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Research Article

Exploring the Marketing Dynamics and Profit Margins of Selected Fishes in Mymensingh District

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ABSTRACT

Fish marketing is pivotal in advancing the fisheries sector's development. The study aimed to explore the marketing dynamics, profit margins and the efficiency of chosen fish species in specific regions of Mymensingh district. The study spanned from October to December 2021, covering various markets within Mymensingh district. Three fish types- *Shing, Rui* and *Pabda*, 40 fish farmers, and 152 intermediaries all were chosen purposively. Primary data were gathered through face-to-face interviews. Descriptive statistics, least significant difference, and Shepherd and Acharya methods were employed for analysis. Three marketing channels were identified in the study area, involving fish producers, *Aratdar*, *Aratdar* cum wholesaler, *Bepari*, hawker, retailers, and ultimate consumers. *Bepari* incurred the highest marketing cost, primarily attributed to transportation costs. Significant differences in marketing costs were observed between *Aratdar* cum wholesaler (for *Pabda* and *Shing*), *Bepari* with *Aratdar*, *Aratdar* with hawker and *Aratdar* cum wholesaler (for all fish types). The *Shing* fish exhibited higher profit margin in marketing across intermediaries, except for *Bepari*. Significant differences in marketing margins were found between *Aratdar* and *Bepari*, *Aratdar* cum wholesaler, hawker and retailer for all three fish types. Retailer marketing margins differed significantly between *Rui* and *Shing* fish, *Pabda* and *Rui* fish, and *Shing* and *Pabda* fish. The Shepherd's method indicated higher efficiency in marketing in channel 1 compared to channels 2 and 3 for all fish types. Thus, future research should expand to include more diverse geographical areas within Bangladesh to validate and broaden the applicability of these findings, contributing to sustainable growth and profitability in the fisheries sector.

Introduction

Fish plays a critical role in the national diet of Bangladesh, often paired with rice in daily meals and ranking as the second most essential food. The fisheries sector not only sustains traditional dietary practices but also serves as a pivotal component of Bangladesh's economy, offering opportunities for self-employment and income generation, particularly in rural areas (Leela et al., 2018). The livelihoods of millions depend directly or indirectly on fisheries activities (DoF, 2018), highlighting the sector's socioeconomic importance.

In the context of this study, which focuses on the marketing dynamics and profit margins of selected fish species in Mymensingh District, understanding the economic implications of fish farming and marketing systems is crucial. Effective marketing systems are essential for enhancing the economic well-being of those involved in fishing activities (Jamali et al., 2013). Moreover, Bangladesh's significant position in global fisheries, fuelled by its rich aquatic biodiversity and substantial aquaculture production, underscores the relevance of studying local market dynamics (Shamsuzzaman et al., 2017).

A fish market serves as a hub where both producers and consumers come together for the buying and selling of fish. Acting as a connection bridge between producers and consumers, the marketing system involves various intermediaries (Monir et al., 2013). The sustainability of the fisheries sector is interconnected with factors such as fish accessibility, fish production growth, institutional arrangements, marketing systems and advanced facilities (Nadia et al., 2022). The marketing system of fish serves as the essential pathway connecting producers to consumer, facilitating the distribution of

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fish. Ensuring the availability of fish at reasonable price relies on consumers depending on an effective fish marketing system (Debnath et al., 2019). The effective timing and proper placement of fish for consumer accessibility require a well-managed marketing system (Deb and Dey, 2020). The satisfaction of consumers and the economic well-being of pond fish farmers, fishermen, and fish traders hinge on a well-organized marketing system (Chowdhury, 2004). An efficient marketing system stands as a pivotal factor for the rapid expansion of the fish farming sector (Shrivastava and Ranadhir, 1995). Fish marketing predominantly operates within the Non-governmental sector, impacting the lifestyle of a substantial group of individuals involved in fish production and marketing systems (Debnath et al., 2019). Inadequate knowledge of pricing policies and a lack of effective market information result in farmers not receiving fair prices. The absence of a proper marketing system and channel disrupts fish supply (Ahamad et al., 2019). Compounded by its perishable nature, fish quickly spoils, necessitating a swift and efficient disposal through an effective marketing system (Edah et al., 2010). Additionally, the fish market demonstrates considerable fragmentation, with numerous small-scale operators involved and these hurdles present difficulties in maintaining quality standards for fish as well as ensuring timely delivery to consumers (Reshma and Kalluraya, 2023). The expansion of fish production and the advancement of the fishery sector depend on the implementation of an efficient fish marketing system (Husen, 2019).

In Bangladesh, efforts are underway to boost fish production, yet there's a notable lack of focus on enhancing the current fish marketing system (Islam et al., 2017). Improving these facilities could ensure fair returns for fishermen and provide traders with better margins from fish farming. Recognizing this need, there is a significant call for a comparative study on the marketing system of fish in Bangladesh. The study specifically targets *Rui (Labeo Rohita), Pabda (Ompok Bimaculatus)*, and *Shing* (*Heteropneustes Fossilis)* fish due to their market availability and popularity among consumers in the study area. The improvement of the fisheries sector and the well-being of fish farmers and traders necessitate the establishment of a sustainable and effective marketing system. Without the development of such a system, both the fisheries sector and the livelihoods of fishermen may not reach a satisfactory level (Islam et al., 2015). An efficient marketing structure is crucial to protect the interests of fishers and producers, ensuring the accessibility of fish at the correct time and place (Ali et al., 2014).

Literature on the comparative analysis of the fish marketing system in selected areas of the Mymensingh district is notably lacking in Bangladesh. However, some relevant information on fish marketing has been documented, and this research aims to provide valuable insights into the efficiency, channels, costs, and margin of fish marketing in the country. Several key studies contribute to the existing literature. For instance, Debnath et al. (2019) focused on the shorter marketing chain in Gazipur district, which was favourable for fish producers due to direct interactions with retailers and consumers. Similarly, studies in Nepal by Koirala et al. (2021) highlighted significant sales through wholesalers, retailers, and direct consumer transactions in the fish market. Ali et al. (2014) provided insights into varying marketing costs and margins for different fish types in Barisal city. Khalil et al. (2017) and Gawa et al. (2017) further contributed by examining the marketing dynamics of marine fish in Chattogram, Cox's Bazar, and unregulated fish markets, respectively, emphasizing diverse marketing channels and cost structures. While these studies collectively enhance our understanding of fish marketing dynamics, a notable gap remains in comparative studies specifically focusing on different regions within Bangladesh. Our study addresses this gap by analyzing the marketing dynamics and profit margins of selected fish species in Mymensingh District, aiming to enhance local system effectiveness and sustainability. This study serves as a pivotal contribution, specifically focusing on the comparative analysis of *Rui, Shing*, and *Pabda* fish marketing channels, functions, marketing costs and margins, and overall efficiency. While acknowledging the need for adaptation to local contexts and specific market conditions, our study provides foundational insights that can be generalized and adapted to foster improvements in fish marketing efficiency on a larger scale. This paper outlines its specific goal as to identify the existing marketing channels and functions of intermediaries for *Rui, Shing*, and *Pabda* fish in designated regions of Mymensingh district and estimate the costs, margins, and efficiency at different levels of fish marketing in the same geographical areas. By achieving these objectives, the study aims to offer valuable insights that can guide improvements in the efficiency of fish marketing, addressing the unique dynamics associated with *Rui, Shing*, and *Pabda* fish in the specified locations within the Mymensingh district.

