An Empirical Analysis on Marine Fishing industry with special reference to Deep-Sea Fishing

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Abstract

In fact, fishing dates back over 10,000 years. The significance of fishing is well articulated in history books. Even today, this profession provides a livelihood for around 16 million fishers. India plays an important role in fish exports. In 2021-22, India was ranked as the third-largest producer of fish, with the production touching 16.24 million tonnes. This sector contributes a significant percentage to the GDP (Gross Domestic Product) and foreign exchange. Coastal fisheries resources are slowly depleting and the governments are pushing the fishers to extend their fishing activities into the EEZ (Exclusive Economic Zone) and high seas with the aim of tapping deep-sea fisheries resources for ensuring a continuous supply of protein-rich food for

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the country and for export. By pushing the coastal fishers into deep-sea fishing, the country's first line of defence can be ensured besides reducing fishing pressure in the coastal belts.

The objectives of the study include the challenges faced by fishers in the deep sea and devising a model for deep-sea fishing. From the pilot study it is understood that switching to deep sea fishing has many challenges, like developing a suitable vessel design, implementation of a vessel monitoring system, disturbed fish catch market, different fishing techniques, multi-day vessel operation and skilled workforce requirements besides adapting to the latest technological developments. These challenges are to be tackled by different stakeholders to ensure a smooth adaption of deep-sea fishing among the fishers. The scope of the study covers the fishers from 5 fishing harbours on the Coromandel, Gulf of Mannar and the Arabian Sea coast from Tamilnadu. Primary data were collected by using a questionnaire and unstructured interviews. Six challenges on deep-sea fishing were identified and rank correlation was employed to analyse the relationship among the challenges and thus measures to overcome the challenges were identified. The conclusion of the study may bring out a deep-sea fishing model to overcome the challenges and the model can serve as a template for developing deep sea fishing.

Keywords: *Deep-sea fishers, Challenges in deep-sea fishing, ocean navigation, vessel design, skill development for fishers, deep-sea fishing model.*

Introduction

India's fish production in 2021-22 reached 162.487 lakh tonnes, with 41.27 lakh tonnes coming from marine sources, accounting for 8% of the world's fish production. This industry not only provides the country with nutrient-rich food but also supports the livelihoods and employment of many fishers. However, the International Labour Organisation (ILO) considers fishing to be one of the most hazardous and dangerous occupations, as fishers venture into coastal waters and beyond to hunt various fishes using different types of crafts.

The majority of fishers work in traditional coastal fishing, passing down knowledge and skills from generation to generation. However, as coastal resources deplete, the government is encouraging deep-sea fishing as an alternative. This transition presents numerous challenges, including financial implications, as deep-sea fishing requires fishers to stay at sea for multiple days, face unpredictable weather conditions, and operate vessels with different techniques and capacities. Coastal fishing vessels are not equipped for multi-day operations, lacking the necessary facilities and capacities. In contrast, deep-sea fishing vessels require higher capacities for fuel, fresh water, provisions, and fish storage, as well as skilled fishers capable of operating the vessel in international waters and complying with maritime regulations.

The transition to deep-sea fishing will also impact the market supply chain, posing further challenges for fishers. To address these issues, stakeholders must work together to introduce modern electronic equipment, train fishers in communication, navigation, and vessel operations, and establish vessel monitoring systems for better fisheries management and search and rescue operations at sea.

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This study aims to analyze the capabilities and challenges of fishers in deep-sea fishing and propose a business model solution for the development of deep-sea fishing.

Literature survey

Coastal fisheries in India are facing significant challenges due to depleted fisheries resources caused by biological and economic overfishing, resulting in economic and food losses for the country (Stobutzki et al., 2006). As a result, governments have been encouraging the conversion of coastal trawlers into deep-sea long liners and gillnetters to exploit untapped fisheries resources in the Indian Ocean, including the Andaman and Nicobar waters, which have remained untapped due to a lack of capacity and weak forward and backward linkages (Das, 2017).

