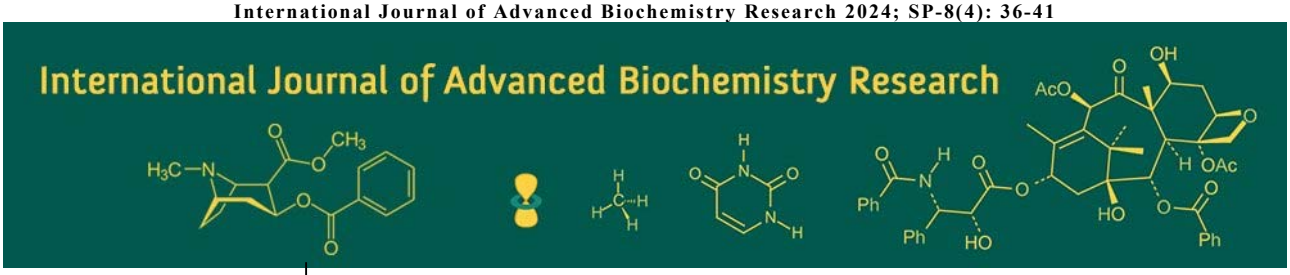

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(4): 36-41
www.biochemjournal.com
Received: 02-02-2024
Accepted: 06-03-2024

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Deciphering the operational challenges in fishing: A holistic constraint assessment of marine fishing activities in West Bengal, India

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DOI: https://doi.org/10.33545/26174693.2024.v8.i4Sa.900

Abstract
This research seeks to pinpoint and prioritize the obstacles fishing vessels operating in the marine waters off West Bengal face. It was carried out across nine Fish Landing Centers (FLCs) in Purba Medinipur (4) and South 24 Paraganas (5) districts of West Bengal. These FLCs were chosen based on the type of vessels utilized: mechanized, motorized, and traditional. Ten fishermen from each type of vessel were selected from each FLC, resulting in a total sample size of 150 respondents for the survey. The study utilized the Henry Garrett ranking technique to assess and categorize fishermen's constraints when fishing. The results of the analysis show that a significant hindrance for non-motorized fishing vessels is the decrease in catch due to overfishing, habitat degradation, or environmental changes. Moreover, the increase in diesel prices poses a significant challenge for motorized and mechanized fishing vessels. Common issues for all fishing vessels include high labour and input costs, fluctuations in market demand, and the scarcity of pricing and market data. The study also identified middlemen prevalence and the absence of government support as substantial constraints impacting fishermen's fishing activities. Additionally, the study highlighted the need for adequate infrastructure, such as landing centers and marketing facilities, to address the challenges fishermen face in West Bengal. Constraint analysis offers a comprehensive understanding of fishermen's diverse difficulties, providing valuable insights for developing targeted interventions and support measures to enhance the sustainability and resilience of marine fishing operations in the region.

Keywords: Constraints, West Bengal, henry Garrett, marine fishing crafts, sustainability

1. Introduction
Seafood, an essential source of nutrition, plays a crucial role in global food security, particularly in developing nations (Bjørndal *et al*., 2024) [2]. The world's fish supply relies on two interconnected sectors: capture (or wild-caught) fisheries and aquaculture (or farmed fish). While capture fisheries have stabilized, aquaculture has become the fastest-growing food sector globally in recent decades (FAO, 2020) [6]. India ranks second among major producers of aquatic animals worldwide. In 2020, India contributed 8% to global fisheries and aquaculture production. India also played a significant role in global marine capture fisheries production, accounting for 4.7%, although China led with 14.9% (FAO, 2022) [6]. The marine fishery potential in Indian waters is estimated at 5.31 million metric tons. West Bengal, situated in eastern India, boasts a rich fishing history, with ample water bodies conducive to inland and marine fish production. The state's total fish production is 1.843 million metric tons, with inland fish production at 1.652 million metric tons and marine fish production at 0.191 million metric tons. In terms of disposition, the majority of the catch (16.58 lakh tonnes) is marketed fresh. In comparison, the rest is distributed as frozen (0.38 lakh tonnes), for reduction (0.54 lakh tonnes), or categorised as miscellaneous (0.06 lakh tonnes). Among coastal districts, South 24 Parganas contributed the highest number of landings at 0.99 lakh tonnes, representing 52% of total landings, followed by Purba Medinipur with 0.90 lakh tonnes, accounting for 48% of the total landings. Primary species of marine catch in West Bengal include anchovies, Penaeid shrimps, croakers, pomfrets, and Bombay ducks, with recorded weights ranging from13.19 to 18.75 thousand tonnes (CMFRI, 2023) [4].