Materials and Methods

Selection of Study Area, Fish Farmer and Intermediary

The choice of the study area is a crucial step, aligning with the study objectives. Fulbaria, Muktagacha, Trishal, Tarakanda, and Mymensingh Sadar Upazillas in the Mymensingh district were purposively selected due to a

significant involvement of people in fish farming in these regions.

Fish farmers and intermediaries were purposively selected from the study area, and fish trading intermediaries were classified into five groups namely hawker, *Bepari*, *Aratdar*, *Aratdar* cum wholesaler, and retailer.

Collection of Data

In the data collection process, primary data from farmers and traders, including *Aratdar, Aratdar* cum wholesaler, hawker, *Bepari*, and retailers, were obtained using an interview schedule. This schedule underwent pretesting, and necessary adjustments were made to ensure consistency and applicability in actual field conditions. Secondary data were sourced from various publications, including those from the Bangladesh Bureau of Statistics, different journals and Department of Fisheries (DoF).

Analytical Techniques

Estimation of Marketing Cost, Margin and Net Margin

For analyzing marketing cost of different intermediaries, the formula $TM_c = C_b+C_a+C_{aw}+C_h+C_r$ was applied, where, TM_c =Total Marketing Cost of all intermediaries, C_b =Summation of all marketing cost of *Bepari*, C_a =Summation of all marketing cost of *Aratdar*, C_{aw} =Summation of all marketing cost of *Aratdar* cum wholesaler, C_h = Summation of all marketing cost of hawker, C_r = Summation of all marketing cost of retailer.

Specifically, the marketing margin was estimated using the formula MM = S - P, where MM denotes Marketing Margin, S represents Sale price, and P is the Purchase price.

To estimate the net margin, the formula NMM = MM - MC is applied, where NMM represents Net Marketing Margin, and MC is Marketing Cost.

Comparative analysis of Marketing Cost of Different Fishes and Margin of Different Intermediaries

The study utilized the Least Significant Difference (LSD) test to compare the marketing cost of different fish by numerous intermediaries and margin of different intermediaries from different fish. The LSD test, a multiple comparison method developed by Fisher, was employed to determine statistically which intermediaries achieve higher profit and bear higher marketing costs for *Rui, Pabda*, and *Shing* fish. The normal distribution of observations for per kg marketing cost and per kg net marketing margin from different intermediaries groups for the three fishes was confirmed through the Kolmogorov-Smirnov test. Subsequently, ANOVA was conducted to identify differences among the groups, and LSD test results were used to identify intermediaries and fish groups with higher marketing cost and margin.

Estimation of Marketing Efficiency

To assess the marketing efficiency of different channels for various fishes, two methods were employed.

Shepherd's Method: Shepherd (1972) proposed using the ratio of the total value of goods marketed to the marketing costs as a measure of efficiency. The formula is ME = RP / MC, where RP is the Retailer's sale price, MC is the Total marketing cost, and ME represents Marketing Efficiency. A higher ratio indicates higher efficiency.

Acharya's Method: Acharya modified the formula for estimating marketing efficiency, calculated as ME = FP / (TMC + TNMM), where ME is Marketing Efficiency, FP is the Net price received by farmers, TMC is Total Marketing Cost, and TNMM is Total Net Marketing Margins of intermediaries. A higher ME value signifies a higher level of efficiency.

Results and Discussion

Fish Marketing Channels and Functions Performed By Market Participants

The distribution network for fish, including *Shing, Pabda*, and *Rui*, in the Mymensingh district involves various intermediaries like *Bepari*, *Aratdar*, *Aratdar* cum wholesalers, hawker, and retailers (as illustrated in Figure 1), aligns with the market chain described by Hossain and Ali (2015). They emphasized the key components, including *Bepari*, supplier, *Aratdar*, wholesaler, and retailer, within the fish market chain from the farmer to the consumer. Figure 1 illustrates the fish marketing channels, demonstrating the involvement of various intermediaries in facilitating the flow of fish from fishermen to end consumers. Four marketing channels were identified such as channel 1: Farmer-*Aratdar*-Hawker-Consumer; Channel 2: Farmer-*Aratdar*-Retailer-Consumer; Channel 3: Farmer-*Aratdar* cum wholesaler- Retailer-Consumer; Channel 4: Farmer-*Bepari*- *Aratdar* (distant)- Retailer (distant)- Consumer (distant) which aligns with Rokeya et al. (1997) findings, emphasizing the limited direct communication between fishermen and consumers. Each stage of the marketing channels involves intermediaries who perform vital commercial functions, connecting producers and consumers for mutual benefit. The current research is further corroborated by Prasad et al. (2023), who identified marketing channels for fish, emphasizing the involved network of intermediaries that link producers to retailers within the fish market chain. In this context, farmers and intermediaries like *Bepari*, hawker, *Aratdar*, *Aratdar* cum wholesaler, and retailer actively participate in marketing of *Rui, Pabda*, and *Shing* fish. Farmers, identified as key players, significantly

contribute to the marketing dynamics of these fish species, consistent with the observations in Netrokona, Gazipur and Mymensingh districts by Rahman (2003) and Mia (1996). Their studies underscore the integral roles of *Aratdar* and *Bepari* within the existing marketing system. In the study area, market participants engage in crucial marketing functions to facilitate the movement of goods from origin to consumption. These functions include buying and selling, storage, grading, financing, transportation, packaging, and market information.

Buying, a fundamental marketing process is carried out by intermediaries like *Aratdar* cum wholesalers, *Bepari*, hawker, and retailers. They acquire products, assemble them, handle packaging, and ultimately sell the products to other intermediaries or directly to consumers. In Table 1, the data reveals that *Bepari* purchased the highest proportion of *Rui* fish (66.67%), *Shing* fish (50%), and *Pabda* fish (80%) directly from farmers, with a smaller share acquired from *Aratdar* (33.33%, 50%, and 20%, respectively). *Aratdar* cum wholesalers secured 75% of *Rui* fish, 100% of *Shing* fish, and 83.33% of *Pabda* fish from farmers. Hawker and retailers exclusively obtained 100% of *Rui, Pabda*, and *Shing* fish through *Aratdar*, while consumers purchased all *Rui* fish from retailers.

