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Analysis of constraints and opportunities in marine small-scale fisheries value chain: A multi-criteria decision approach

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ABSTRACT

Small-Scale Fisheries (SSFs) globally and in Kenya face myriad constraints. However, there is little empirical information about actors' perspectives of these constraints and proposed solutions. The present study contributes to addressing this empirical gap. The study was conducted in Kenya's coast at Malindi, Mayungu, Mombasa, Shimoni and Vanga study sites. Data was collected through focus group discussions and supplemented by interviews of 403 actors (fishers, middlemen and small-scale processors). Constraints and opportunities were ranked using Analytical Hierarchical Process (AHP) method and reported under nine broad value chain dimensions. Results showed that all actor groups ranked financial capital as the most severe constraint. Market related constraints were ranked as the second most pressing problem amongst fishers and middlemen, while processors identified scarcity of fish. Other constraints identified, were related to resource, equipment and infrastructure, training, costs, governance, trust and labour dimensions. Solutions were ranked in corresponding order of constraints, except in a few cases. These findings can assist to bridge actors' perspectives with those of managers and other value chain development agents, and thus help to define appropriate interventions.

1. Introduction

Globally, particularly in developing countries, Small Scale Fisheries (SSFs) play an important role to millions of people depending on them for food, nutrition, income and employment as well as contribution to Gross Domestic Product (Béné et al., 2016; Mills et al., 2011; Salas et al., 2007). Goals of most fisheries policies, legal framework and management strategies are to sustain resource integrity to achieve these roles (Andalecio, 2010; Leung, 2006; Samoilys et al., 2017). However, SSFs face myriad constraints that hamper their full potential contribution. These include economic and political marginalization, perennial underfunding, lack of political voice, poor infrastructure, overfishing, habitat degradation, resource decline, poverty, threats from commercial vessels fishing inshore, illegal and destructive fishing practices, resource use conflicts, siltation, pollution and weak governance (Andalecio, 2010; Salas et al., 2007).

While a majority of these constraints are extensively documented in literature, they mostly address extrinsic environmental, resource or governance concerns (Pedroza-Gutiérrez and López-Rocha, 2016; Salmi, 2015). There is a shortage of information on value chain intrinsic and operational constraints. Most of the noted intrinsic and operational constraints include lack of infrastructure and equipment, poor transportation, high costs of operations, poor access to capital, scarcity of fish, low market demand and prices (Emdad Haque et al., 2015; Olsson, 2009; Pedroza-Gutiérrez and López-Rocha, 2016). These constraints have however been scantily addressed in context of actors' perspective in SSFs. Opportunities have also not been well analysed, due to general marginalization of SSFs and their perceived low returns (Mills et al., 2011; Pedroza-Gutiérrez and López-Rocha, 2016; Salas et al., 2007). The above constraints are not unique to fisheries. Other small-holder sectors such as agriculture also face similar constraints such as; poor access to credit and savings services, seasonally induced fluctuations in produce, price and income, poor access to inputs, high cost of inputs, weak capacity and poor governance of farmer organizations, lack of market information, poor transport systems, high cost of transport, poor and inadequate market infrastructure, post-harvest losses, poor market access and domination by cartels (Lenné and Ward, 2010; Poulton et al., 2006; Salami et al., 2010).

In Kenya, only a few studies have analysed marine fisheries constraints and opportunities. Karuga and Abila (2007) identified constraints as; high cost of inputs, low offshore fishing capacity, declining stocks and catch rates, weak actor organizational capacity, inadequate

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cold chain facilities, lack of business management skills, lack of appropriate markets, lack of market information, lack of landing site infrastructure, lack of banking services, actor's poor saving culture and inadequate training. Wamukota (2009) identified fish marketing constraints as; fishers' lack of ownership of fishing equipment, inadequate cold chain facilities and poor means of transport. Identified opportunities include facilitation to acquire modern fishing equipment, improvement of the cold chain, full implementation of the fisheries policy, promotion of aquaculture, formation and support of marketing groups and facilitation of training in organizational, managerial and business skills (Karuga and Abila, 2007). Despite these analyses, there is still lack of studies that empirically rank importance of constraints and opportunities in fisheries in Kenya.