Deep-sea fishing is considered one of the most dangerous jobs, with a high risk of longer work duration and fatigue (Schilling, 1971). Heavy weather is one of the factors that increases the probability and consequences of navigational accidents, especially along the international trade route on the southwest coast of India, where appropriate Vessel Traffic Management Systems (VTMS) are lacking (Atacan & Ozan, 2023). This uncertainty of navigational accidents and damage to fishing gears during deep-sea fishing operations necessitates insurance coverage for deep-sea fishing vessels and the implementation of vessel traffic management systems (Stobutzki et al., 2006). Additionally, weather downtime during the monsoon season presents a new challenge to the fishing industry, requiring the development of more suitable fishing vessels capable of withstanding heavy weather during this time (Yaakob & Chau, 2007).

Modern electronic equipment, such as GPS (Global Positioning System), is commonly used for navigation during long-duration fishing voyages, making sailing safer and more efficient (Akhilesh et al., 2011). The Indian Space Research Organization (ISRO) has developed NavIC (Navigation in Indian Constellation) messaging service, which provides communication for sending weather warnings, high wave alerts, and Potential Fisheries Zones (PFZ) to fishers in their local language on their mobile phones, as well as Distress Alert Transmitters (DAT) for sending distress messages from vessels to the shore through Indian satellites (C. Viswanathan, 2021). The design of fishing vessels' bridges should allow skippers to watch echo sounders and chart plotters simultaneously, as they are often busy shooting and hauling nets rather than keeping a lookout for other vessels (Findlay, 2006). Additionally, vessel design should consider stability issues such as broaching, reduction of righting arm, and parametric rolling (Cross, 2018).

The development of the deep-sea fishing industry is likely to bring sudden changes in the sustainability of fisheries resources, and a high fishing power may cause a sharp reduction in resources (Perez et al., 2000). Multiday shark-targeted fishing using over 65ft long boats is being carried out on the southwest coast of India, with fishing voyages extending up to 30 days (Akhilesh et al., 2011). Fishers must have sufficient knowledge of fishing techniques, such as the behavior of small pelagic fish based on lunar cycles, to ensure successful fishing operations (Paschen, 2013).

Simulator-based training should be provided to fishers to improve their skills in handling fishing gears, vessel maneuvering, safe operation of fishing craft, and communication (Paschen, 2013). Fatigue is a risk to safety on fishing vessels, and proper training and monitoring are essential to prevent accidents caused by fatigue (Høvdanum & Jensen, 2014). Communication and cultural barriers can lead to fatal accidents and loss of lives at sea. The shortage of fisher crew has led to deep-sea fishing vessels being manned with multi-cultured crews, which may lead to cultural and communication-based problems

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onboard vessels (Rehman, 2007). Language proficiency affects safety onboard, and training in maritime English is essential for effective communication with other vessels (Thorvaldsen & Sønvisen, 2014).

Vessel Monitoring Systems (VMS) should be established to effectively supervise the fishing behavior of fishing vessels and assist in search and rescue operations (Nur & Suranto, 2021). Strengthening training for operators and better use of technology and equipment can improve the safe communication abilities of fishing vessels operating at high seas (Li et al., 2020).

Methods and methodology

The study utilized a qualitative research methodology and applied rank correlation for analysis. Data were collected using a stratified random sampling method and a structured interview schedule, as well as unstructured interviews with fishers. A total of 52 fishing vessel drivers from geographically diverse fishing zones in Tamil Nadu were randomly selected for data collection. The fishing harbours included Chennai (10) and Nagappatinam (12) on the Coromandel Coast, Tharuvaikulam (10) in Gulf of Mannar Coast, and Thengappainam (10) and Colachel (10) on the Malabar Coast. The data was analyzed with six important traits such as ocean navigation, vessel operation, navigational knowledge, vessel design, fishing techniques, and handling modern electronic equipment. The researcher wants to identify whether there exists a close correlation between these six traits. From the study and statistical results, it is very evident that there is a close correlation between the six parameters selected for the study. Rank correlation has been used to find out the relation between the parameters.

Findings and Discussion

The relationships between the variables were determined using rank correlation for the six tasks of deep-sea fishing in 5 zones in Tamilnadu. The results are outlined in the following table.