In India, three sectors are utilized for fish harvest: mechanized, motorized, and non-motorized. Mechanized fishing accounts for 82% of the total catch at 2.85 million metric tons. In comparison, motorized vessels contribute 17% at 0.61 million metric tons, and traditional crafts make up a marginal 1% at 0.04 million metric tons. In West Bengal, the mechanized sector dominates with an 86% share of the catch, followed by the motorized sector with 12%, while the non-motorized sector lags with only 2% (CMFRI, 2023) [4]. These fishing crafts face operational constraints that affect their contribution to the total catch. Constraints were identified through an extensive literature review and field surveys. This research aims to identify and prioritise the obstacles faced by crafts operating in the marine waters of West Bengal. The Henry Garrett ranking technique was employed to assess the constraints systematically. This method is frequently used to recognize and evaluate the challenges encountered by fishermen. The outcomes of the Henry Garrett method provide a comprehensive understanding of the difficulties diverse fishing vessels face. A similar constraint analysis related to marine fishermen was conducted by Boro and Agbugba (2023) [3] in the Gokana Local Government Area of Rivers State, Nigeria, and Raju SS *et al*. (2022) [16] in Andhra Pradesh.; Raju, S. S., *et al*., (2022) [16] in Odisha, N. Aswathy *et al*. (2019) [1] in Ernakulam district, Kerala., Radhakrishnan *et al*. (2018) [15] in Thoothukudi, Tamil Nadu., Patilkhede, B., Patil, V., & Kadam, J. (2018, February 10 2018) [13] at Konkan, Maharashtra, R.S.. Kumari (2017) [18], Visakhapatnam, Andhra Pradesh, R. Senthiladeban, *et al* (2015) [19] in Thoothukudi, Tamil Nadu., Kanaga, V., & Sivasankar, P. (2015) [11] in Therespuram., Andhra Pradesh., Immanuell, S., and Rao, S. (2012) [9] in Visakhapatnam, Andhra Pradesh., Onomolease and Oriakhi (2011) [12] in Nigeria., Hewamanage, L. A. K. *et al*., (2010) [8] in Sri Lanka.

2. Materials and Methods

2.1 Study area

The study was conducted across nine Fish Landing Centers (FLC) in Purba Medinipur and South 24 Paraganas districts of West Bengal. The depiction of the sampling area is given in Figure 1.

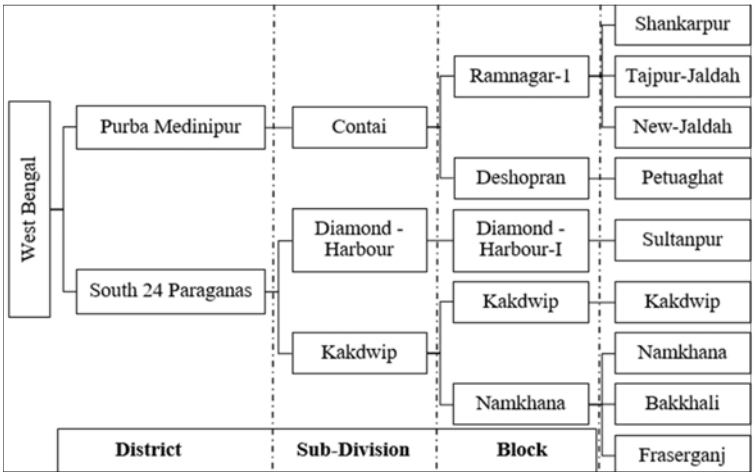

Fig 1: Sampling frame followed in the study

From each FLC, ten fishermen from 5 FLCs for each type of craft were chosen for the study, which made the total sample size of the survey 150 respondents (3 types of crafts X 5 FLCs X 10 Fishermen). In the present study, fishermen operating non-motorized fishing crafts expressed that eight significant constraints were faced while fishing. In comparison, motorized fishing crafts recorded ten constraints, and mechanized crafts faced fifteen constraints. Then, fishermen were asked to give rank based on the severity of the problem in ascending order. These constraints were recorded and analyzed based on the formula provided and prioritized based on the average score realized from calculations.

