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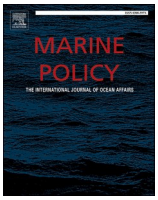

Patron-client relationships shape value chains in an Indonesian island-based fisheries system

Nicky Roberts [a,*], Buchari Mengge [b], Muh. Rifadly Utina [b], Farhan Muhatar [b], Anugerah [b], Arham Icwardanhi [b], R. Muhammad Zulkifli [b], Austin Humphries [a,c]

[a] Department of Fisheries, Animal and Veterinary Sciences, University of Rhode Island, Kingston, RI, USA
[b] Department of Sociology, Hasanuddin University, Makassar, Indonesia
[c] Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, USA

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ABSTRACT

Fishing is vital to millions of people in Southeast Asia. Overfishing along with climate-induced stressors have presented significant challenges to managers. Solutions for fisheries management in the region, however, tend to narrowly focus on production and catch restrictions despite the importance of local economies and relationships. For example, the role of networks known as patron-client systems are understood by scholars and local populations as important drivers of fisheries exploitation in Indonesia, but policy is rarely directed at them. Here, we perform value chain analysis to better understand the socioeconomic factors that mediate fish catch, distribution, and governance outcomes in an Indonesian fishing community. The community's social context spurred the following research questions: i) In what ways does the regional fish trading system influence fisheries value chains; and ii) How does the current structure of trade align with fisheries and fishing actors on the island? Survey-based fieldwork collected data on species composition, revenue, and buyer/seller relationships from the point of catch to sale. These results showed that patrons earn disproportionate trading benefits compared to fishing clients, including higher revenues, bargaining power, and flexibility from their central position as lenders. Findings also revealed a strong connection between pelagic-based fishing crews and the wider market system, which mediates the trade of fish off-island. Given the links between trading hierarchies and fish flows in our study, we argue that efforts to enhance fisheries governance would be most effective if introduced through off-island auctioneers since they have significant power in controlling fish catch and distribution.

1. Introduction

Fishing is vital to livelihoods in tropical developing countries such as Indonesia. For millions of people living in the Indonesian archipelago, fish are a critical piece of subsistence, market trade, and identity [1]. However, the rich marine biodiversity and its associated values are under threat from overfishing combined with climate change and a transition to global fishing markets [2,3]. Maintaining the socio-economic functions of fisheries to support regional coastal populations has thus become increasingly challenging in Indonesia.

Indonesia employs over 7 million people in the fisheries sector and is the second largest producer of fish worldwide [4]. Fishers and fishing communities, however, tend to occupy the lowest economic strata and are thus vulnerable to fluctuations in supply and demand [5–7]. Government data indicate that Indonesia faces the greatest decline in marine fisheries as a result of climate change compared to other nations, with a potential decrease in catch of 20% in the next three decades [8]. Ironically, evidence of this shift has become increasingly apparent since Indonesia's post-independence efforts to expand fish production capacity during the late 1960s [9]. Strategies to mechanize the nation's fish production capacity are believed to play a significant role in marginalizing traditional small-scale producers [9,10]. In particular, there are concerns that subsequent growth in the international fish trade has brought institutional support and beneficial market arrangements to only a few privileged actors, including trading middlemen [11–13].

The essential and vulnerable nature of fisheries in Indonesia has made securing equitable livelihood outcomes a critical task [14,15]. However, much of the existing work on fisheries sustainability in Indonesia is focused on managing fish stocks rather than the local value chain and associated cultures and economies [9]. For instance, the most

* Corresponding author.
E-mail address: nicole.grace33@gmail.com (N. Roberts).

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popular strategies for managing fisheries in Indonesia include gear restrictions, marine protected areas (MPAs), and even coral reef restoration [1]. The Coral Triangle Initiative is one such program aimed at managing fisheries to improve food security through coral reef protection (e.g., MPAs) and restoration. However, attempts to achieve those objectives have drawn criticism for a lack of understanding of local power dynamics, local/global relationships, and historical relations [1,16–18]. In other words, the focus of the Coral Triangle Initiative managing bodies– including the Ministry of Marine Affairs in Indonesia, private, and public conservation partners–on fisheries production tends to simplify trading roles beyond the harvest level, and in effect, fails to consider the political or social ecology within the fisheries system [14,9,17]. Just as ecological factors affect fishing access to the resource, social attributes including trade networks and market structures shape how benefits are distributed [2,13,19]. These dynamics have important implications for the sustainable and equitable exploitation of marine resources and must be considered by policy to better align governance with unique institutional settings [13,20,21].

In contexts like Indonesia, where formal regulatory enforcement is weak or nonexistent, informal social networks called patron-client systems often persist [15,22]. A patron-client relationship is characterized as an "unequal (but theoretically nonbinding) relationship between a superior (a patron or leader) and a number of inferiors (clients, retainers, or followers), based on an asymmetric exchange of services" ([23], p.16). In these institutions, traders and boat owners– often embedded in multi-level forms of patronage themselves– function as bankers to provide credit and social services to lower fisherfolk. As "gatekeepers" of the value chain, patrons influence gear choice, target species, and market pricing, and in turn, social, economic, and political decision-making [24]. Though these kinds of hierarchical relationships existed long before the industrial age of fishing, policies attached to the Blue Revolution have amplified and reinforced their effects in Indonesia [9]. Financial assistance in this form is at once considered essential to fisheries production, while also being a barrier to socio-economic equality and sustainable fishing practices [21,23,25]. De-facto trading institutions like these are entry points for understanding the Indonesian fish trade's impact on social governance, or the rules operating in a value chain [26,27].

Previous studies have demonstrated the influence of fisheries patron-client systems over distributional outcomes at the national or regional scale [21,23,28,29], but how these processes manifest at the community level is poorly documented. Multi-stranded relationships with economic, political, and social ties demand a more detailed analysis that goes beyond the dichotomies of "fisher" and "trader" and into nested systems and relationships [23,30]. While value chain studies have examined the macro-level function of national economies extensively, data-poor fisheries in Indonesia lack empirical evidence of species composition and value attached to this system of trade, particularly at the local level (e.g., [31]).

Value chain analysis (VCA) is one way to understand the distributional effects of trade. A VCA maps the activity of actors participating in production, marketing, sales, and consumption of a product. With the ever-expanding nature of market economies, VCA has become a tool for researchers to examine the composition of value chain governance within a given supply chain: profit and cost structures, characteristics of agents, and the flow of goods and services [32]. More recent VCAs applied to fisheries have taken social equity into consideration [33–35]. Although VCAs are designed to assess barriers to equitable value chain governance, few move beyond production performance indicators (i.e., income, fish volume, pricing) and actors at the harvest end of the chain like fishers and their immediate buyers [20,35]. A lack of data depicting multi scalar socio-political organization in Indonesia limits strategies for enhancing the contribution of fisheries to social and economic development of all actors [36].