To fully understand constraints and opportunities across SSFs' spectrum, it is necessary to consider the whole value chain, and not only on single nodes where governments and development agents' interventions have tended to focus (Salmi, 2015). Involvement of all value chain players in analysis allows broader capture of local concerns (Pita et al., 2010; Verweij et al., 2010).

The present study aimed at empirical analysis of critical challenges facing actors, and identification of solutions from their perspective. The objectives of the study were thus to i) identify and rank constraints and opportunities based on actors' perspective; ii) to analyse type, and level of support and services provided to actors in the value chain. The study used the Analytical Hierarchical Process (AHP)—a Multi-Criterion Decision Analysis (MCDA) tool to rank constraints and opportunities. Such tools suitably employ established criteria and sub-criteria to elicit actors' viewpoints (Andalecio, 2010). They help in balancing conflicting viewpoints by transparently ranking participant choices, and thereby improving acceptance of decisions arrived at (Andalecio, 2010; Leung et al., 1998). The study takes a value chain approach where all key stages and activities performed by actors are considered (Kaplinsky and Morris, 2001).

2. Overview of Kenya's SSFs

Fishing in Kenya's marine waters is dominated by SSFs, with approximately 13,000 fishers operating about 3000 vessels (Government of Kenya, 2014). Most vessels are canoes of various types, but large wooden boats (*Mashua*) and fibre boats are also in use (Government of Kenya, 2014). Only 2% of vessels are mechanized, with the rest using sails, poles and paddles for propulsion (Government of Kenya, 2016). However, the fishery shows steady mechanization, with increasing use of engines by 37% in the period 2014–2016 (Government of Kenya, 2016). Generally, supportive services and infrastructure such as improved landings sites and roads have been on a steady increase (Government of Kenya, 2014). The fisheries management structure includes community level management under the Beach Management Units (BMUs) at fish landing sites, and consists of fishers, middlemen, processors and other persons whose livelihood depends on fisheries (Government of Kenya, 2007).

The fishery is marked by seasonal migrations of local and foreign fishers (Fulanda et al., 2009). They arrive during the North East Monsoon (NEM) season and leave at the onset of the South East Monsoon (SEM) season. They are mainly attracted by calm seas in NEM season and availability of middlemen facilitation in cash and fishing equipment (Wanyonyi et al., 2016a, 2016b). Middlemen prefer migrant fishers because of their acclaimed superior fishing skills and hence land more fish (Wanyonyi et al., 2016a, 2016b). This however often leads to lowering of fish prices, and is a source of conflict with local fishers.

The value chain structure of the fishery consists of fishers who sell fish to small-scale fish processors, primary middlemen and company agents (Fig. 1). Small-scale processors target low-grade, low-priced fish and add value for sale to local consumers. Company agents and primary middlemen who also double as boat owners, target fresh fish for international and local markets respectively. Primary middlemen also sell

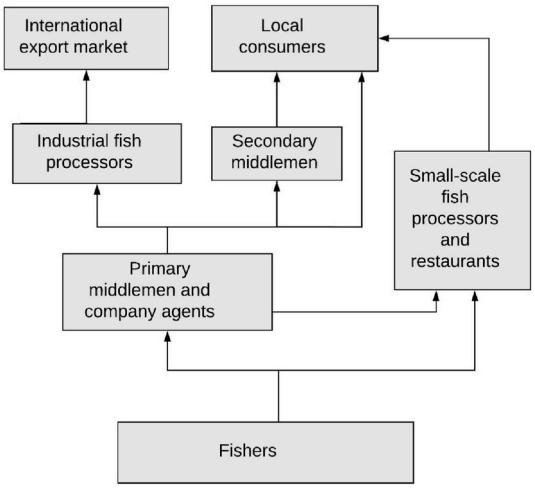


Fig. 1. Simplified marine fisheries value chain structure in Kenya.

low-grade fish to small-scale processors and high-grade to secondary middlemen. Fishing operations are largely facilitated by primary middlemen and company agents who provide fishing equipment and advance money to fishers.