2.2 Statistical Analysis

Henry Garrett's ranking technique was utilized to identify the production constraints faced by the fishermen. This technique translates the changes in order into numerical scores. Using this technique, the respondents' perceptions of the significance of the reasons and factors are considered, making it superior to a simple frequency distribution. The following steps illustrate the process of determining the average Garrett Ranking score and rank in a step-by-step manner:

1) **Data collection:** The fishermen were asked to identify and prioritize the various constraints affecting marine capture fishing according to the order of severity. For example, if ten constraints were identified, fishermen were advised to rank limitations from 1 to 10 in ascending order based on severity.
2) **Data cleaning:** Find the Minimum, Maximum, and mode of the ranks of the fishermen to clean the data from duplications and omissions. Additionally, rank-wise and factor-wise, frequency and its total were calculated to ensure no omission or duplication of data.
3) **Percentage position of ranks**: The percentage position of ranks was calculated using the formula [1].

$$\text{Percentage position} = 100 \times \frac{R_{ij} - 0.5}{N_j} \quad [1]$$

Were

R_{ij} = Rank given for i^{th} factor by j^{th} individual.

N_j = Number of items ranked by j^{th} individual.

In the case of non-motorized fishing crafts, the first factor's percentage position is calculated as (100*(1-0.5)/8) = 6.25%, Similarly, for motorized crafts, it is (100*(1-0.5)/10) = 5%, and for mechanized crafts, it is (100*(1-0.5)/15) = 3.33%. Detailed % positions of each factor for every craft type are shown in Table 1.

Table 1: Percentage position and its corresponding Garrett Value for each factor.

Non-motorized			Motorized		Mechanized	
Factor	**%**	**Garret Value**	**%**	**Garret Value**	**%**	**Garret Value**
1	6.25	80	5.00	82	3.33	85
2	18.75	68	15.00	70	10.00	75
3	31.25	60	25.00	63	16.67	69
4	43.75	53	35.00	58	23.33	64
5	56.25	47	45.00	52	30.00	60
6	68.75	40	55.00	48	36.67	57
7	81.25	32	65.00	42	43.33	53
8	93.75	20	75.00	36	50.00	50
9			85.00	29	56.67	47
10			95.00	18	63.33	43
11					70.00	40
12					76.67	36
13					83.33	31
14					90.00	25
15					96.67	15

4) **Conversion of percentage position to Garrett value:** The per cent position of each rank was converted into scores according to the table given by Garrett and Woodworth (1969). The corresponding Garrett Values were tabulated in Table 1.
5) **Multiplication of Garrett value with frequency**: Multiply factor-wise, rank-wise frequency with corresponding Garrett value.
6) **Adding up the score for each factor**: Add up all values obtained from step 5, i.e., adding up all values obtained for every factor individually.
7) **Average**: Calculate the average value for each factor separately by dividing the sum of the rank values for each factor by the number of respondents. For the present study, the number of respondents was 50 for each craft type.
8) **Scoring:** Score each factor in ascending order, i.e., the highest score got rank 1, followed by rank 2…

3. Results and Discussions

The constraint analysis conducted on marine fishing operations carried out by non-motorized, motorized, and mechanized crafts is presented in Table 2. This study aims to recognize and rank the obstacles faced by crafts operating in the marine waters of West Bengal. Employing the Henry Garrett method, this study categorizes and analyzes fishermen's constraints in fishing activities. The findings of the Henry Garrett method provide a comprehensive understanding of the diverse difficulties faced by different fishing vessels. This method enables the prioritization of constraints, offering valuable insights into the specific issues affecting each sector. The subsequent sections provide detailed results of the constraint analysis for non-motorized, motorized, and mechanized fishing crafts.