There is ample evidence to suggest that governance is a crucial component of sustainable fisheries [15,35,37,38]. Promoting equity in fisheries governance first requires an assessment of the relationships that exist, and the local institutions that mediate them. To fill this gap, this paper aims to better understand the socioeconomic factors that mediate fish catch and distribution in a small Indonesian island-based fishing community governed by patron-client systems using VCA. The island's social context gives rise to the following questions: i) In what ways do the regional trading systems influence fisheries value chain governance?, and ii) How does the current structure of trade align with certain fisheries and fishing actors on the island? By situating the role of fishes (pelagic and reef-based) within dynamic social networks, another research aim is to characterize trading dependence in this community. This case study adds to the growing literature documenting the impacts of trade and relationships on fisheries, which remains a significant gap in Indonesia's current fisheries governance [9]. In being the first research to connect community-level outcomes to regional fish trading activities, this study demonstrates the critical need for coordination among formal and informal governance bodies at the national, provincial, and local levels in Indonesia. Results are discussed in the context of improving coastal governance strategies to better address uneven outcomes and the divergent roles various actors play in shaping them.

2. Methods

2.1. Study site and context

The research focuses on a small fishing island community located in the Spermonde Archipelago (Fig. 1). The Spermonde Archipelago in Indonesia extends about 60 km offshore from Makassar in South Sulawesi Province, a popular port for the region's fish trade. As with many other areas in Indonesia, the local coastal population in the region is highly dependent on fisheries resources [39]. Several thousand fishing households are spread throughout the islands and rely on fishing as their primary source of income [13,40]. Fisheries in the region are characterized by a large variety in gear types and boat sizes, targeting species across both shallow coastal coral reefs and deeper pelagic areas in the open ocean.

Fig. 1. Map of the study region of Sulawesi and the Spermonde Islands (shown by the arrow) where the study island is located. Much of the fish caught by Spermonde islanders is traded in the city of Makassar, a regional fishing port.

The Spermonde Archipelago is believed to have been first inhabited by the nomadic Bajau people in the 16th century [41]. The region's islands became important trading outposts under Dutch occupation in the 17th century and various ethnic groups permanently settled thereafter. Accounts from Spermonde households [42] and other scholarly sources (e.g. [43]) surmise that the people of Spermonde fled mainland Makassar in the mid 20th century, seeking political refuge and economic opportunities. Once settled, the once agrarian Makassarese were forced to adapt to their new maritime existence and the social organization it entailed [43].

Like other islands in the Spermonde, nearly all adult men on the study island are fishers. Here, a total of 185 households reside on approximately 50,000 square meters, making it one of the smaller islands in the area. Many islanders belong to pelagic fishing crews with 8–15 members on a single medium-sized vessel (~20 GT) built for purse seine fishing. A significant proportion of fishers also engage in small-scale fishing of pelagic squid during its season from June to November. The remainder fish for pelagic and reef fish using small boats (<10 GT) and handlines.

Patron-client systems govern access to fisheries and trade in the region [15,21]. It is theorized that characteristics of patron-client relationships, including asymmetrical exchange of resources, market access, and gear loans, indirectly drive habitat and fisheries degradation in the Spermonde [13,15,21]. These social networks are thus key features of the value chain to examine when devising fisheries governance [30].

Patron-client systems in the Spermonde have been shaped by a centuries-long history of political regimes and maritime trade. The foundation for patronage formed during the pre-colonial era where local rulers required kinship and loyalty to access socioeconomic benefits of the Makassar kingdom [23]. With the Dutch colonization of Indonesia, Makassar became a center for international trade in the 18th century and economic terms of patronage developed significance [43]. Post-independence, political instability in the 20th century encouraged the development of informal governance systems to organize trade. Patronage offered protection to those who engaged in the patron-cl; additionally, it enabled them to appeal to urban institutions [44]. Modern patron-client systems have retained some aspects of traditional hierarchies (e.g., social prestige, loyalty) while also being flexible enough to adapt to changing circumstances [9,13,23].

2.2. Data collection and sampling approach

This study sets out to map the dynamics of fish catch and sale originating from the study island with surveys and key informant interviews from December 2019 to February 2020. The hour-long surveys tracked fish volumes, prices, links, and relationships in the local language of Makassarese and included both open-ended and closed responses from both fishers and traders. Questions were tested twice with a subset of respondents (in Makassarese) and modified based on the actor types and dynamics in each fishery. The final survey captured value chain data related to: i) catch, using local fish guides developed with islanders prior to the survey; ii) sale, including which actors the fish are bought and sold from, prices, and places, iii) revenue, and iv) seller/buyer relationships. Since some of the qualitative survey questions did not distinguish between multiple roles, only single-role respondents (e.g., independent squid fishers who did not also serve as crew members) were considered in final analyses for buyer/seller relationships. Each respondent was asked to consider their catch and trade for a typical day during the calm and windy season, with the calm season (June to November) representing a period of high catches, and the windy season (December to April) yielding fewer catches.

The proportion of each fisher type on the island was not known, however, insight during key informant interviews with community leaders determined that fishing groups tended to reside on different sides of the island. Therefore, to obtain a representative sample of the island's fishers, a stratified random sampling design was employed, yielding a total of 13 fishers in each directional quadrant of the study island: north, south, east, and west. Semi-structured surveys were administered to the head fisher of each household, in total representing nearly one-third ($N = 52$) of the 182 households located on the island.

All traders ($N = 9$) residing on the study island took part in the survey; this way, total trade volume exiting the island could be approximated. The next step was to identify actors "downstream" (i.e., the off-island points of trade in the value chain). Here, a snowball sampling approach was used to identify the remaining actors connecting the value chain that did not reside on the island (e.g., middlemen). In contexts where the composition of actors was unknown by the researchers in advance, this method can ensure that the appropriate contacts are eventually identified [45]. The data collection period reached its completion with end traders in the Makassar markets, the last trading junction for island-based fish before they reach local consumers throughout Makassar and beyond. In all, this approach yielded information from 23 traders on- and off-island.

Price and volume of fish species were generally given in formats akin to their sale, such as baskets, individual fish, and boxes. Additional interviews in March and December 2020 sought to standardize these size ratios to kilograms (kg) for analysis, and triangulate market prices provided during the survey interviews. Small baskets were estimated to contain approximately 5 kg of fish, while large baskets and boxes were estimated to contain 15 kg of fish.

2.3. Data analysis

Descriptive analyses with average catch volume, prices, expenses, and income were performed using SPSS Version 26. The data sample includes a significant portion with fishers who belong to boats with multiple fishers, so to avoid overestimation, only the fish catch reported by the boat captain or boat owner of each vessel was reported. Additionally, island-based fishers only go out to sea when the weather is permissible, while Makassar traders handle fish every day. Catch per unit effort (CPUE) was equivalent to the amount caught on each boat for each gear type. To convert catch amounts to trade, the total amount caught was divided by the average number of days each fisher goes out to sea in the calm or windy season.

Data on actor connections, catch volume, and market value for the fisheries informed value chain maps. A different map was created for each fishery and season using R statistical software [46] and the 'netmeta' package [47]. Actors in the value chain were represented by nodes. Total value and volume between each node were represented with proportional arrows as the fish catch moved from the beginning to the end of the chain. The size of each node indicated the degree of connectedness (i.e., number of links) between each actor and the rest of the value chain.

Value represents revenue, calculated using the following equations for fishers (Eq. 1) and traders (Eq. 2):

$$R_f = ((q_p{*}s_p){*}T_f{*}\ P_s) \quad (1)$$

Where R_f is fisher revenue on an average day during the calm or windy season, q_p is quantity of fish caught in kg on an average day during the calm or windy season, s_p is selling price of fish in Rp/kg on an average day during the calm or windy season, T_f = proportion of time spent fishing on an average day during the calm or windy season, P_s = profit share.

$$R_t = ((q_p * s_p) - (q_p * b_p)) * P_s \quad (2)$$

Where R_t is trader revenue on an average day during the calm or windy season, b_p is the buying price of fish in Rp/kg on an average day during the calm or windy season.

