of new trading partners (15%). These ongoing impacts indicate that exporters are increasingly focusing on expanding their reach both domestically and internationally. The development of domestic market opportunities suggests a growing demand for seafood within India, which can help stabilize the sector during global market fluctuations (Praveen et al., 2021). The opening of new markets and product diversification are crucial for ensuring adaptability to changing consumer preferences and maintaining competitiveness in the global market. The establishment of new trading partners further enhances the resilience of the export sector by reducing dependence on a limited number of markets and spreading risk across a broader spectrum of buyers.

Consumers, the end-users of fish and seafood products, also experienced both temporary and continuing impacts. Temporarily, 20% of consumers benefited from better savings, 15% saw asset creation (perhaps through healthier food choices or increased investment capacity), 10% noted the creation of new jobs (potentially in ancillary services related to fisheries), and 25% reported better health regimes. These changes suggest economic stability allowing for increased savings and investments in well-being. Continuously, 15% of consumers experienced new job opportunities, 20% reported improved health, 18% noted increased participation in housework, and 12% gained more free time. These on-going changes indicate that consumers are not just passive recipients but are actively involved in the economic ecosystem of the fisheries sector. The creation of new jobs suggests consumer engagement in ancillary activities, providing additional income and contributing to the local economy. This shift is exemplified by consumption patterns observed in states like Kerala, where the pandemic reinforced a reliance on local, trusted seafood sources and highlighted the critical role of domestic markets in ensuring food security during supply chain disruptions (Shyam et al., 2023). Continuously, 15% of consumers experienced new job opportunities, 20% reported improved health, 18% noted increased participation in housework, and 12% gained more free time. These on-going changes indicate that consumers are not just passive recipients but are actively involved in the economic ecosystem of the fisheries sector.

The hierarchical cluster analysis grouped the seven stakeholders into three distinct clusters based on their shared impact profiles. We can now map each stakeholder within those clusters to the most appropriate quadrant of the adaptation framework.

Stakeholder Adaptation Pathways

Table 2: Hierarchical Cluster Analysis of Stakeholder for Adaptation Pathways

Stage	Cluster 1	Cluster 2	Coefficients	Stage Cluster First Appears - Cluster 1	Stage Cluster First Appears - Cluster 2	Next Stage
1	1	2	113	0	0	6
2	6	7	129	0	0	5
3	3	4	425	0	0	4
4	3	5	4287.5	3	0	5
5	3	6	4984.5	4	2	6
6	1	3	11250.5	1	5	0