3.1 Economic Constraints Impacting Fishermen's Productivity: The current study reveals that non-motorized fishing vessels encounter a significant limitation in catch reduction, with a mean Garrett score of 76.32. This constraint also ranks as the second most substantial obstacle for motorized and mechanized fishing crafts, with Garrett scores of 68.6 and 72.72, respectively. It reflects the broader issue of declining catch due to overfishing, habitat degradation, or changes in marine environments, resulting in reduced production and financial setbacks for fishermen. Similarly, Raju *et al*. (2022) [16] reported elevated input costs and low-output fish catch as significant constraints. Radhakrishnan *et al*. (2018) [15] also identified declining fish catch as a primary constraint (66.25%) for motorized crafts, the second most significant for mechanized crafts (61.25%), and the third most critical challenge for traditional crafts (58.75%).

An increase in diesel prices poses a significant constraint for motorized and mechanized fishing crafts, with mean Garrett scores of 82 and 85, respectively. Fuel expenses constitute a substantial portion of the overall variable costs for motorized fishing vessels, ranging from 35% to 40%. They represent an even more significant percentage, between 45% and 60%, of the total variable costs for mechanized fishing vessels. The limitation is coupled with the inadequate diesel supply in the case of mechanized crafts, with an average Garrett score of 42.36 and a ranking of X. Radhakrishnan *et al*. (2018) [15] identified the lack of adequate supply of diesel as a significant constraint in mechanized crafts with a mean score of 63.75, while this constraint posed as a fifth constraint in the case of motorized crafts with a mean score of 38.75. Raju, S.S. *et al*. (2022) [16] suggested that cheaper fuel rates are necessary to increase productivity in mechanized crafts.

Fishing trip expenses are affected by rising fuel prices, increased labour wages, craft and gear maintenance costs, and other operational expenses. Increased trip costs rank as the third most significant constraint, with scores of 61.52 for non-motorized crafts, 64.1 for motorized crafts, and 69.82 for mechanized crafts. Elevated labour and input expenses were identified as the fourth and fifth limiting factors for motorized vessels, scoring 56.78 and 51.66 Garrett points, respectively. Kanaga, V. (2015) [11] also noted that high investment costs for multiday motorized fishing crafts posed a significant constraint with a score of 59.2 in Tharuvaikulam, Thoothukudi district. The study further found that high investment costs ranked as the fifth major constraint for single-day motorized and multiday mechanized crafts, with mean scores of 57.2 and 53.3,

respectively. Radhakrishnan *et al*. (2018) [15] identified the high wage rate of the crew as the seventh constraint in the case of mechanized vessels, with a mean percentage of 33.75%. In line with these findings, Senthiladeban R. *et al*. (2015) [19] also found that an increase in the cost of fishing assets posed a significant constraint with 79.27%.

3.2 Financial and Marketing Constraints Affecting Fishermen: Access to financial resources from institutions is restricted, which hinders the ability to invest in the necessary equipment, technology, and operational improvements. Institutional finance facilities present a significant financial constraint with varying intensity across all craft types. For non-motorized fishing crafts, fishermen's financial inability ranks as the fourth major constraint, with a Garrett score 52.46. In the case of motorized fishing crafts, this constraint is listed as the eighth constraint, with a score of 34.28. Finally, mechanized crafts rank sixth with a Garrett score of 56.88. Patilkhede B. *et al*. (2018) [13] listed the lack of credit as a significant economic constraint reported by 80.41% of fishermen. Reza S. *et al*. (2015) also identified the lack of credit as a constraint in their study area. Senthiladeban R. *et al*. (2015) [19] found that an insufficient supply of institutional finance for procuring and maintaining fishing crafts and gear is a serious concern, with an 85.68% mean score ranked as the second constraint for operating non-mechanized fishing crafts in the Thoothukudi district.

Fluctuations in market demand, seasonal variations, and external factors contribute to this constraint, posing challenges for fishermen in maximizing their earnings. In the present study of traditional fishermen, the erratic price change of fish catch is the second major challenge, with a 69.6 Garrett score. Similarly, in the case of mechanized fishing crafts, this constraint ranks as the fourth significant constraint, with a Garrett score of 64.86. Patilkhede B. *et al*. (2018) [13] observed that the absence of pricing and market data has diminished the bargaining power of fishermen, leading them to rely on intermediaries for price setting and impacting their income. Inadequate infrastructure, such as cold storage facilities, drying and processing areas, jetties, and weighing facilities, has resulted in "distress selling." Radhakrishnan *et al*. (2018) [15] found that in the case of traditional fishing crafts, the low price for the catch is the primary constraint, with a mean of 76.25%. Motorized and mechanized fishing crafts listed this constraint as the second and third in order, with mean percentages of 56.25.