Profit share is the proportion of the selling price that each fisher or trader receives from the sale. Profit sharing is an extension of the patron-

client system, existing as the primary line of credit for fishers and traders for whom formal banking systems are inaccessible [25]. Patrons extend credit to their clients to meet their everyday needs, or to purchase gear and boats. In exchange, the client is obliged to sell their fish to their patron. The patron then takes a portion of the profits from the fish sale. This setup can confer stability to both the patron and client by ensuring the relationship continues, and additional financial advantage to the patron by granting power to set the price and reduce transparency in the buyback process compared to a conventional loan [13,25]. Since payment amounts and frequency depend on debt status and relationship with each buyer and seller, the exact profit-sharing amount for each respondent in the study could not be obtained. Each respondent was instead asked to report the proportion of value they retain in a standard transaction. Although this method potentially reduces the accuracy of revenue estimates, inquiring about individual debt was not feasible. The intent instead was to gain a general understanding of trading patterns across different links of the value chain.

Quantitative analyses were undertaken in SPSS Version 26. Differences in revenue among actor groups were tested using a one-way analysis of variance (ANOVA) and Tukey post-hoc tests. The Kruskal–Wallis test with Bonferroni correction, followed by Mann Whitney post-hoc tests, were used for catch and trade volume across actors because the data were non-parametric. Finally, Welch's ANOVA and Games–Howell post-hoc tests (non-parametric) were applied to evaluate differences in market price across fish groups (small pelagic, large pelagic, reef, and pelagic squid).

3. Results

3.1. Actor titles and responsibilities

3.1.1. Fishing

Survey sampling and key informant interviews identified three main fishing formats on the study island: medium-sized vessels (~20 GT; hereafter called crew boats) which targeted pelagic fish; independent fishing for pelagic or reef fish; and independent squid fishing in the nearshore pelagic areas. All independent fishers- referring to independent pelagic/reef fishers and squid fishers- were considered small-scale in Indonesia because they operated vessels under 10 GT in size.

Crew-based fishing was the most popular fishing format on the study island (Table 1). Within each boat there were three categories of actors: owner, captain, and crew members. Two of the actors interviewed held both boat owner and captain positions. The average size of a boat crew was 13 members (± 2). Boat captains handled the daily affairs of the boat, including trade, most of the cash lending to crew, and fishing management at sea. This left boat owners with the responsibility of fronting all expenses- fixed and variable- required to fish. All crew boats targeted pelagic fish with 200–300-meter purse seine nets.

Half of surveyed crew members and most independent fishers also operated squid fishing boats during the squid season from June through November (Table 1). Squid fishing was a role taken on by nearly half of all fishers on the island and most respondents overall. The operation involved some gear exclusive to squid fishing, including specific bait hooks, but much of the physical capital required was interchangeable with other independent fishers. Independent pelagic and reef fishing was the least popular fishing approach on the island (Table 1). Independent fishing consists of one-man crews employing small-scale handline and longline techniques in reef and nearshore pelagic areas.

All fishers were engaged in fishing during both the calm and windy season; however, the extent of their involvement was seasonally determined. In the calm season from April to November, fishermen went out to sea an average of 20 (± 5) days a month. Most fishing did not occur during the week of a full moon based on the belief that light interferes with fishing activities. Fishers reported less frequent trips during the windy season (November to April; 13 ± 6 days) as strong winds brought adverse weather conditions to the surrounding reef and pelagic areas.

3.1.2. Trading

Surveys revealed a systematic regional trading system from point of capture to end sale in the port city of Makassar. The morning following each fishing trip, crew boats traded their catch on-island to the next link in the chain: crew collectors ($N = 3$). Crew collectors on the study island sourced exclusively from the island's fishing captains, who pooled the day's catch from their fishing crews. All independent fishers sold the entirety of their catch to on-island independent collectors ($N = 5$). Both types of collectors reported selling their catch to traders off-island: auctioneers at the landing site in Makassar ($N = 4$), or less commonly, to auction traders ($N = 2$). Auctioneers are auction site owners, acting as mediators between the island sellers (fishermen and small traders) and Makassar's regional buyers (auction traders, end traders, and consumers). Auctioneers would collect the catch from island sellers and market the catch each morning at the auction. Several buyers sourced from the auction, including consumers in Makassar markets, auction traders, and end traders in Makassar markets ($N = 9$). Auction traders sourced exclusively from auctioneers and sold to a combination of end traders and consumers in Makassar markets.

3.2. Fish composition in harvest and trade

3.2.1. Harvest

Fishers on the study island reported catch amounts and values for 20 species: 16 pelagic-associated and 4 reef-associated species. This analysis details the 12 species that were mentioned by 5 or more fishers. The final list spans 4 fish types that are biologically and spatially distinct: small pelagic fish ($N = 5$) (classified as "small" if their listed common length was 30 cm or less on FishBase [48–50], large pelagic fish ($N = 3$), pelagic squid ($N = 1$), and reef fish ($N = 3$) (Table 2).

Catch was dominated by pelagic species, with pelagic finfish representing 78% by volume and 77% of the value gained by the study island fishers in the calm season and 88% of the volume and 90% of the value in the windy season. Small pelagic species had the largest share of volume and value of any fish type across both seasons (Fig. 2). Total harvest was dominated by crew boats which caught 78% of all fish by weight on the island in the calm season and 82% in the windy season and retained 77% of the value in the calm and 85% of the value in the windy season accrued by on-island fishers. Small-scale capture was compositionally like crews except for large pelagic species, which were not part of the independent fishing portfolio, and squid, which crew boats did not catch (Fig. 2). Purse seines had a higher average catch per unit effort across both seasons (calm, $X^2 = 10.687$, $p = 0.005$; windy, $X^2 = 10.705$,

Table 1
Demographics of fishers surveyed in the study community. If there are two percentage values, the first refers to the proportion of respondents in each category out of the total fishers on the island (N = 237), and the second indicates the percentage out of the total respondents interviewed (N = 53). A single value shows the proportion of respondents in each category out of the total interviewed.

Fishing format[a]	Actor type[a]
Crew-based fishing (76%;77%)	*Crew owner* (11%)
	Crew captain (13%)
	Crew member (58%)
Independent pelagic/reef fishing (8%;8%)	*Pelagic fisher* (8%)
	Reef fisher (2%)
Squid fishing (43%;55%)	*Squid fisher* (43%;55%)

[a] Percentages sum to over 100% because some fishers have multiple roles.

Table 2
Fish species included in the value chain analysis, stratified by fish type.

Fish type	Fish species		
	Scientific name	Common name (English)	Common name (Makassarese)[a]
Small pelagic fish	*Rastrelliger kanagurta*	Long-jawed mackerel	*Banyara*
	Selar boops	Oxeye scad	*Katombo*
	Sardinella gibbosa	Goldstripe sardine	*Tembang*
	Decapterus macarellus	Mackerel scad	*Layang*
	Karalla dussumieri	Dussumier's ponyfish	*Bete-bete*
Large pelagic fish	*Sphyraena qenie/jello*	Pickhandle/blackfin barracuda	*Asa-asa*
	Katsuwonus pelamus	Skipjack tuna	*Cakalang*
	Scomberomorus commerson	Spanish mackerel	*Tenggiri*
Reef fish	*Siganus lineatus*	Golden lined spinefoot	*Baronang*
	Balistapas undulatus	Orange-lined triggerfish	*Papakulu*
	Sepioteuthis lessiona	Bigfin reef squid	*Cumi bantolang*
Pelagic squid	*Loligo spp.*	Mixed pelagic squid	*Cumi teropong*

[a] Makassarese is the local language spoken in Makassar and on the study island.