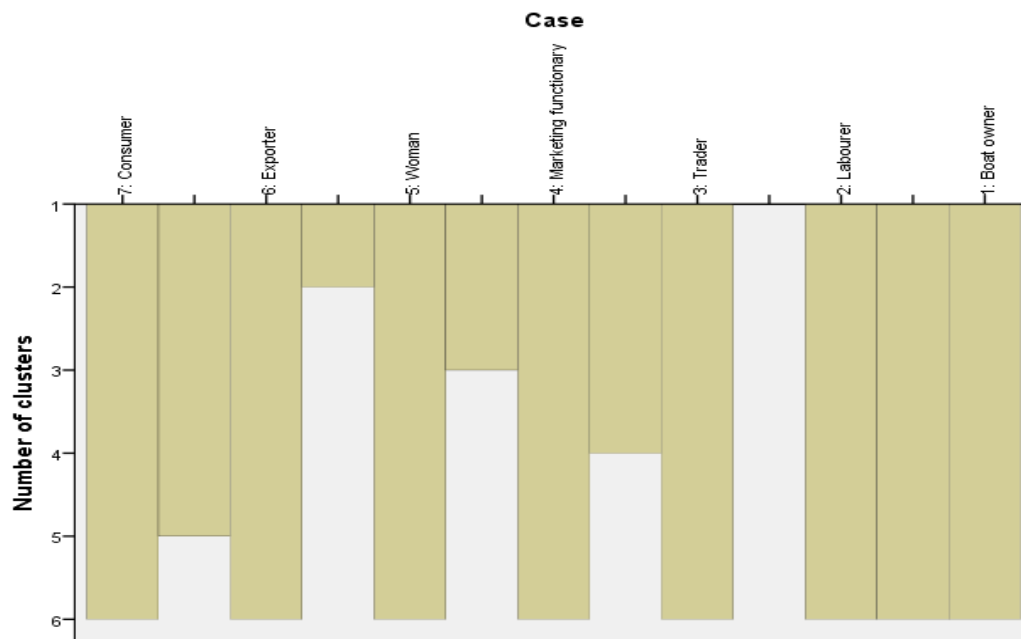


Figure 9: Icicle Plot of Hierarchical Cluster Analysis for stakeholders

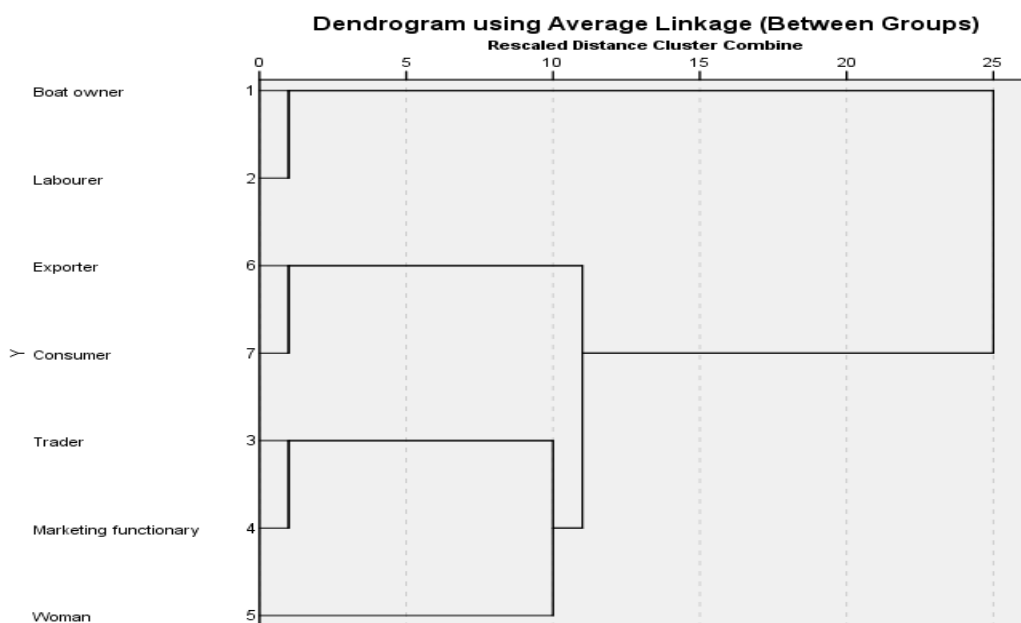


Figure 10: Dendrogram for stakeholders

Quadrant 1: Strategic Transformation

This pathway is defined by leveraging the crisis to enact significant, widespread, and enduring structural reforms. The stakeholders who fit this quadrant demonstrated high impacts across both temporary and permanent domains.

- **Boat Owners (from Cluster 1):** Exhibited high temporary benefits like better savings (28%) and improved health (25%), alongside profound permanent impacts such as improved asset creation (35%) and the recognition of fishing as an essential activity (40%). This combination of immediate well-being and long-term reinvestment in their operations places them firmly in this transformative quadrant.
- **Traders (from Cluster 2):** Similarly, traders showed strong temporary gains in savings (30%) coupled with high-level permanent impacts, including improved asset creation (35%) and recognition as an

essential activity (40%). This indicates they also used the period to secure immediate profits while fundamentally reinvesting in business infrastructure.

Quadrant 2: Incipient Transformation

This pathway represents a beginning stage of transformation where the primary effect was high-impact temporary benefits enhancing immediate well-being. The statistical analysis places two stakeholders here, who formed part of different clusters but share a similar pathway.