Fishermen reported a lack of marketing facilities as a least-conceived constraint in each category, i.e., non-motorized, motorized, and mechanized fishing crafts, with Garrett scores of 23.12, 20.1, and 17.58, respectively. Rajib Bhuyan (2006) found that there needs to be an established framework for marketing the sale of fish. In 2015, Senthiladeban R. *et al*. [19] also found that there still needs to be a well-established marketing system for fish sales in some FLCs of the Thoothukudi coast of Tamil Nadu.

3.3 Policy-Related Constraints Faced by Fishermen

Surtida, A. P. (2000) defined a middleman as an individual with specialized knowledge in purchasing or selling on behalf of a client without possessing or having title to the merchandise. The current research reveals that the prevalent intermediaries pose a significant obstacle for non-motorized, motorized, and mechanized fishing vessels, with mean Garrett scores of 38.26, 49.14, and 38.72, respectively. In the ranking, non-motorized and motorized fishing crafts were placed sixth in dominance by intermediaries, while mechanized vessels were ranked eleventh for dominance by agents. Kanaga, V., and Sivasankar, P. (2015) [11] listed middleman interference as a fifth constraint with a 52.78 mean score. Kanaga, V. (2015) [11] revealed that in the case of multiday motorized crafts, it is a second significant marketing constraint with a Garrett score of 92.4; furthermore, in the case of single-day motorized and multiday mechanized fishing crafts, middlemen interference is registered as a third marketing constraint with 82.1 & 68.1 Garrett score respectively.

Fishermen rely heavily on marine resources and face many hazards and uncertainties. Inadequate government assistance exposes them to adverse weather conditions, declining fish populations, and health risks (Kalikoski *et al*., 2010) [10]. Fishers operating non-motorized fishing crafts ranked this constraint fifth with a Garrett score of 47.4. Garrett score. Moving on to motorized fishing crafts, the same constraint was ordered as the VII constraint, with a Garrett score of 41.88. Finally, mechanized vessel operating fishermen also expressed that lack of government support is a constraint, with a Garrett score of 24.78. Patilkhede B. *et al*. (2018) [13] recorded that there were no schemes for fishermen as a third major social constraint, as stated by 77.92% of respondents. Furthermore, the research revealed that 68.33% of fishers also perceived inadequate subsidies and incentives as an economic limiting factor.

Fishers frequently need help locating appropriate sites to land their catch or securely dock their boats. As a result, there may be delays in unloading and processing the catch, leading to reduced freshness and quality of the harvested seafood (Nugroho *et al*.; S. A., 2021). The current research demonstrates that the landing centres in West Bengal need adequate infrastructure, which presents a challenge for non-motorized, motorized, and mechanized fishing vessels. The mean Garrett scores for these categories are 31.32, 29.46, and 30.4, respectively.

In the present study, the lack of navigational equipment and fish aggregation detecting devices like SONAR and PFZ maps posed a significant constraint in mechanized vessels with a 46.96 Garrett score. Immanuel, Sheela, Rao, and G. Syda (2012) [9] found that Visakhapatnam's lack of advanced technology was a significant constraint while operating hook and line. Radhakrishnan *et al*. (2018) [15] in Thoothukudi, Tamil Nadu, recorded that the absence of extra navigational equipment for mechanized fishing crafts is a sixth constraint with a mean percentage of 36.25.

Regulations and resource management rules, including restrictions on fishing areas and access to productive zones, limit mechanized fishing boats. The present study shows that fishing area restriction is listed as an XII constraint with a Garrett score of 36.32. Kanaga, V., and Sivasankar, P. (2015) [11] noted a considerable rise in fishing vessels, leading to an IV constraint with a Garrett score of 53.35. The survey by Patilkhede B. *et al*. (2018) [13] documented that 70% of the interviewed fishermen reported experiencing conflicts in the fishing region.