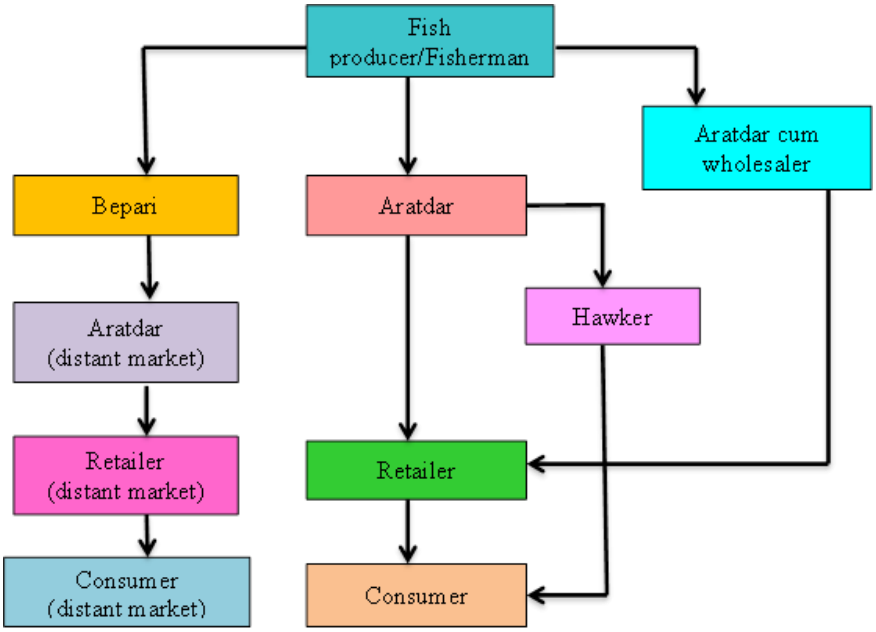

Figure 1. Fish marketing channels in study area

Table 1. Buying function of market actors for different fishes (in percentage)

Market actors	*Rui* fish		*Shing* fish		*Pabda* fish	
	Farmer	Through *Aratdar*	Farmer	Through *Aratdar*	Farmer	Through *Aratdar*
Bepari	66.67	33.33	50	50	80	20
Aratdar cum Wholesaler	75	25	100		83.33	16.67
Hawker		100		100		100
Retailer		100		100		100

Source: Field survey 2022

Moving to Table S1, the primary objective of selling is to achieve a satisfactory price. The majority of farmers sold *Rui* fish (94.74%), through *Aradar*, *Shing* fish (63.64%) through *Bepari* and *Pabda* fish (79.17%) through the same. This choice may be influenced by factors such as convenience, logistic support provided by *Aratdar* and *Bepari*, and established retailing within this marketing channel. Additionally, the predominant share of *Aratdar* sold 56.25% of *Rui* fish, 52.94% of *Shing* fish, and 58.33% of *Pabda* fish to retailers. This indicates that a substantial transaction where the majority of the available *Rui, Shing*, *Pabda* fishes were transferred to the retailer suggesting a significant distribution to meet consumer demand. *Bepari* exclusively sold 100% of *Rui*, *Shing*, and *Pabda* fishes to distant *Aratdar*. This means that all available quantity of these three types of fishes were transferred to retailer indicating a comprehensive sale of their

inventory. *Aratdar* cum wholesalers, in turn, sold 100% of *Shing*, *Rui*, and *Pabda* fishes to retailers. Meanwhile, hawker and retailers sold the entire stocks of *Shing*, *Pabda*, and *Rui* fishes directly to consumers. This aligns with the outcomes of Salam et al. (2008) and Janifa et al. (2014), who similarly noted that retailers were the primary sellers of entire *Rui* fish stocks to ultimate consumers. This finding is further supported by Aktar et al. (2013), who reported that retailers sold their fish to local consumers.

Table S1. Selling function of market actors for different fishes (in percentage)

Market actors	*Rui* fish					*Shing* fish					*Pabda* fish				
	B	A	DA	R	C	B	A	DA	R	C	B	A	DA	R	C
Farmer	5.26	94.74				63.64	36.36				79.17	20.83			
A	43.75			56.25		46.07			52.94		41.67			58.33	
B			100					100					100		
AW				100					100					100	
H					100					100					100
R					100					100					100

Note: B = *Bepari*, A = through *Aratdar*, DA = through Distant *Aratdar*, AW = *Aratdar* cum wholesaler, H= Hawker, R = Retailer, C= Consumer
Source: Field survey, 2022

In the study area, ensuring sufficient and effective transportation is crucial for a modern marketing system. Fish intermediaries and farmers employ numerous means of transport, including van, *nasiman*, pick-up, bus, truck, train, and auto-rickshaw, to facilitate the transfer of fishes from the farmer to the consumer. Table 2 reveals that the predominant transportation choices among farmers, *Bepari,* and *Aratdar* cum wholesalers are pick-up (47.5%), van (100%) for hawker, and auto rickshaw for the majority of retailers (46.48%). These observations align with Islam et al. (2018) findings, where various transportation modes like van, rickshaw, truck, and *nasimon* were used by fish farmers and intermediaries.

Table 2. Mode of transportation and packaging technique of fishes by market actors (in percentage)

Mode of transportation						
Market actors	Van	*Nasiman*	Pick up	Bus	Truck	Auto rickshaw
Farmer	45	2.5	47.5			5
Bepari		29.17	33.33	16.67	20.83	
Aratdar cum wholesaler	14.28	14.28	57.14	14.28		
Hawker	100					
Retailer	40.84	4.23	5.63	2.82		46.48

Packaging technique					
Market actors	Plastic drum	Bamboo basket	Crate	Silver pot	Cock sheet box
Farmer	55	7.5	37.5		
Bepari	100				
Aratdar cum wholesaler	28.57	42.85	28.57		
Hawker				100	
Retailer	16.90		26.76	22.53	33.80

Source: Field survey, 2022

Similarly, Salam et al. (2008) noted the prevalent use of van by fish farmers. At the retail level, van/rickshaw emerged as the primary means to transport fish from Arat centre to sales outlets. Fish grading based on size and weight, as well as the use of refrigeration and ice for preservation, resonates with the practices identified by Salam et al. (2008), highlighting the importance of packing for maintaining fish quality during transit and storage. In Table 2, it is notable that plastic drums are the preferred choice for the majority of farmers (55%) and all *Bepari* (100%), while 42.85% of *Aratdar* cum wholesalers opt for bamboo baskets. Hawkers universally utilize silver pots, and the primary packaging material for most retailers (33.80%) is cock sheet boxes. These packaging trends align with Paul et al. (2016) findings, where bamboo, aluminium containers, plastic half drums, plastic crates, plastic full drums, steel half drums, and cock sheet boxes were common choices among intermediaries. Consistently, Islam et al. (2018) noted the use of bamboo tied with rope, polythene, plastic drums by producers, retailers and Paiker for packaging various fish types. Moreover, Rokeya et al. (1997) also reported diverse materials such as bamboo baskets, plastic baskets, leaves, polythene or plastic bags, aluminium cans, and drums being used by *Aratdar* and fishermen for packaging and preserving fresh fish, with the contemporary adoption of plastic crates by intermediaries in Bangladesh.

In the monarchy of fish marketing, financing various aspects like raw material purchases, transportation costs, labor payments, and other associated expenses is crucial for farmers, *Aratdar*, *Bepari*, *Aratdar* cum wholesalers, hawker, and retailers. Figure S1 illustrates the sources of finance for farmers and intermediaries, revealing that a significant portion of them in the study area were self-financed. Essentially they did not heavily rely on external financial assistance, loans or subsidies to start and operate their fish farms. This self-financing approach could imply a level of financial autonomy and confidence in the viability of fish farming as a profitable endeavour. This align with the findings of Debnath et al. (2019), where approximately 70% of retailers engaged in fish trading utilized their own funds. The remaining 30% obtained loans from friends and relatives without incurring any interest.