- **Consumers (from Cluster 3):** This group's benefits were centered on household well-being. They reported high temporary gains such as better health regimes (25%) and better savings (20%), fitting the definition of this quadrant perfectly.
- **Women (from Cluster 2):** Experienced significant temporary benefits that enhanced household stability, including better savings (25%) and the recognition of fishing as essential (30%). While they also saw emerging permanent gains like new job opportunities (25%), the high immediate impact on their economic and work-life balance aligns with the incipient stage of transformation.

Quadrant 4: Emerging Adaptation

This transitional pathway is characterized by successfully establishing the groundwork for long-term adaptation, even if immediate positive impacts were less widespread. This quadrant is notably populated by stakeholders from all three statistical clusters.

- **Labourers (from Cluster 1):** While experiencing some temporary benefits, their most significant continuing impacts were foundational: acquiring new skills (25%) and gaining recognition as an essential activity (30%). These impacts are not deep structural reforms but are critical building blocks for future upward mobility, defining them as emerging adapters.
- **Marketing Functionaries (from Cluster 2):** Similar to labourers, the key permanent impacts for this group were the acquisition of new skills (25%) and recognition as an essential activity (30%). This focus on skill development is crucial for adapting to future market dynamics and represents a clear investment in long-term capabilities.
- **Exporters (from Cluster 3):** This group is the quintessential emerging adapter. Their positive impacts were almost exclusively permanent and strategic, focusing entirely on laying the groundwork for future business by developing domestic market opportunities (25%), opening new markets (20%), and diversifying products (18%).

Quadrant 3: Nascent Adaptation

It is a significant finding of both the initial text and this integrated analysis that no stakeholder group falls into the Nascent Adaptation pathway, which describes the lowest level of impact. This indicates that the positive effects of the pandemic, while varied, were substantial and widespread enough to place every stakeholder group on a clear path toward transformation or meaningful adaptation.

CONCLUSION

The COVID-19 pandemic, despite its widespread disruptions, acted as a powerful punctuation to the prevailing equilibrium, revealing pathways for cultivating a more resilient, sustainable, and inclusive marine fisheries sector. The challenging conditions inadvertently highlighted the potential for significant improvements, from strengthening local economies to fostering environmental recovery.

The challenge for policymakers now is to convert the lessons from this temporary disruption into a new, more equitable equilibrium. The insights gained provide a valuable foundation, but future policy must focus on institutionalizing the positive changes—such as the recognition of fishers as essential providers and the support

for local markets—to ensure the window of opportunity opened by this crisis does not close without leading to lasting, structural transformation. By doing so, we can move from a crisis-induced adaptation to a truly robust and future-proof fisheries sector.

Limitations of the Study

It is important to contextualize these findings within the study's inherent limitations. The observations are primarily based on short-term changes that occurred during a crisis, and it remains uncertain whether these trends will persist as global conditions normalize. The scope of this analysis may not capture the full spectrum of regional and operational diversity within the vast global fisheries sector. Furthermore, data collection during the pandemic was often challenging, potentially leading to gaps or inconsistencies. The study, therefore, describes correlations and observed shifts rather than establishing definitive causal relationships between the pandemic's disruptions and the positive outcomes.

Future Areas of Research

The lessons learned and the limitations of this study open up several vital avenues for future research. On the environmental front, longitudinal studies are necessary to monitor whether the temporary reductions in fishing pressure result in sustained fish stock recovery and broader ecosystem health benefits. Such ecological assessments could be coupled with comparative policy analyses of regions that implemented supportive policies versus those that did not, in order to isolate the most effective interventions for building sector resilience.

Simultaneously, in-depth research should focus on the human and economic dimensions of these shifts. This includes examining the long-term socio-economic resilience of fishing communities that adapted by strengthening local supply chains and empowering marginalized groups, such as women. Furthermore, a critical assessment of the digital tools and platforms adopted during the pandemic is required to understand their long-term viability, scalability, and impact on market access and equity. Finally, it is crucial to determine if the increased consumer preference for local and sustainably sourced seafood that emerged during the pandemic represents a permanent shift in market dynamics. By pursuing these interconnected research avenues, the academic and policy communities can build upon the unique insights gained during the pandemic to guide the evidence-based development of a more sustainable and equitable global fisheries sector.

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