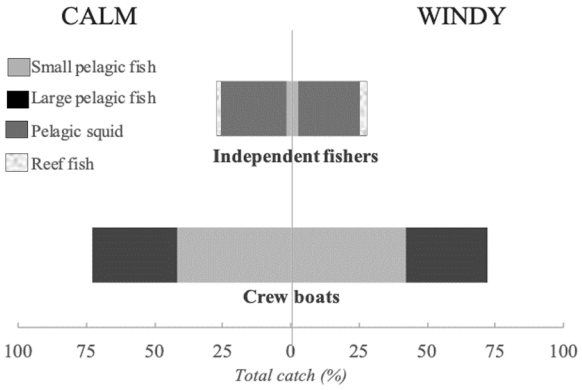

Fig. 2. Catch composition of fishing actors as a percentage of total catch volume (kg) during the calm and windy seasons.

$p = 0.005$) when compared to independent fishers (pelagic/reef, $P = 0.016$; squid fishers, $p = 0.005$). This trend continued with higher catch per capita compared to independent pelagic/reef ($p = 0.055$) and squid fishers ($p = 0.03$) in the calm season ($X^2(2) = 7.165$, $p = 0.028$), and a nonsignificant pattern in the windy season ($X^2(2) = 5.394$, $p = 0.067$). No statistically significant difference was found between independent and squid boats in per boat or per capita catch ($X^2(2) = 6.345$, $p > 0.05$). There was a significant decline in average catch amount per boat for all boat types (crew boats, $t(3) = 10.549$, $p = 0.002$; independent pelagic/reef boats, $t(4) = 3.925$, $p = 0.017$; squid boats, $t(3) = 4.119$, $p = 0.026$) in the windy season.

The pelagic squid fishery played a smaller role in the island's harvest but a major role in small-scale fishing. In the calm season, squid fishers caught 20% of the total fish volume and retained 19% of the value in the study island fishing portfolio, ranking squid (*cumi teropong*) third for the island's harvest in that season (Fig. 2). Squid represented 84% of the island's small-scale fish harvest in the calm season and 73% in the windy season respectively, and 87% of the value retained by independent fishers in the calm season and 80% in the windy season. Small pelagic and reef fish each made up around 7% of the small-scale fish catch by volume in the calm season and 15% in the windy season. At 2% and 3% of the total catch by volume in the calm and windy seasons respectively and 2% of the catch value, reef fish were the least represented fish type in the study island catch. Only 2 fishers in the survey reported catching species on the reef.

3.2.2. Trade

Marketplaces connected to the study island trade were oriented towards crew-based fisheries landings. The top three most popular species traded by weight were consistent across crew boats, on-island, and off-island traders: *Rastrelliger kanagurta* (English name "long-jawed mackerel"; Makassarese name "banyara") *Selar boops* (English name "oxeye scad"; Makassarese name "katombo"), and *Katsuwonus pelamus* (English name "skipjack tuna"; local name "cakalang"). Pelagic fish represented 89% of the volume and 83% of value in the trading system overall, followed by squid and then reef fish (Fig. 3). Small pelagic fish was the top fish type traded by volume during the calm (70%) and windy (75%) seasons. Species in this category accounted for over half of the total traded volume for nearly every link in the chain across both seasons, and a slightly greater dominance during the windy season (Fig. 4). Independent fishers and their collectors on the study island were exceptions because squid was the dominant catch. The share of small pelagic fish in the trading portfolio was highest at the end of the chain; over 80% of the fish offered by end traders in Makassar during the calm and windy seasons were small pelagic species.

Pelagic squid (*Loligo spp.*; local name "cumi teropong") was the third-most popular species offered by the study island fishers overall, and the only species exhibiting an export trade pathway. 34% of squid volume in the calm season and 41% in the windy season sold by on-island traders went directly to exporters instead of the regional marketplace. Squid was the least represented catch in the Makassar marketplace at 4% of end trader volume in the calm and windy seasons (Fig. 4).

With only 2 independent fishers in the surveys harvesting on reefs, and around 8% of the island's fishers identifying as independent pelagic/reef ($N = 18$), exchange of reef fish from the study island was limited. Reef fish represented 3% of the catch leaving the study island in the calm season, and 1% in the windy season. In the Makassar marketplace, a similar pattern arose: end traders sold fish consisting of 8% reef-derived species in the calm season, and 7% in the windy season (Fig. 4).

3.3. Trade relationships in the patron-client system

Surveys and key informant interviews with the study island fishers and traders described a hierarchical, debt-based structure to regional trade. The patron-client system was common from the study island to the Makassar landing site; 87% of fishers ($N = 53$) and 42% of traders ($N = 24$), including 5 out of 9 on-island, were involved in credit relationships. The status of patron (lender) or client (debtor) was determined based on whether each respondent was on the giving or receiving end of a) debt to a buyer, and/or b) profit sharing. These arrangements are explored in the following sections.

3.3.1. Profit sharing

Profit sharing was one of the primary means by which actors in the chain settled debt. In a profit share, patrons lend money to clients in exchange for a percentage of the client's sale. In this island setting, profit sharing was enacted in part because of the high capital requirements of crew boats on the study island, all of which ($N = 8$) took part in the profit-sharing scheme. At an average cost of nearly 180 million Rp ($\pm$ 63 million), crew boats were the largest reported expenses by any fisher or trader. This is compared with 4 million Rp ($\pm$ 3 million) for small-scale fishing boats. Crew boats typically accrue higher fuel costs from traveling up to 20 km from land to target schools of pelagic fish. Fishers in the key informant interviews explained that owners and captains were bridging actors, acting not only as clients borrowing from their collector and auctioneer buyers, but as patrons to their crew. Most crew members borrowed money from their boat captain and/or boat owner for daily needs in the windy season or to purchase equipment for their seasonal squid fishing operations. Creating debt to the boat was one of the primary means by which boat owners and captains maintained the loyalty of their crew.

Profit sharing steps from crew boats to the landing site in Makassar

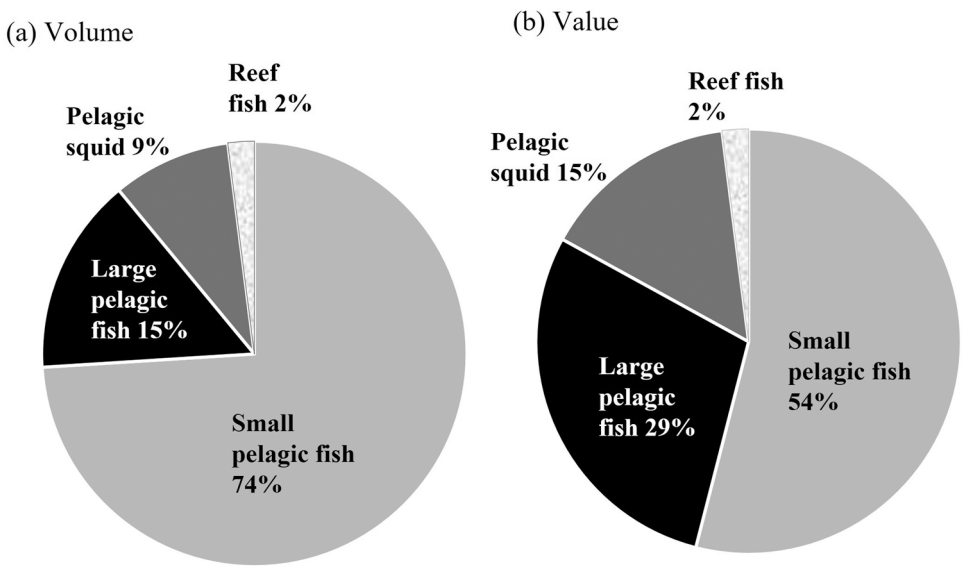

Fig. 3. Proportion of total traded (a) volume and (b) value of fish types, combined across the calm and windy season.