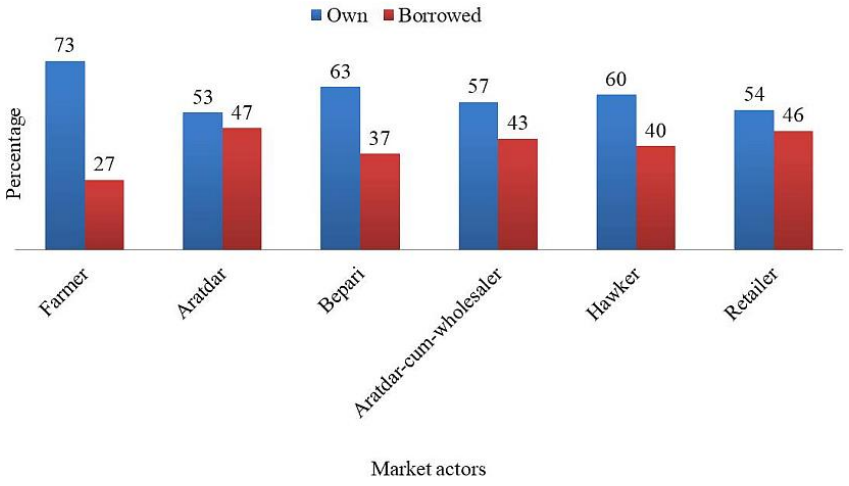

Figure S1. Source of finance for farmers and intermediaries

Indeed, in any business, valid, timely, authentic, and reliable information is a crucial asset. Figure S2 illustrates the information sources for farmers and intermediaries within the study region. Notably, the majority of fish farmers and traders acquire information through personal visits to the market. Personal visit allow them to directly observe fish market demand, prices and trends providing first-hand knowledge that may be more immediate and accurate compared to other sources. This approach reflects an effective way of gathering information for decision making in fish marketing. Interestingly, the highest number of *Aratdar* relies on mobile phones for collecting information. This aligns with the findings of Islam et al. (2018), highlighting the common practices of physically visiting markets and using telephone/mobile phones as sources for gathering market information.

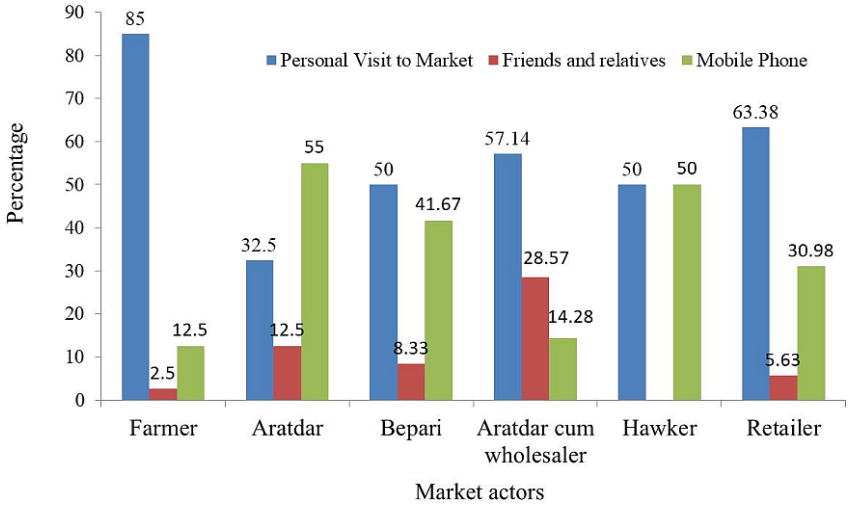

Figure S2. Sources of information for farmers and intermediaries

Marketing Cost of Different Intermediaries for Selected Fishes

The cost of marketing of different intermediaries for selected fish types is outlined in Table S2. The marketing cost of a product encompasses expenses associated with performing diverse marketing functions and operations throughout the entire marketing process, extending from production to consumption. Retailers, among all traders, incur the highest cost for *shing* fish, amounting to 13.76% (Figure 2). Transportation costs involve expenses related to moving goods from one location to another. *Bepari* faces higher costs associated with transporting *Rui* fish affecting its cost structure in the marketing channel. Transportation cost, notably at 7.55 Taka per kg for *Rui* fish, constitutes the highest expense for *Bepari*, while water bills are the least at 0.003 Taka per kg. This aligns with Paul et al. (2016) findings, emphasizing transportation as the costliest sector. The increased cost of transporting *Rui* and *Shing* fish by *Bepari* could be attributed to factors such as long distances travelled, specific handling requirements, perishable nature of the fish requiring swift transportation and the need for specialized condition like temperature control to preserve fish quality during transit.

Table S2. Marketing cost of fish (Taka per kg)

Items	Farmer			*Bepari*			*Aratdar*			*Aratdar* cum wholesaler			Hawker			Retailer		
	R	P	S	R	P	S	R	P	S	R	P	S	R	P	S	R	P	S
Transportation	2.93	3.21	3.33	7.55	5.41	6.21				3.10	2.76	2.38	2.55	2.54	2.48	2.15	2.52	2.47
Storage				1.00	1.50		0.26	0.32	0.39							1.20	1.13	1.25
Market toll							0.09	0.20	0.18	0.06	0.06	0.04				0.38	0.38	0.24
Wastage				1.00				0.24								0.55	1.74	0.45
Personal expenses				0.59	0.68	0.50	0.53	0.40	0.58	1.32	0.91	0.54	0.54	0.60	0.54	1.15	0.68	0.54
Icing				0.61	3.00	2.25	0.53	0.67		1.34	1.25	0.90	2.00	1.88	.81	1.88	2.34	0.85
Electricity							0.12	0.14	0.12	0.08	0.16	0.12				0.33	0.34	0.36
Shop rent							0.14	0.64	0.69	0.50	0.32	0.16				0.88	0.78	0.78
Mobile	0.22	0.22	0.21	0.06	0.44	0.22	0.14	0.1	0.14	0.54	0.95	0.81	0.59	0.58	0.61	0.29	0.31	0.35
Labor	1.52	1.42	1.80	1.07	2.33	0.98	1.80	1.95	1.94	1.85	1.65	1.41	1.12	1.04	1.54	1.59	1.35	1.45
Un official Payment							0.65	0.26	0.45									
Cleaning Cost										0.62	0.24	0.62				0.13	0.13	0.13
Water				0.003		0.06	0.04	0.07	0.06									
Security manager cost							0.02	0.06	0.06	0.08	0.04	0.08				0.05	0.06	0.06
Commission	3.86	5.47	4.82	3.55	4.10	3.18	0.59	0.53	0.54				3.50	4.30	3.81	3.56	4.68	4.78

Note: S = *Shing*, P= *Pabda*, R= *Rui*

Figure 2 illustrates the percentage breakdown of marketing costs for farmers and traders, highlighting *Bepari* as the highest spenders, with costs of 15.45% for *Rui* fish and 13.12% for *Shing* fish. In contrast, *Aratdar* bear the lowest costs, amounting to 4.95% for *Rui* fish, 5.21% for *Shing* fish, and 5.67% for *Pabda* fish.