Generally, value addition in Kenya's small-scale marine fisheries is minimal. During fishing, offshore fishers, gut and ice fish at sea, while inshore fishers don't. Gutting is mostly done for large-sized fish. All industrial fish processor's agents enforce fish gutting before freezing or chilling as a requirement by the processors. Primary middlemen, majority of whom own the fishing boats, collect gutted fish from fishers for direct sales or freeze it for later sale as whole fish. Only a handful of actors fillet, package and label fish products. Value addition by small-scale fish processors mainly involves gutting at landing sites before frying and sale.

3. Materials and methods

3.1. Study area

The study was conducted in Kenya's coast at five sites; Malindi and Mayungu fish landing sites in the North, Shimoni and Vanga fish landing sites in the South and Mombasa (Fig. 2). Mombasa is an urban convergence fish market for other coastal areas. Malindi is urban, while Mayungu is rural. Shimoni and Vanga are rural, and situated farther South of Mombasa. The dispersion of sites between rural and urban sites, and the North and South coastal spread, provides diverse and representative characteristics of the Kenyan marine SSFs. In addition, Malindi and Shimoni are near marine parks and reserves, while Mayungu and Vanga are farther to the South and bordering Tanzania. These variations capture fisheries dynamics relating to closed no-take zones and open fishing zones that may impact on catches. The sites also represent diverse types of fisheries. In Malindi, catch is dominated by high valued target species caught using handlines and is destined for premium markets. In Mayungu and Vanga, catches are dominated by small pelagics caught using reef seine nets and ring nets, although other large pelagics and demersals are also caught. Shimoni fisheries are dominated by reef demersals. Apart from Mombasa, all the study sites are frequented by migrant fishers. In terms of supportive infrastructure, new paved roads have been constructed at Vanga and Shimoni but access to Mayungu is still poor. A new ice making machine has also been installed at Shimoni. These new developments were not there by the time of the field study.

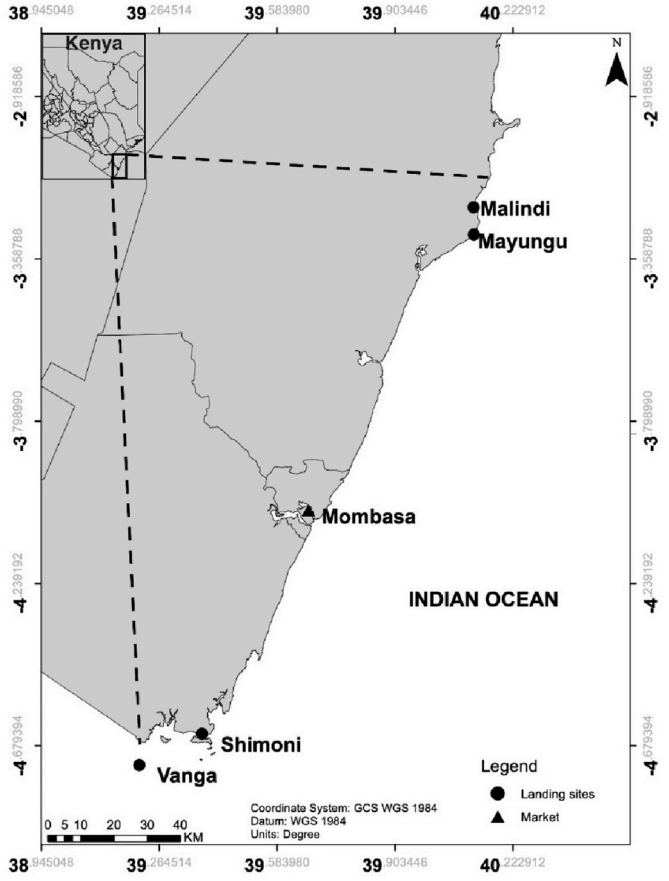


Fig. 2. A map of the Kenyan coastline showing study sites.