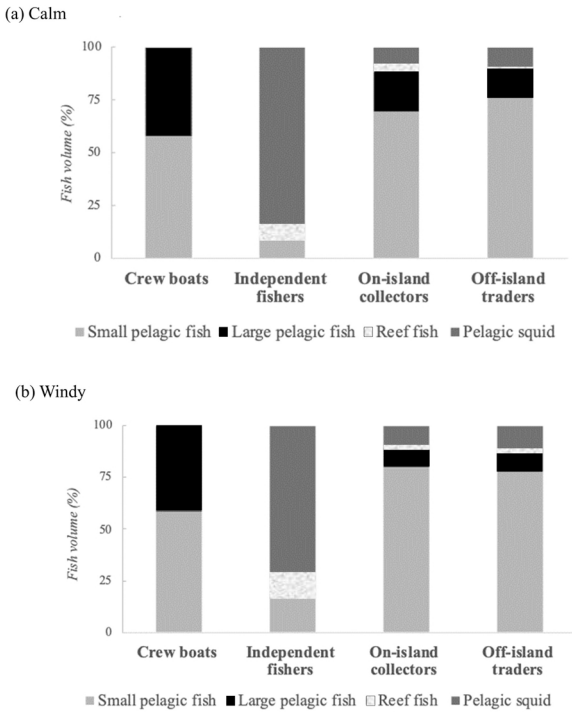

Fig. 4. Composition of fish types by volume in the value chain on an average day during the (a) calm and (b) windy seasons. Each actor is ordered in the direction of trade.

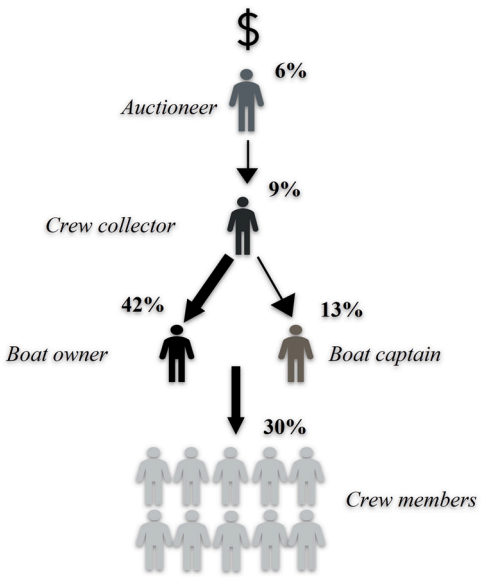

Fig. 5. The profit-sharing structure of the study island-Makassar crew-based trade as reported by fishing and trading respondents. The width of the arrows represents the relative proportion (shown in %) of profit from a fish sale going to each actor. The first monetary sale of crew-based catch is made by the auctioneer. The arrow direction shows the order in which the profits from that sale are distributed.

applied to all respondents attached to crew-based fishing trade. In the surveys, crew collectors reported taking each desired fish species from the boat captains on the study island to the landing site in Makassar. At the landing site, auctioneers appraised the catch for 5–7% of the sale profit. After the collector received their cut of 8–10%, the remaining profit was then transferred to the crew boat for distribution. There, the boat owner would take 50%, the captain would take 15%, and each crew member would split the remaining value (approximately 2–4% per fisher, depending on the size of the crew) (Fig. 5). During informal discussions several fishers indicated that these values were conservative because patrons may take a greater proportion of profits if they deem it appropriate for the debt owed.

3.3.2. *Bargaining power*

The status of patron or client in selling relations dictated bargaining power, or the capacity of actors to negotiate a trading agreement, in the study island-Makassar value chain. Twenty-nine percent ($N = 78$) of seller respondents were classified as clients based on their credit-based relationships with at least one buyer. Of this, most were independent fishers (including squid, pelagic, and reef) (9 out of 23 clients) and crew members (7 out of 23 clients) in debt to independent/crew collectors, while the remaining were independent/crew collectors (7 out of 23 clients) who borrowed from their auctioneer. 25% of buyers ($N = 24$) were classified as patrons based on their credit-based relationships with at least one seller. This included all auctioneers ($N = 4$) and two independent collectors, both of whom were also clients because of having debt to sellers.

Flexibility in buyer/seller choice was a key feature of patron-client relationships. 95% of client sellers ($N = 24$) did not feel they could replace their buyer and/or sell to another buyer, compared to 25% of non-client sellers ($N = 56$). A primary reason given by non-client sellers for their obligation was family connections between on-island fishers and on-island traders (15 out of 16 responses). One off-island trader stayed with his client because of the debt he was owed. All patrons ($N = 6$) felt free to replace their buyer or sell to another buyer if they wished.

Position in the value chain and patron-client status also played a role in autonomy over buying/selling price. 83% of patrons ($N = 6$) reported having sole control over the price of the fish they buy, compared to 33% of non-patron buyers ($N = 18$). On the selling end, only 8% of clients ($N = 21$) reported having sole control over the price of fish, compared to a vast majority of non-client sellers (44 out of 56 sellers). According to responses for "who determines the buying/selling price of your fish?", auctioneers and boat captains had the most autonomy over sale price; 39% of fisher responses ($N = 53$) suggested that price was set by the boat captain, while 40% of trader responses ($N = 48$) and 33% of all responses ($N = 101$), noted the auctioneer. All auctioneers believed that they had sole control over both the buying and selling prices of fish. A majority (19 out of 24 interviewed) of all traders believed they jointly or solely decided on buying and/or selling prices of fish. Bargaining power was further illustrated by the exclusive membership of actors in information exchange. Of all the fishing and trading actors prompted, only auction traders and auctioneers ($N = 5$) were members of trading organizations.

3.4. Trading structure of the patron-client system

3.4.1. Trading network capacity

The value chain exhibited an hourglass shape (Fig. 6), whereby a small number of actors in the middle of the chain channeled fish from much a much larger number of fishers and collectors at the Makassar landing site. On a typical day of trade, active fishers on the island ($N = 120$) sold to 9 collectors on the study island. All collectors sourced their catch from on-island actors and sold to 1 Makassar auctioneer. Records of the auctioneer names provided by collectors identified 5 auctioneers and 5 auction traders involved in the study island-Makassar chain. The pool of buyers expanded once the catch reached Makassar: receiving catch at the Makassar port from the study island and other islands in the region, auctioneers purchased from 18 collectors and sold to 35 end traders and an unknown number of consumers. Similarly, auction traders in Makassar bought from the available auctioneers and sold to around 20 consumers. End traders sourced from a combination of auction traders and auctioneers, before selling the final product to approximately 60 consumers.