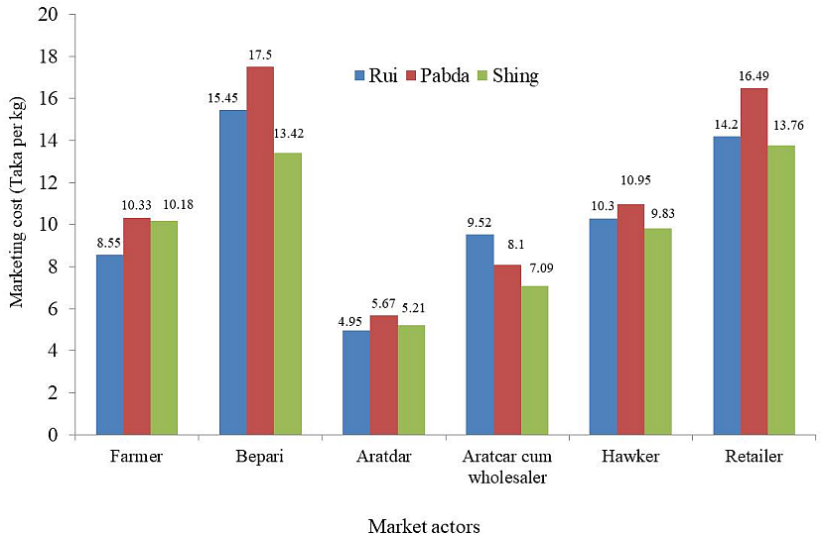

Figure 2. Percentage of marketing cost of fish farmers and intermediaries

Table S2 and Figure 2 reveal that farmers face a higher marketing cost of 10.33% for *Pabda* fish, followed by 10.18% for *Shing* fish and 8.55% for *Rui* fish. Specifically, farmers encounter elevated commission costs (5.47 Taka per kg) for *Pabda* fish. *Aratdar* bears the highest labor cost (1.95 Taka per kg) for *Rui* fish, with security being the lowest cost item at 0.02 Taka per kg. Among all cost items, *Aratdar* cum wholesaler bears a substantial transportation cost (3.10 Taka per kg) for *Rui* fish, while market toll is the lowest at 0.04 Taka per kg for *Shing* fish, and security charge is 0.04 Taka per kg for *Pabda* fish. Hawker faces higher commission costs (3.81 Taka per kg) for *Shing* fish, with personal expenses being the lowest at 0.54 Taka per kg, consistent across *Rui* and *Shing* fish. Janifa et al. (2014) support these findings, noting that transportation costs account for the highest percentage (40.54%), followed by *Aratdar's* commission (26.92%), icing (8.23%), wages and salaries (4.81%), and tips and donations (4.32%) in rohu fish marketing. For *Pabda* fish, *Aratdar* cum wholesalers, *hawker*, and retailers incur costs of 8.10%, 10.95%, and 16.49%, respectively. Similarly, for *Shing* fish, *Aratdar* cum wholesalers, hawker, *Bepari*, and retailers bear costs of 7.09, 13.42, 9.83, and 13.76%, respectively. Figure 2 illustrates that among all intermediaries, the marketing cost of *Pabda* fish is highest for *Bepari* at 17.50%, *Bepari* might invest more in marketing activities to distinguish *Pabda* fish in a competitive market while *Aratdar* incur the lowest cost at 4.95% for *Rui* fish.

Comparative Analysis of Marketing Cost for Selected Fishes and Intermediaries

Differences in marketing costs among intermediaries for different fish were evident in the previous findings. To determine which intermediary incurred higher costs, a statistical test, specifically the Least Significant Difference (LSD) of multiple comparisons, was employed. Initially, a variance analysis was performed to assess the significance of marketing cost variations for *Pabda, Rui*, and *Shing* fishes across different intermediaries. The F test yielded a significant result (p-value = 0.000, less than 0.05), indicating variations in marketing costs. However, discerning the intermediary with higher costs required further analysis, leading to the application of LSD for multiple comparisons, with the results detailed in Table S3.

Table S3. Comparisons of marketing cost of fish incurred by different intermediaries

Intermediaries (I)	Intermediaries (J)	*Pabda*		*Rui*		*Shing*	
		Mean Difference (I-J)	Sig.	Mean Difference	Sig.	Mean Difference	Sig.
Retailer	*Bepari*	-.551	.665	-2.835	.080	.529	.541
	Aratdar	9.388*	.000	7.781*	.000	6.745*	.000
	Aratdar cum wholesaler	6.876*	.000	3.048	.060	4.869*	.000
	Hawker	4.010*	.092	1.964*	.037	2.115	.114
Bepari	Retailer	.551	.665	2.835	.080	-.529	.541
	Aratdar	9.940*	.000	10.617*	.000	6.215*	.000
	Aratdar cum wholesaler	7.428*	.000	5.884*	.009	4.340*	.003
	Hawker	4.562*	.115	4.800*	.008	1.585	.260
Aratdar	Retailer	-9.388*	.000	-7.781*	.000	-6.745*	.000
	Bepari	-9.940*	.000	-10.617*	.000	-6.215*	.000
	Aratdar cum wholesaler	-2.512	.056	-4.732*	.005	-1.875	.172
	Hawker	-5.378*	.000	-5.816*	.000	-4.630*	.001
Aratdar cum wholesaler	Retailer	-6.876*	.000	-3.048	.060	-4.869*	.000
	Bepari	-7.428*	.000	-5.884*	.009	-4.340*	.003
	Aratdar	2.512	.056	4.732*	.005	1.875	.172
	Hawker	-2.866*	.007	-1.083	.544	-2.754	.113
Hawker	Retailer	-4.010*	.092	-1.964*	.037	-2.115	.114
	Bepari	-4.562*	.115	-4.800*	.008	-1.585	.260
	Aratdar	5.378*	.000	5.816*	.000	4.630*	.001
	Aratdar cum wholesaler	2.866*	.007	1.083	.544	2.754	.113

*The mean difference is significant at the 0.05 level

The results show a significant mean difference in marketing costs for all fishes between retailers and *Aratdar*. Moreover, the marketing cost for all fish is higher for retailers compared to *Aratdar*. This suggests that *Aratdar* incur lower marketing costs for all fishes than retailers. The consistent sign of the mean

difference for both lower and upper bounds (negative or positive) indicates a non-zero difference. Additionally, the marketing cost for all fish is higher for retailers compared to *Aratdar* cum wholesaler. Notably, a significant difference exists in the marketing cost of *Bepari* compared to *Aratdar* and *Aratdar* cum wholesaler, indicating that *Bepari* incurs higher marketing costs for all fish than both *Aratdar* categories. Significant differences in the marketing cost of *Rui* fish were observed between *Aratdar* cum wholesaler and *Aratdar*, with a significance level of 0.00, indicating that the cost of marketing for *Rui* fish is greater for *Aratdar* cum wholesaler than that for *Aratdar*. Consequently, it can be inferred that *Aratdar* bear lower marketing costs for *Rui* fish compared to *Aratdar* cum wholesaler. Similarly, there are significant differences in the marketing cost of *Rui* fish between *Bepari* and hawker, where the marketing cost for *Rui* fish with *Bepari* is higher than with the hawker. Moreover, significant differences in the marketing cost of all fishes between hawker and *Aratdar* were found. The marketing cost for all fishes with hawker is higher than with *Aratdar*, indicating that *Aratdar* bear lower marketing costs for all fishes compared to hawker.