Table 1.1

Correlation Coefficients for Deep-Sea Fishing Tasks

Tasks	*Task*	*Rank Correlation*	*R*
Ocean Navigation	T1	T1-T2	0.70
Vessel Operation	T2	T2-T3	0.45
Navigational Knowledge	T3	T3-T1	0.83
Vessel Design	T4	T4-T5	0.75
Deep-sea Fishing Techniques	T5	T5-T6	0.30
Modern Electronic Equipment	T6	T4-T6	0.80

Ocean navigation and Vessel operation

Ocean navigation is a crucial task for any vessel venturing into the sea. It involves determining the vessel's position, calculating distance traveled, distance remaining to the destination, and estimating the time of arrival. Modern electronic equipment aids in making navigational decisions to avoid collisions and maintain watch-keeping at sea (Omar, Zobidah et al., 2011). Table 1.1 shows a high positive rank correlation (0.70) between ocean navigation and vessel operation. Deep-sea fishers develop operational skills through their own experience, which also contributes to their navigational abilities. However, this limits their skills to their exposure at sea, leading to a lack of specific skills needed during critical times. Effective decision-making and weather prediction are essential for efficient navigation at sea. Satellite-based ocean state forecast services, such as Navigation with Indian Constellation (NavIC) and GAGAN

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Enabled Mariner's Instrument for Navigation and Information (GEMINI), provide support for onboard decision-making for fishing vessels operating far from shore (Balakrishnan Nair et al., 2023). Poor knowledge and usage of these systems can leave fishers vulnerable to adverse weather conditions, as seen during the Ockhi cyclone in 2017. Therefore, it is crucial to equip vessels with modern electronic equipment to support decision-making at sea and to train the workforce in handling this equipment and developing specific skills for critical situations.

Vessel operation and Navigational knowledge

The responsibility of vessel operation lies with the skipper, who maximizes profit by efficiently managing time, human resources, and vessel operation to minimize fuel consumption and damages. Quick decisions on vessel movements and navigation ensure safe maneuvering in various sea conditions with minimal fuel usage. Ocean vessel operation presents numerous challenges, and fishers develop operational and navigational skills through experience. Table 1.1 indicates a moderate positive correlation (0.45) between vessel operation and navigational knowledge, suggesting that classroom training may contribute more to navigational knowledge development than operational skills. The absence of structured navigational training allows individuals with poor educational backgrounds to enter the marine fishing industry, leading to a perception of inferiority. The study reveals that the average education level of fishers is at or below middle school completion (S. Viswanathan, 2023). Vessels are equipped with VHF radios for external communication, with a limited range of about 20nm, and satellite phones are sparingly used due to their higher cost.

Navigational Knowledge and Ocean Navigation

The skilled and capable workforce is a crucial factor in the survival of the fishing industry. Fishers must be physically and mentally fit, as well as capable of enduring long periods at sea for deep-sea fishing. An analysis shows that fishers have a high level of navigational knowledge, which is positively correlated (0.83) with ocean navigation. Despite lacking formal education in navigation, their practical experience at sea enhances their navigational knowledge. Some fishers have never attended school, yet they are able to embark on longer fishing trips at sea. Their knowledge of navigational regulations is below average due to the absence of structured education, but they are able to gain navigational knowledge through their own experiences. However, the current level of skilled training for fishers is insufficient to enhance their knowledge. Despite this, they are able to avoid collisions with other vessels due to their vessel's maneuverability and practical knowledge. A more structured training program would further enhance the navigational knowledge of fishers and improve their ocean navigational abilities.

Vessel Design and Deep-sea fishing techniques

The design of a fishing vessel is crucial for its ability to effectively carry out various fishing techniques at sea. It must be able to withstand different weather conditions, utilize the appropriate fishing methods, store fish catches for extended periods, display correct navigational signals day and night, communicate with shore during routine and emergency situations, and have sufficient spares for emergency repairs. This study shows a strong positive correlation (0.75) between vessel design and fishing technique. In Tamilnadu, fishers use boats over 50 ft long for deep-sea fishing, employing long line and gillnet fishing and traveling up to 2000 nm in the Indian Ocean. These vessels are equipped with necessary engine spares and fire extinguishers for emergencies during their extended time at sea. Efficient fish storage systems are essential for long trips, with crushed ice commonly used to preserve the quality of the fish catch. However, modern refrigeration or slurry ice machines are uncommon among fishers. Many vessels do not have the necessary facilities to display day and night signals as required by collision

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regulations. A well-constructed vessel capable of doing sustainable fishing and displaying proper navigational signals will enhance the safety of fishing at sea.