3.2. The Analytical Hierarchical Process (AHP)

The AHP method used in the present study utilizes pairwise comparison matrices to compare two choices at a time. This reduces chances of overwhelming participants in decision-making. The method developed by Saaty (1977) is widely used and described by many researchers in fisheries resource management (Baio, 2010; Jennings et al., 2009; Soma, 2003; Tuda et al., 2014). It was chosen in the present study due to its usability characteristics such as; 1) transparency, 2) simplicity in use, 3) and understandable to persons of low literacy. In the actual mechanism of comparisons, the subjective assessment of attributes assigns a weighted score, based on importance placed on each item at a time. A nine-point scale that infers respondents' preferences is employed during comparisons. A choice score of one on the scale indicates equal preference for the two items in comparison, while a choice of nine indicates the highest preference. During comparisons, a reciprocal scoring matrix is used. For example, when comparing *X* and *Y*, if a score of two for *X* is given, then *Y* is assigned a reciprocal score ($^{1}/_{2}$) when comparing *Y* against *X*.

The process of assignment of preference scores in AHP is deemed subjective, hence yielding inconsistent responses (Andalecio, 2010; Pascoe et al., 2014). Inconsistences should be checked through calculation of Consistency Ratio (CR) and inconsistent responses eliminated. Examination of inconsistencies follows basic AHP principles, that if a>b, and b > c, then a > c (Soma, 2003). CR is obtained by dividing individual weighted scores by the geometric mean as follows;

$$CR = \frac{CI}{RI} \quad (1)$$

Where RI is the (Random Indicator); a randomly generated value already obtained by Saaty (1990) depending on number of items being compared. CI is the Consistency Index obtained as follows;

$$CI = \frac{\lambda max - n}{n - 1} \quad (2)$$

Where n is the dimension of the matrix and λ is the largest eigenvalue of the matrix. A CR < 0.1 is considered inconsistent and the results should be rejected.

3.3. Data collection

Data collection using Focus Group Discussions (FGDs) as the primary data gathering tool to identify and rank constraints and opportunities was undertaken in 2016.

Actor groups targeted included fishers by gear, middlemen and processors (small-scale processors and small-scale restaurant operators). To avoid domineering of weaker groups by powerful ones (Andalecio, 2010), actor groups participated separately, in groups of 6–12 on separate days. Thus, a total of 12 FGDs were held at Malindi, Mayungu, Shimoni and Vanga. Participant selection was based on local leaders' advice, in addition to actors' experience and expertise identified earlier during individual interviews.

During the FGD exercises, constraints and opportunities were identified and ranked using the AHP method, following steps below (Fig. 3). In step 1, actors were asked to state their main purpose of participating in fisheries activities. In all the FGDs, actors' purpose revolved around improvement of incomes and economic well-being. Thus, the purpose was stated as attainment of financial performance. In step 2, listing of constraints preventing attainment of financial goals was done exhaustively. Similar points were amalgamated. Listing of proposed solutions (opportunities), was also done using similar procedure.

The third step involved ranking of listed constraints and opportunities. During ranking, the nine-point AHP scoring scale was explained to participants. The local Swahili language was used throughout the exercise. Analogy of fish weights was used to elicit importance along the weighted scale. For example, actors were asked how many kilograms they would place on a constraint against the other. A weight of 9 kg would mean a score of nine which is the highest score on AHP scale (Saaty, 1977). This made it easier for participants to relate with the problem and provide an appropriate score. The constraint with the highest score meant the most limiting challenge and vice versa. Consensus around participant choices was made through discussions. As ranking proceeded, a research assistant entered agreed scores on a pre-prepared excel matrix with automatic calculations. The same