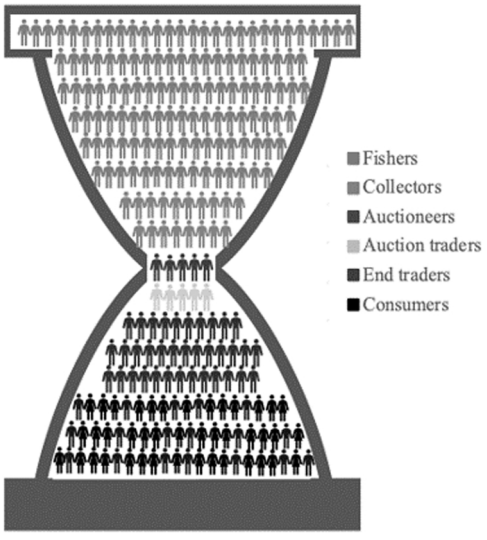

Fig. 6. Hourglass trading network of the Makassar value chain shown with actor type and number. Each icon is equivalent to one actor in the chain. The diagram is ordered from top to bottom in the direction of trade (Adapted from Purcell et al. [32]).

3.4.2. Volume capture by actors

Auctioneers exchanged the most volume out of any actor group- 4 traders handled 46% during the calm season, and 58% during the windy season (Fig. 7). Each auctioneer handled more volume on average compared to every other fishing or trading role in both the calm ($Z = -2.449$, $p = 0.014$) and windy ($Z = -2.449$, $p = 0.014$) seasons except for crew collectors (calm, $p = 1.00$; windy, $p = 0.077$). During the calm season, 29% of daily fish volume passed through 3 crew collectors on the study island. This proportion dropped to 9% during the windy season when crew catches were low. Five independent collectors on the study island, sourcing from independent fishermen, handled 6% of the volume during the calm season and 3% during the windy season. Lastly, 4 crew boats harvested and traded 9% of the total volume in the value chain during the calm and windy seasons. Twenty-eight squid fishers from the study island traded a total of 2% of the volume during both seasons- 19% and 11% in the squid fishery alone, for the calm and windy seasons respectively. Independent fishers caught less than 1% of the total fish volume in the value chain across both seasons, and 10% in the calm season (14% in the windy) when only considering the reef fishery. Leading to the Makassar landing site, 8% of the total traded volume in the calm season passed through the independent fisher pathway, while 38% was crew-based catch (Fig. 7).

3.4.3. Value capture by actors

In the calm season, total value retention, or the total proportion of sales for all species that were kept by each actor group in the value chain, was highest for crew collectors (3 individuals retaining 23%), boat owners (4 individuals retaining 18%), and auctioneers (4 individuals retaining 10%) (Fig. 7). The value accruing to crew members (26% for 43 fishers), independent pelagic/reef fishers (1% for 5 fishers), and independent squid fishers (11% for 28 fishers) was lowest. The Kruskal–Wallis test showed there were significant differences in revenue, calculated as the average value retained by individual actors, across actor types in both the calm ($X^2(9) = 51.912$, $p < 0.001$) and windy ($X^2(9) = 50.925$, $p < 0.001$) seasons (Fig. 8). Based on the post hoc pairwise comparisons, differences in the calm season can be attributed to patrons involved in crew-based trade (crew collectors, boat owners, auctioneers) with higher revenues than clients (crew members, independent pelagic/reef fisher, independent squid fisher) and end traders. Crew collectors and boat owners earned more revenue than all other actors except auctioneers. Up until their collection in Makassar, the independent fisher pathway on the study island generated 18% of the total value in the chain, while the crew-based pathway captured 56% (Fig. 7). In the windy season, value retention remained high for boat owners (19%), while auctioneers played a larger role at 20% the total value. Additionally, end traders became more important players, with 8 capturing 22% of the value compared to 5% in the calm season. Value retention for crew collectors, squid fishers, and independent collectors declined in the windy season, while independent fishers increased slightly to 1.5%. Auctioneers and end traders maintained higher revenues over clients (crew members and independent squid fishers) in the windy season (Fig. 8).

3.4.4. Desire to change positions

When asked "would you want to switch to a different fishing/trading role?", a vast majority of fishers (43 out of 53 interviewed) responded with "yes". All but 4 responses were crew members or independent fishers desiring a boat captain or boat owner position. Most of the fishers (31 out of 43 interviewed) who wanted to change desired more income.

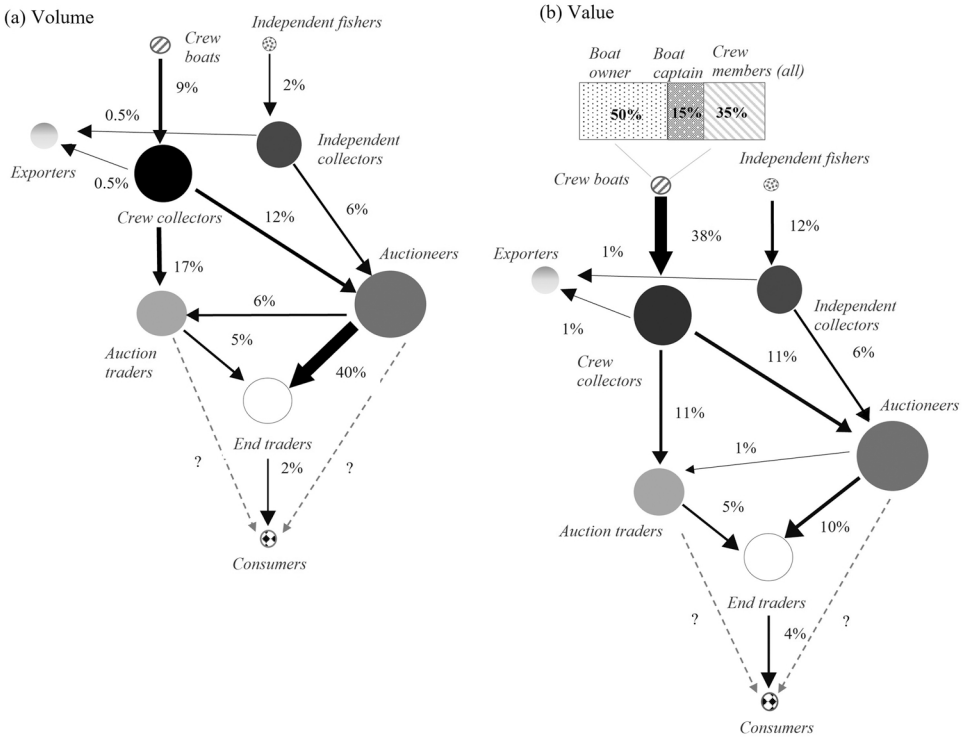

Fig. 7. Fish value chain depicting (a) volume (kg) and (b) value for all catch in the calm season. Arrows represent the direction of trade flow from fishers (orange) to on-island collectors (blue) to Makassar collectors (green), Makassar end traders (purple), and finally, consumers in Makassar (black). Arrow (vector) width represents the proportion of value traded, in percentage. Node size indicates the degree of connectedness, based on the number of trade connections going to and flowing from the actor. The dotted lines are existing connections whose values could not be obtained.