Deep-sea fishing techniques and Modern electronic equipment

Although gillnets and longlines are commonly used fishing methods among deep-sea fishers, trawlers are also used in areas where the depths are less. Fishers depart from the port with confidence that they will return with a good catch. They rely on their own experience, sea surface temperature, the color of the sea, and the moon's phase to find fish. Gillnet fishers use sea surface temperature to find fish, while other fishers look for fish in heavy traffic areas. They change their fishing method when the yield is low, based on the available fishing facilities on their vessels. This study shows a weak positive correlation (0.30) between deep-sea fishing techniques and modern electronic equipment. This may be because fishers still rely on traditional methods of finding fish at sea. In addition to traditional methods, modern equipment such as SONAR and drone cameras could be used more effectively for accurate fish finding and to reduce fuel consumption by not searching for fish aimlessly.

Modern electronic equipment and Vessel design

The technology industry includes the fishing industry, where modern electronic equipment is used for decision making in various tasks such as navigation, communication, fish finding, weather monitoring, and vessel tracking. GPS, AIS, and electronic charts are commonly used for vessel navigation, while echo sounder and AIS are used for fish finding and net tracking. A study shows a high positive correlation (0.80) between modern electronic equipment and vessel design, indicating that new vessel constructions rely heavily on these technologies. However, radar is not popular among fishers, with AIS being preferred for collision avoidance. VHF radio is commonly used for communication, with fishers often carrying multiple radios for uninterrupted communication with other vessels. Weather maps and messaging services such as NavIC and GEMINI are available on mobile devices for weather monitoring and decision making. While keeping a listening watch on VHF channel 16 is essential, fishers rarely use it unless they need assistance. Weather monitoring equipment such as barometers, anemometers, and Distress Alert Transmitters are sparingly used by fishers.

Recommendation

Developing deep-sea fishing is an inevitable component in future, but its success will only be possible through coordinated efforts among stakeholders. The bottle neck in the industry is the feeling of mediocrity among fishers and their profession. Therefore, there is a requirement for a structured training to impart knowledge to the fishers and also to overcome the sense of inferiority. It is suggested to develop a deep-sea fishing model, to demonstrate it at sea for sustainability, and integrate it into the industry. This can be achieved through a well-designed fishing vessel equipped with modern electronic equipment for efficient and sustainable fishing operations. The vessel can be operated only by a skilled and well-trained fisher; hence training is required for these fishers to handle the modern equipment fitted in the vessel. These activities should be monitored by authorities through a vessel monitoring system. The efficiency of the vessel's operation can be continuously monitored for financial success and sustainability of the fisheries resources. Once the model proves to be viable both in terms of sustainability and financially, it can be integrated into the marine fishing industry. From the unstructured interview with the fishers, it is understood that they have to be properly trained and educated about the deep-sea fishing. The training has to be initiated on a continual basis, and should make them understand the importance of fishing and how sea food exports brings lot of foreign exchange reserves to the country.

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Conclusion

Fishing has been a longstanding tradition, with fishers acquiring their skills through experience and passing them down through generations. As most fisheries resources are located in the coastal belt, fishers have historically concentrated their efforts there. However, due to dwindling resources in the coastal belt, governments are now encouraging fishers to venture into the Exclusive Economic Zone (EEZ) and beyond to exploit untapped fisheries resources. This shift requires fishers to enhance their skills, as many deep-sea fisheries resources are migratory. Moving more fishers from the coastal belt into the high seas presents challenges, as their fishing patterns, vessel construction, and skills differ significantly. Existing fishers also need to enhance their vessel operational capabilities in international waters, including communication, navigation, safety, technology integration, and decision-making abilities. Additionally, coastal fishers need training in deep-sea fishing skills. Developing these abilities requires properly constructed and equipped vessels operated by well-trained fishers, along with modern electronic equipment for decision-making at sea. Experimenting with a deep-sea fishing system using such vessels and fishers, with continuous shore monitoring, could enhance the marine fishing industry's status. This system could then be integrated into the fishing industry after successful operation at sea. Furthermore, the government must support high-seas fishing through policy decisions and arrangements to manage market fluctuations when deep-sea fish replace coastal varieties.

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