Table 2: Constraints faced by fishermen operating all kinds of fishing crafts.

		Non-Motorized		Motorized		Mechanized	
Sl.no	**Constraints faced by fishing crafts**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**
1	Increase in diesel price	-	-	82	1	85	I
2	Reduced fish catch composition	76.32	I	68.6	II	72.72	II
3	Increased cost of fishing per trip	64.1	III	61.52	III	69.82	III
4	Erratic variation in the price of fish	69.6	II	-	-	64.86	IV
5	High labour wages	-	-	56.78	IV	59.86	V
6	Lack of institutional finance	52.46	IV	34.28	VIII	56.88	VI
7	High cost of fishing equipment	-	-	-	-	53.32	VII
8	High input and repair costs	-	-	51.66	V	50.42	VIII
9	Lack of extra navigational apparatus	-	-	-	-	46.96	IX
10	Lack of adequate supply of diesel	-	-	-	-	42.36	X
11	The supremacy of the Intermediaries	38.26	VI	49.14	VI	38.72	XI
12	Fishing area restriction	-	-	-	-	36.32	XII
13	Scarce landing berthing facilities	31.32	VII	29.46	IX	30.4	XIII
14	Lack of Proper Government schemes	47.4	V	41.88	VII	24.78	XIV
15	Lack of proper marketing for catch	23.12	VIII	20.1	X	17.58	XV

Source: Author's Calculation

4. Conclusion

In conclusion, the study conducted in West Bengal aimed to identify and rank the constraints faced by fishermen operating different types of fishing crafts. Using the Henry Garrett ranking technique, the study found that economic constraints, mainly catch reduction, increase in labour wages, diesel prices, and subsequently, increase in cost per trip, were significant challenges for all fishing vessels. Financial and marketing constraints include a lack of institutional finance, unpredictable changes in catch prices, and fewer marketing facilities. The main challenges were policy-related constraints, the presence of middlemen, inadequate landing and berthing facilities, and lack of government support. The study provides valuable insights into the specific issues affecting each sector, enabling the prioritization of constraints. This highlights the need to thoroughly examine operational efficiency and profitability factors, especially without proper marketing facilities. However, future studies could address the research gap by exploring potential solutions to the identified constraints. The findings of such research could inform policymakers, development practitioners, and other stakeholders working to support the fisheries sector's sustainable development and improve fishermen's livelihoods.

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Appendix

GARRETT'S RANKING TABLE

Percentage	Score	Percentage	Score	Percentage	Score
0.09	99	20.93	66	80.61	33
0.2	98	22.32	65	81.99	32
0.32	97	23.88	64	83.31	31
0.45	96	25.48	63	84.56	30
0.61	95	27.15	62	85.75	29
0.78	94	28.86	61	86.89	28
0.97	93	30.61	60	87.96	27
1.18	92	32.42	59	88.97	26
1.42	91	34.25	58	89.94	25
1.68	90	36.15	57	90.83	24
1.96	89	38.06	56	91.67	23
2.28	88	40.01	55	92.45	22
2.63	87	41.97	54	93.19	21
3.01	86	43.97	53	93.86	20
3.43	85	45.97	52	94.49	19
3.89	84	47.98	51	95.08	18
4.38	83	50	50	95.62	17
4.92	82	52.02	49	96.11	16
5.51	81	54.03	48	96.57	15
6.14	80	56.03	47	96.99	14
6.81	79	58.03	46	97.37	13
7.55	78	59.99	45	98.72	12
8.33	77	61.94	44	98.04	11
9.17	76	63.85	43	98.32	10
10.16	75	65.75	42	98.58	9
11.03	74	67.48	41	99.82	8
12.04	73	69.39	40	99.30	7
13.11	72	71.14	39	99.22	6
14.25	71	72.85	38	99.39	5
15.44	70	74.52	37	99.55	4
18.69	69	76.12	36	99.68	3
18.01	68	77.68	35	99.80	2
19.39	67	79.12	34	99.91	1
				100	0

E.Garrett's statistics in Psychology and Education, Feffer and Simans Private Limited, 21969, p.329.