Traders were largely satisfied with their roles; 17% wanted to become a boat owner for more income ($N = 24$), while one independent collector wanted to become a crew collector for the same reason.

4. Discussion

While defining features of patron-client relationships have been examined in Indonesia and elsewhere [13,25,31], few studies have connected this governance system to fish flows and community-level outcomes. Value chain analysis is a useful tool for management planning in data-poor fisheries because it can identify socially meaningful dependencies between actors and marine resources. To the best of our knowledge, this study is the first to document the trade dynamics of a regional value chain from the perspective of a single fishing community. By tracking nested relationships, resource dependence, and socio-economic outcomes at the local level, the survey data show that patron-client relationships mediate catch and trade on- and off-island. On the study island, a debt repayment system known as profit sharing organized pelagic fishing crews- the dominant form of fishing on the island- and their trading partners. This coupled dependence on fishing form and the trading system it connects not only affects the immediate economic and social outcomes from the value chain, but also may limit the feasibility of livelihood flexibility and sustainable fishing practices. Since binding social and economic ties extend throughout the value chain, any reform efforts should involve cross-sectoral cooperation between formal management at the regional and local level, fishing and trading actors at each link in the value chain, and private and public conservation partners.

4.1. Patron-client relationships

The self-governing function of patron-client relationships and their unequal livelihood outcomes have major implications for social and ecological sustainability [22]. This study has provided additional evidence for the "captive value chain" theory [32], in which suppliers are dependent upon larger, more connected buyers for financial support and sales [51]. Patrons are central actors in the study island-Makassar value chain, controlling the flow of fish volume, prices, and market information.

Nearly all respondents sampled engaged in direct lending and/or profit sharing, providing clear evidence that the patron-client system is extensive and deeply embedded throughout the value chain. Based on their lending activity, four patron categories were identified: boat owners (on-island), boat captains (on-island), collectors (on-island), and auctioneers (off-island). As with other patron-client systems in Indonesia (e.g. [13]) debt and profit sharing influence unequal profit distribution. All types of patrons were found to have higher revenues over the remaining fishers. This conclusion is similar to the one drawn in Kenya which showed that traders had higher income levels than fishers [31]. However, in this study, the type of fisher and their status as a patron or client mattered greatly for revenue. Fishing clients who owe debt to a seller, including crew members and independent fishers, occupied the lowest revenue grouping. In the case of fishing crews, profit sharing locked each crew member into receiving on average 3% of the first sale, compared to 43% for each boat owner and 13% for every boat captain. These values are nearly identical to the profit-sharing breakdown reported in a value chain analysis of Philippine fisheries under patron-client governance [35], suggesting it might be a regional norm.

In addition to lending, other forms of social capital may contribute to the relatively higher returns achieved by patrons. Patrons in this value chain enjoyed greater control over buying and selling price and flexibility in trading arrangements. All patrons and most other non-client sellers reported determining the prices of fish they exchanged either jointly or solely, while essentially no clients had influence over sale price. Inflexibility accompanied a lack of bargaining power among clients: because of their debt, most could not replace their buyer or sell to anyone else. Previous studies have found that a lack of bargaining power and flexibility are often indicators of economic vulnerability because they restrict adaptive capacity [11,34,52]. For example, a case study in the Philippines demonstrated that while patron-client systems can shield fishers from short-term economic hardship through gear and loan provisioning, these coping mechanisms can inhibit long-term investments in sustainability and alternative livelihoods [53]. Unchecked bargaining

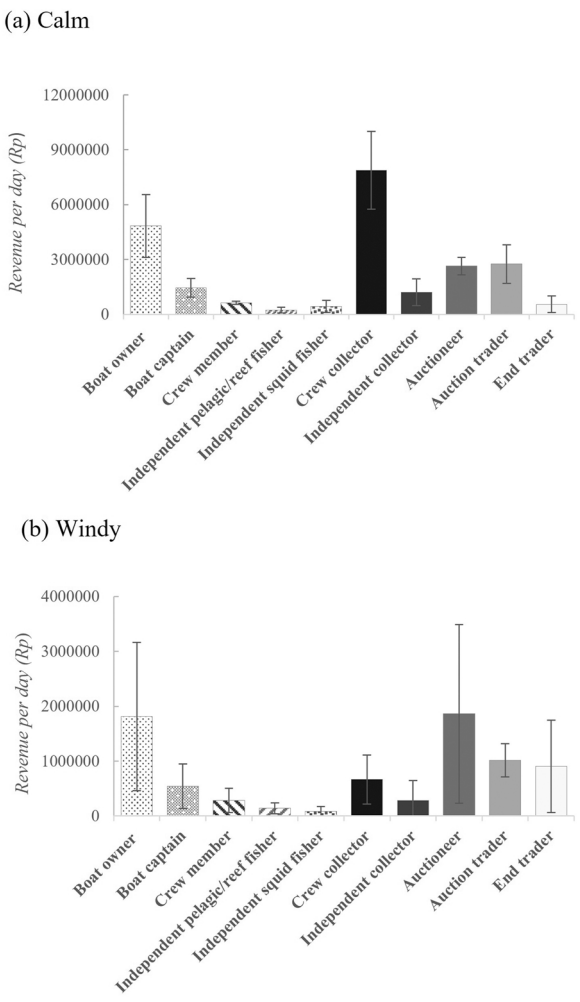

Fig. 8. Revenue (Rp) for each actor type on a typical day of trading in the (a) calm, and (b) windy season. Error bars represent standard deviation. Letters indicate statistically significant differences ($p < 0.05$).

power by patrons has been linked to overexploitation of target species [13,54], and often prevents fishers from engaging in collective action for fishing rights and market information [55].

Another element that is facilitating power asymmetries between actors is the value chain's distinct hourglass shape. The number of actors reduces significantly at the middle of the chain, with 120 fishers on the study island supplying just 5 auctioneers in Makassar. This pattern is consistent with other fishery value chains in the region [32,52]. A narrowing of buyers at Makassar ports means that auctioneers hold a central position as gatekeepers in the value chain, trading large fish volumes, accruing most of the value available, and establishing the largest number of connections with fishers and traders. Nearly all catch from fishermen on the study island (reef, pelagic finfish, pelagic squid) appeared to be sold at auction with auctioneers taking the first profits from off-island sales. The wide pool of buyers and sellers available to auctioneers could also help explain why they experienced greater revenue stability from the calm to the windy season compared to other actors. Borrowing is particularly important during the windy season as fishers cope during low catch periods [11]. Auctioneers, possessing high capital and diverse market connections, were best positioned to provide support through lending.

4.2. Dominance of pelagic crew-based trade

The findings show that pelagic crew-based trade mediates the movement of catch from island to market. Most of the volume and value in the supply chain was handled by crew collectors and auctioneers sourcing from pelagic fishing crews. Small pelagic fish were the most common fish caught and traded both on and off-island, while coral reef fish made up only a small fraction. The dominance of small pelagic fish in island catch was expected given that a vast majority of fishers on the island were employed in crew-based fishing and that crew boats were found to have the highest catch efficiency. On the other hand, small-scale fisheries catch was diluted in the total catch: independent fishers harvested less popular fish types like reef fish, and the pathway from catch to market involving small-scale fishers captured only a fraction of value and volume available in the value chain. As documented in the Spermonde [9,28] and Kenya [19], gear ownership networks marked by a few lending actors often determine harvest patterns, restricting flexibility and diversification in harvest.