Statistical test LSD of multiple comparisons was applied to identify which fish bears higher marketing cost. The results, detailed in Table 3, reveal a significant mean difference in marketing costs between retailers for *Pabda* fish and *Rui* fish, as well as *Pabda* and *Shing* fish. The findings reveal that a significant disparity in the marketing costs of retailers between *Pabda* and *Rui* fish, as well as *Pabda* and *Shing* fish, with a significance level below 0.05. Moreover, retailers incur higher marketing costs for *Pabda* fish compared to both *Rui* and *Shing* fish. Consequently, it can be inferred that retailers face lower marketing expenses when dealing with *Rui* and *Shing* fish. The sign of the mean marketing cost difference between *Pabda* and *Rui* fish, as well as *Shing* fish, remains consistent, indicating a non-zero difference. On the other hand, the mean marketing cost difference between *Rui* and *Shing* fish is not statistically significant, suggesting no significant distinction in marketing costs between these two types.

Table 3. Comparisons of marketing cost of intermediaries for different fishes

Fish(I)	Fish(J)	Retailer		*Bepari*		*Aratdar*	
		Mean Difference (I-J)	Sig.	Mean Difference (I-J)	Sig.	Mean Difference (I-J)	Sig.
Rui	*Pabda*	-2.696*	.000	-.412	.898	-1.077*	.002
	Shing	.3171	.652	3.682	.182	-.686	.051
Pabda	*Rui*	2.696*	.000	.412	.898	1.077*	.002
	Shing	3.013*	.000	4.094	.069	.390	.264
Shing	*Rui*	-.3171	.652	-3.682	.182	.686	.051
	Pabda	-3.013*	.000	-4.094	.069	-.390	.264

Additionally, the marketing cost difference for Aratdar between *Pabda* and *Rui* fish is significant, indicating higher costs for *Pabda* fish. Similarly, the mean marketing cost difference between *Pabda* and *Rui* fish for *Bepari* is not significant, implying no substantial difference in marketing costs among these fish types.

Marketing Margin of Intermediaries for Different Fishes

Moving on to marketing margins, Table S4 displays the net marketing margins for different intermediaries and fish types. Retailers achieve the highest marketing margin at 56.71 for *Shing* fish, while *Aratdar* records the lowest at 9.27 Taka per kg. This aligns with Azam et al. (2016) who reported the highest gross margin for retailers at 1100 Taka/quintal. Similarly, Ara et al. (2010) noted the lowest and highest marketing margins per quintal for retailer and *Aratdar* at 340.40 and 334.65 Taka, respectively. Janifa et al. (2014) also affirmed that among all intermediaries, retailers have the maximum profit amounting to Taka 624.29 per maund of fish. Similarly, Aktar et al. (2013) reported that the average gross profit of retailers was higher due to increased fish supply and demand. The higher gross marketing margin suggests that retailer is able to sell fish at a satisfactory price. Factors contributing to this could include effective pricing strategies, demand for fish or efficient supply management. It is a positive indicator for retailer in terms of profitability per unit of fish sold. *Aratdar* cum wholesalers achieve the highest net margin at 45.76 Taka, while *Aratdar* have the lowest at 4.05 Taka per kg for *Shing* fish. *Bepari records the highest marketing margin at 58.6 Taka per kg for Pabda fish. Bepari* might have a strong market presence offering high quality *Pabda* fish, superior handling method allowing them to command higher prices for their *Pabda* fish compared to other intermediaries. Similarly, for *Aratdar* cum wholesalers, the highest net margin is 41.89 Taka, and *Aratdar* have the lowest at 3.67 Taka per kg for *Pabda* fish. *Bepari* achieved the highest marketing margin at 51.6 Taka per kg of *Rui* fish, while *Aratdar* recorded the lowest marketing margin, standing at 8.62 Taka. Additionally, *Bepari* secured the highest net margin of 36.21 Taka, contrasting with *Aratdar's* lowest net marketing margin of 3.67 Taka per kg of *Rui* fish. Among the intermediaries, hawker attained the highest net marketing margin in *Shing* fish,

followed by *Rui* and *Pabda* fish. *Shing* fish might be in higher demand compared to *Rui* and *Pabda* fish enabling the hawker to set higher prices and achieve a more significant net marketing margin. In the selected area, market position and reputation of hawker for *Shing* fish might be stronger compared to *Rui* and *Pabda* fish influencing consumer to be willing to pay more price for this type of fish. Notably, *Aratdar* cum wholesaler claimed the highest net marketing margin of 45.76 Taka per kg for *Shing* fish suggest that they have effectively managed their business operations to maximize profitability. This achievement could be attributed to various factors including efficient marketing channel, strong negotiating skills, high quality and market demand, for fish, potential geographic advantage *Aratdar* cum wholesaler seem to have positioned themselves strategically in the *Shing* fish market allowing them to command higher prices and generate a significant marketing margin for per kg of fish. Further analysis of their specific business strategies, market conditions and operational efficiency would provide a more comprehensive interpretation of how they have attained maximum net marketing margin. Conversely, *Aratdar* were the least profitable for all fish types. Higher marketing cost may reduce the overall profitability of *Aratdar*. Moreover, changes in market condition, such as fluctuation in fish prices, demand variation or shift in consumer preference may impact the profitability of *Aratdar*. Another reason may be *Aratdar* have limited negotiating power with supplier, they may struggle to secure favourable pricing terms impacting their overall net marketing margin. *Aratdar* are facing challenges that impact their ability to generate significant profits across different types of fish. Further analysis would be needed in this context.

Table S4. Net marketing margin of fish for different intermediaries (Taka per kg)

Particulars	*Bepari*			*Aratdar*			*Aratdar* cum wholesaler			Hawker			Retailer		
	S	P	R	S	P	R	S	P	R	S	P	R	S	P	R
SP	242	303	263.33	223.41	207.81	207.81	302.85	270	235	273.57	297	253	341.57	330.54	255.07
PP	189.86	244.4	211.66				250	220	191.66	227.14	256	208.5	284.86	278.69	212.03
MM or GR	49.86	58.6	51.66	9.27	8.62	8.62	52.85	50	43.33	46.42	41	44.5	56.71	51.84	42.28
MC	13.42	17.50	15.45	5.21	4.95	4.95	7.09	8.10	9.52	9.83	10.95	10.30	13.76	16.49	14.20
NMM	36.44	41.09	36.21	4.05	3.67	3.67	45.76	41.89	33.80	36.59	30.05	34.24	42.94	35.34	28.07

Note: SP = Selling Price, PP = Purchasing Price, MM = Marketing margin, GR = Gross Return, MC= Marketing Cost, NMM= Net Marketing Margin, S = *Shing*, P = *Pabda* and R = *Rui*

Comparative Analysis of Marketing Margin for Selected Fishes and Intermediaries

The LSD results in Table S5 highlight a significant mean difference in the marketing margin of all fishes between retailers and *Aratdar*. Furthermore, the marketing margin for all fishes is observed to be higher for retailers compared to *Aratdar*. It's noteworthy that the sign of the mean marketing margin difference between retailers and *Aratdar* remains consistent (either negative and negative or positive and positive), indicating a non-zero difference. Additionally, the marketing margin of *Pabda* and *Shing* fish to retailers surpasses that of hawker.