The strong orientation of the study island and other neighboring islands (N. Roberts, personal communication) towards specialized fishing methods appears to support the concept of a fishing "lock-in", applied previously to the Spermonde region [9]. A lock-in occurs when repetitive interactions between actors result in a dominance of a particular mode of action. The drivers and consequences for dependence on fishing at a regional level include resistance to switching technologies or targeting new species [9,52]. Results from the study support this theory at the community level, with noticeable effects on the composition of island professions, harvest, and trade. Specializing in pelagic crew-based fishing on the study island means engaging in long chains of indebtedness where financial protection is strong, but autonomy and alternatives are scarce. Such a dependence may provision vital short-term support at the expense of social and ecological resilience within the fishery [53]. By structuring catch and trade around pelagic crews, regional markets also risk the long-term sustainability of small pelagic fish stocks; in fact, overexploitation of pelagic species has already occurred throughout much of Indonesia [14].

This initial assessment provides an overview of catch and trade composition by species in the study island-Makassar value chain. There are limitations to using estimates of seasonal time frames to guide responses. Since the surveys prompted fisher and trader respondents to consider all species and amounts caught and traded on a "typical" day during the calm and windy seasons, value and volume are potentially overestimated. The estimates provided here are primarily intended to provide relative comparisons, and therefore caution should be used if interpreted as absolute figures. Time series data on catches and trade are needed to triangulate the findings presented here and used by managers to track fluctuation in supply and demand.

4.3. Governance and management implications

Since patron lending appears to be the primary way capital accumulates in the value chain, alternative credit could offer one avenue for more equitable returns. It is widely believed that microcredit and savings schemes can improve value chain equity by reducing dependence on patrons [34]. However, there are several constraints to achieving a structural change in the value chain. This context-specific analysis revealed nested hierarchies where on-island traders function as both patrons and clients, and where entire value chains are involved in cascading profit shares and debt repayment, suggesting that these relationships are deeply embedded [19,21]. Profit sharing and predictable relational structures further suggest interdependencies in the value chain, or the need for resources of others to achieve one's goals [56]. As suggested by Nachum (2021), interdependence often defines power asymmetries in value chains and therefore can be a powerful mechanism for value redistribution. Comparative research on the nature of various interdependencies in fisheries would further articulate the potential for interdependent relationships to be leveraged for social change.

The survey data have also revealed that trust and family are major components of trading relationships on the island of study. Ignoring

these cultural and social factors governing trade at the local level can lead to oversights in management and assumptions that adaptations will be readily adopted when in reality that may be impossible given the current fishing structure [28,53]. For instance, microcredit schemes provided by formal institutions are less likely to be adopted by regional actors because they cannot match the flexibility and familiarity/loyalty of informal lending regimes [34].

Having flexibility in one's livelihood strategies is necessary to improve adaptive capacity and adjust to the various stressors existing in the fish trade [57,58]. Path dependence may reduce the ability of resource users to navigate change, like seasonal variability and long-term shifts in fish stocks [53]. Value chains examined here exhibit several characteristics supporting path dependence for the study island's catch and trade: i) highly predictable exchanges, ii) centrality of a few actors, and iii) a "lock-in" with crew-based fishing. This structure appears to be enabled and maintained by profit sharing, wherein many actors are dependent on their sellers for loans. While this study did not investigate the causal relationship of species demand, other research set in the Spermonde and small-scale African fisheries has suggested that demand for particular species originates from lenders (e.g. [19,20,28,59]). One major consequence of lending dependence is a structural inability of fishers and traders to switch out of their current mode of fishing, which can contribute to overfishing and to economic disparity [59]. The study island-Makassar trading system exhibits a strong dependence on highly migratory pelagic species, which despite their importance in this local-regional context, have received less attention from management and conservation in Indonesia compared to coral reefs [16]. Given the existence of other island communities in the Spermonde such as the one depicted on the study island (e.g. [15]) which are governed by dynamic and complex interactions between people and fish resources, interventions in the region should not assume a uniform dependence on any particular actor or fish, but must instead be attuned to the existing trading asymmetries of local communities.

Actors who possess bridging, bonding, and linking ties—the major components of social capital– offer potential for coordinating efforts at the island and inter-island level, making their cooperation paramount in management efforts [60]. Auctioneers are considered "opinion leaders" for holding central positions in both the knowledge and lending networks [19]. Additionally, they offer bridging ties between fishing and trading actors on individual islands and link them to the wider market as auction site owners [28,61,62]. Based on the nature of their centrality, auctioneers are highly influential actors with the capacity to build trust in governance processes. Patrons who are fishers themselves (i.e., boat owners/captains) can also have a profound influence over the structure of fishing and trade [9]. In the case of the study island, most fishers aspired to become boat owners because of their higher income status and believed that boat captains had most of the bargaining power over fish price. In addition to bridging crew members and small-scale traders, boat owners/captains also bond multiple types of fishers through debt, contributing to social cohesion and offering opportunities for knowledge transfer within the community [9,19].

5. Conclusions

In summary, this study has utilized a value chain analysis to reveal key socioeconomic factors affecting relationships in the highly localized yet widespread patron-client fish trading systems of Indonesia. Improving resource governance has become a key focus for fisheries management, however, formal regimes in the Spermonde Archipelago have struggled to translate their goals into practice [14,16,26]. Current strategies for fisheries management in the Spermonde do not consider the impacts of trade on capture fisheries, nor do they sufficiently acknowledge the importance of developing inclusive management and conservation strategies for pelagic species. Rather than limiting forms of management to fishing effort or gear restrictions and marine protected areas, for transformations to occur, actors and their interactions with one another must be prioritized [16,53]. Patron-client systems offer a level of social and economic security that would be difficult to replicate with other forms of lending (e.g., microcredit) in the Spermonde [28]. Additionally, patrons are the gatekeepers of information that they can transmit across bridging ties. However, the long-term sustainability of patron-client relationships is questionable because they rely on asymmetrical exchanges [24]. Fishers face many of the most commonly discussed indicators of livelihood vulnerability, including: seasonal fluctuations in natural resources, variable access to markets, and high dependence on patron-client relationships [11]. Systems with these characteristics tend to respond poorly to conventional top-down management strategies to improve fish stocks, food security, and fish-based livelihoods [63]. Results from this study instead support the idea that for fisheries reform to be effective, managers must strike a balance between working with the hierarchical socioeconomic structures in place within the trading system while also incorporating the perspectives of fishers and traders. Management that only considers fish production and general fisher or trader categories at the regional level are likely to miss the localized nuance that defines informal governance systems like the one featured in this study. Management and conservation partners would benefit from a greater awareness of organizing factors and of the granularity of social arrangements exhibited by the study island-Makassar trading system.

CRediT authorship contribution statement

Nicky Roberts: Conceptualization, Formal analysis, Methodology, Visualization, Supervision, Writing – original draft, Writing – review & editing; **Buchari Mengge:** Conceptualization, Methodology, Supervision, Investigation; **Muh. Rifadly Utina:** Investigation; **Farhan Muhatar:** Supervision, Investigation; **Anugerah:** Investigation; **Arham Icwardanhi:** Investigation; **Muhammad Zulkifli R:** Investigation; **Austin Humphries:** Conceptualization, Methodology, Visualization, Supervision, Writing- review & editing, Project administration, Funding acquisition.

Declaration of interest

None.

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