Table S5. Comparison of marketing margin of all fishes between different intermediaries

Intermediaries (I)	Intermediaries (J)	*Pabda* Mean Difference (I-J)	Sig.	*Rui* Mean Difference (I-J)	Sig.	*Shing* Mean Difference (I-J)	Sig.
Retailer	*Bepari*	-1.667	.563	-4.017	.470	7.637*	.001
	Aratdar	36.737*	.000	28.452*	.000	42.795*	.000
	Aratdar cum wholesaler	-3.807	.188	-3.829	.491	-.646	.849
	Hawker	8.058*	.006	-3.912	.226	35.256*	.000
Bepari	Retailer	1.667	.563	4.017	.470	-7.637*	.001
	Aratdar	38.404*	.000	32.469*	.000	35.158*	.000
	Aratdar cum wholesaler	-2.139	.580	.187	.980	-8.283*	.024
	Hawker	9.726*	.013	.105	.986	27.619*	.000
Aratdar	Retailer	-36.737*	.000	-28.452*	.000	-42.795*	.000
	Bepari	-38.404*	.000	-32.469*	.000	-35.158*	.000
	Aratdar cum wholesaler	-40.544*	.000	-32.281*	.000	-43.441*	.000
	Hawker	-28.678*	.000	-32.364*	.000	-7.538*	.032
Aratdar cum wholesaler	Retailer	3.807	.188	3.829	.491	.646	.849
	Bepari	2.139	.580	-.187	.980	8.283*	.024
	Aratdar	40.544*	.000	32.281*	.000	43.441*	.000
	Hawker	11.866*	.003	-.082	.989	35.902*	.000
Hawker	Retailer	-8.058*	.006	3.912	.226	-35.256*	.000
	Bepari	-9.726*	.013	-.105	.986	-27.619*	.000
	Aratdar	28.678*	.000	32.364*	.000	7.538*	.032
	Aratdar cum wholesaler	-11.866*	.003	.082	.989	-35.902*	.000

The difference in marketing margin for *Pabda* and *Shing* fishes between *Aratdar* cum wholesaler and hawker is deemed significant. Specifically, the marketing margin for *Pabda* and *Shing* fishes from *Aratdar* cum wholesaler is higher than that from the hawker. The consistent sign in the mean marketing margin difference between *Aratdar* cum wholesaler and hawker (either negative and negative or positive and positive) implies a non-zero difference. Similarly, the marketing margin for all fish between *Aratdar* cum wholesaler and *Aratdar* is statistically confirmed with a significance level of 0.000 which is below 0.05, with the marketing margin for all fishes to *Aratdar* cum wholesaler being higher than to *Aratdar*. In conclusion, *Aratdar* gains a lower marketing margin for all fishes compared to *Aratdar* cum wholesaler. The sign consistency in the mean net return difference between *Aratdar* cum wholesaler and *Aratdar* also suggests a non-zero difference. The marketing margin disparity between *Aratdar* cum wholesaler and hawker for *Pabda* and *Shing* fishes is statistically significant, with a significance level below 0.05. This indicates that the marketing margin for *Aratdar* cum wholesaler is higher than that for hawker. The significant marketing margin difference between hawker and *Aratdar*, with a level of 0.000, indicates higher margins for hawker. Consequently, *Aratdar* gains a lower marketing margin for all fish compared to hawker.

The results of the study revealed a statistically significant mean difference in retailers' marketing margins between *Pabda* and *Rui* fish, with a significance level of 0.003, which is below the 0.05 threshold (Table 4).

Table 4. Comparison of marketing margin of intermediaries from different fishes

Fish(I)	Fish (J)	Retailer		*Bepari*		*Aratdar*	
		Mean Difference (I-J)	Sig.	Mean Difference (I-J)	Sig.	Mean Difference (I-J)	Sig.
Rui	*Pabda*	-6.178*	.003	-6.521	.440	-.321	.461
	Shing	-13.951*	.000	-4.151	.559	.039	.930
Pabda	*Rui*	6.178*	.003	6.521	.440	.321	.461
	Shing	-7.773*	.001	2.369	.678	.361	.420
Shing	*Rui*	13.951*	.000	4.151	.559	-.039	.930
	Pabda	7.773*	.001	-2.369	.678	-.361	.420

The difference in the marketing margin of retailers between *Shing* and *Pabda* fish is deemed significant. The marketing margin for retailers with *Shing* fish is higher than that for *Pabda* fish. Therefore, it can be concluded that retailers gain a lower marketing margin for *Pabda* fish compared to *Shing* fish. The consistent sign in the mean marketing margin difference between *Shing* and *Pabda* fish (either negative and negative or positive and positive) suggests a non-zero difference. Additionally, retailers experience a higher marketing margin with *Pabda* fish compared to *Rui* fish. In summary, it can be inferred that retailers earn a lower marketing margin with *Rui* fish than with *Pabda* fish. The sign of the mean difference in marketing margin remains consistent (either both negative and both positive) for both lower and upper bounds, indicating that the difference is never zero. The observed marketing margin difference between *Shing* and *Rui* fish is statistically significant. Moreover, retailers exhibit a higher marketing margin for *Shing* fish compared to *Rui* fish, suggesting that retailers gain a lesser marketing margin from *Rui* fish than from *Shing* fish. The consistency in the sign of the mean marketing margin difference between *Shing* and *Rui* fish for both lower and upper bounds indicates a non-zero difference.

Marketing Efficiency of Different Marketing Channels for Selected Fishes

The marketing efficiency of *Shing, Pabda*, and *Rui* fishes varies across different channels. Channel 4 is excluded from consideration due to the involvement of distant market intermediaries beyond the study area. Table 5 outlines the marketing efficiency of *Shing, Pabda,* and *Rui* fish across various channels. For *Pabda* fish, Channel 3 incurred the highest marketing cost compared to Channels 2 and 1. Despite this, Channel 3 demonstrated the highest total net marketing margin, followed by Channel 2 and 1. Consequently, channel 1 exhibited maximum marketing efficiency with values of 19.58 using the Shepherd formula and 4.82 with the Acharya formula. This finding aligns with Parmar et al. (2018) study, which also observed higher marketing efficiency in Channel 1 using Shepherd's method compared to Acharya's method. This consistency across different methods implies a robust conclusion about the relative performance of these channels. It strengthens the argument that channel 1 consistently demonstrated higher marketing efficiency compared to channel 2 and 3. Moreover, when the product is distributed through various intermediaries, the marketing efficiency in Channel 3 decreases to 13.44 using the Shepherd formula and drops to 2.36 with the Acharya method in Channel 3, and 3.97 in Channel 2. Despite Channel 1

being identified as more efficient by both formulas, it has a lower transaction volume compared to the other channels. Notably, Channel 3 exhibits the lowest marketing efficiency for both Shepherd and Acharya methods. When comparing the two methods, the average marketing efficiency of *Pabda* fish is 15.57 in Shepherd's method and 3.41 in Acharya's method. The data from the table reveals that marketing costs were highest in Channel 3 compared to Channels 2 and 1. Additionally, the highest total net marketing margin was in Channel 3, with Channel 2 and 1 following in sequence. Consequently, marketing efficiency reached its maximum in Channel 1 (15.76) using the Shepherd formula and 3.12 in Channel 2 using the Acharya formula.

Furthermore, when the product is distributed through different intermediaries, marketing efficiency in Channel 3 as per the Shepherd formula, decreases to 13.31. In contrast, the Acharya method shows a drop to 1.72 in Channel 3 and 2.95 in Channel 1. Shepherd's formulas consistently indicate that Channel 1 is more efficient than Channels 2 and 3, aligning with Husain et al. (2022) findings that marketing efficiency is high in fish marketing Channel 1 (39.78). On the other hand, the Acharya formula suggests that Channel 2 is more efficient than Channels 1 and 3. However, it's noteworthy that the transaction volume of fish through Channel 1 is lower than the other channels. For *Rui* fish, Channel 3 consistently exhibits the lowest marketing efficiency in both formulas. The average marketing efficiency of *Rui* fish is 14.04 in Shepherd's method and 2.59 in Acharya's method. In the case of *Shing* fish, the data indicates that marketing costs were highest in Channel 3 compared to Channels 2 and 1. Likewise, the highest total net marketing margin was observed in Channel 3, with Channel 1 and 2 following in sequence. Consequently, marketing efficiency reached its maximum in Channel 1 (22.31) using the Shepherd formula and 3.56 in the same channel using the Acharya formula.

Moreover, when the product is distributed through different intermediaries, the marketing efficiency in Channel 3, according to the Shepherd formula, decreases to 16.38. Meanwhile, the Acharya method shows a drop to 1.77 in Channel 3 and 3.01 in Channel 2. Both formulas consistently identify that Channel 1 is more efficient than Channels 2 and 3. However, it's worth noting that the transaction volume of fish through Channel 1 is lower than the other channels. The marketing efficiency of Channel 3 is found to be the lowest for both formulas. The average marketing efficiency of *Shing* fish is 18.57 in Shepherd's method and 2.55 in Acharya's method.

Table 5. Measuring marketing efficiency of fish (Taka per kg)

Particulars	Channel 1			Channel 2			Channel 3		
	Pabda	*Rui*	*Shing*	*Pabda*	*Rui*	*Shing*	*Pabda*	*Rui*	*Shing*
1.Retailer's sale price or consumer's purchase price (Taka per kg)	325.54	250.07	335.57	330.54	255.07	341.57	330.54	255.07	341.57
2.Total Marketing cost (Taka per kg)	16.62	15.86	15.04	22.16	19.13	18.97	24.59	19.15	20.85
3.Total net marketing margins of intermediaries (Taka per kg)	34.38	37.86	4.06	39.68	31.74	46.99	77.23	69.96	88.7
4.Net price received by farmers (Taka per kg)	245.83	158.83	198.73	245.83	158.83	198.73	240.83	153.83	194.02
5. Marketing efficiency									
Shepherd's method (1/2)	19.58	15.76	22.31	14.91	13.33	18	13.44	13.31	16.38
Acharya's method 4/(2+3)	4.82	2.95	3.56	3.97	3.12	3.01	2.36	1.72	1.77

According to Figure S3, the average marketing efficiency was highest in *Shing* fish (18.57), followed by *Pabda* fish (15.57) and *Rui* fish (14.04). Additionally, across all types of fishes, marketing efficiency in Shepherd's method surpassed that of Acharya's method.

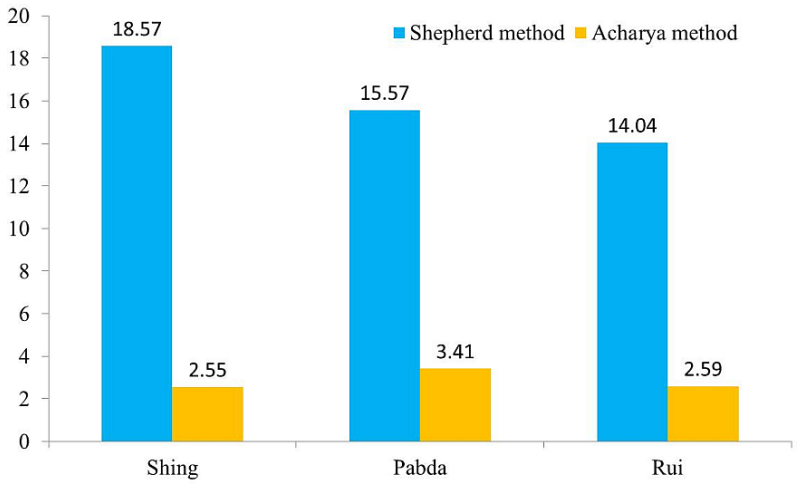

Figure S3. Average marketing efficiency of *Shing, Pabda* and *Rui* fish

Conclusion

This study provides a comparative analysis of pertaining to the marketing system of fish in Mymensingh district, emphasizing the potential for enhancing the country's economy through improvements in the fishery sector. Results indicate that intermediaries secure market information primarily through market visits. *Pabda* fish incurs higher marketing costs for all stakeholders, with transportation costs being significant for *Bepari* and commission costs for retailers. *Shing* fish demonstrates higher net marketing margins across intermediaries, except for *Bepari*. *Aratdar* consistently exhibits lower marketing margins compared to other intermediaries. Channel 1 demonstrates higher marketing efficiency for *Shing*, *Pabda*, and *Rui* fish, despite lower transaction volume. Shepherd's method indicates *Shing* fish has the highest average marketing efficiency. It is necessary to concentrate on implementing measures to decrease the transportation costs incurred by *Bepari*, a significant contributor to the highest marketing costs in the study. Addressing the notable variations in marketing costs among intermediaries is crucial for creating a fair and competitive market environment. Efforts should be directed towards fostering efficient marketing channels to streamline the fish marketing channel. Furthermore, there is a need to enhance the overall marketing efficiency, particularly in channels 2 and 3, to ensure a smoother flow of fish products from producers to consumers. This involves optimizing processes, reducing inefficiencies, and facilitating better coordination among the various actors in the marketing channel. It is crucial to acknowledge the study's limitations, particularly its focus on specific species within the Mymensingh district. We advocate for further research that includes a more diverse range of geographical regions and fish varieties to validate and expand upon our initial findings. This approach will contribute to a more comprehensive understanding of marketing dynamics, profit margins, and efficiency in the broader context of Bangladesh's fisheries sector.

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Conflict of interest

All Authors declare that they have no conflict of interest.

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