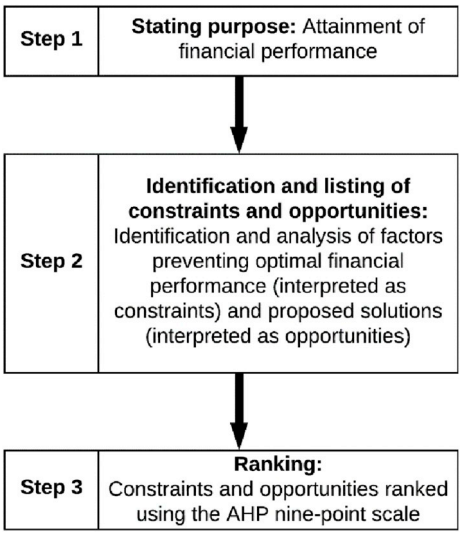


Fig. 3. Schematic presentation of Analytical Hierarchical Process steps followed during ranking of constraints and opportunities.

exercise was repeated for opportunities and took about 2-2$^{1}/_{2}$ h on average.

Individual surveys were also undertaken between 2014 and 2015 to gather key value chain related and demographic variables to supplement FGDs. Key variables targeted included; access to loans, support in training, provision of equipment, ownership of equipment, practise of alternative livelihoods, gender, age and education. Sampling followed procedures described in (Cochran, 1977; Wamukota et al., 2014), where systematic sampling targeting every *k*th respondent by actor category was applied. The sample size was calculated using Slovin's formula (Tejada et al., 2012; Yamane, 1967). A total of 403 respondents were interviewed and consisted 73 middlemen, 108 processors and 222 boat captains (representing fishing units), out of an estimated population of 601 respondents (109 middlemen, 157 processors and 335 fishing units).

3.4. Data analysis

Obtained AHP scores for constraints and opportunities as described above (section 3.2 and 3.3), were further analysed in a series of steps. This was done using an excel spreadsheet with formulae to calculate weightings as the FGD exercise proceeded. In the first step, scores were normalized by dividing each cell value with the sum of the column. In the second step a geometric mean was obtained along the normalized row scores. In the third step a weighted matrix product was calculated from the geometric mean array of scores and array of original row scores. In the fourth step, the Consistency Ratio was calculated as described in (section 3.2). Participants were asked if they were satisfied with the overall scores or wished to revisit their answers. In some cases, they revisited and changed them. This also helped to improve Consistency Ratio (CR), where it was poor. In addition, probing of answers was done during the scoring exercise for purposes of consistency control as suggested by Diamantopoulos et al. (2013).

Many constraints and opportunities were thematically similar. To enhance clarity, they were grouped into coherent categories that reflect broad value chain themes. These themes are referred to as "value chain dimensions" in this study. They included; capital, costs, equipment and infrastructure, governance, labour, markets, resource, training and trust. The dimensions, together with the weighted scores of constraints and opportunities were then graphed using polar plots in R statistical software (Version 3.5.3) (R-Development Core Team, 2019). The plots were based on averaged scores for all sites and by actor group.

4. Results

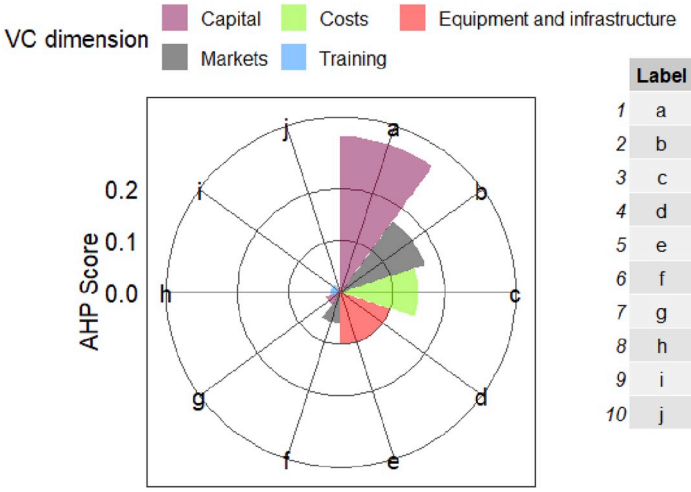
The gender of all fishers in the survey were male, middlemen were 5% female and 95% male, while processors were 97% female and 3% male. Most actors were youthful, with 45% being below 40 years. Education level was low with over 90% of fishers and processors, and 67% of middlemen having only primary education. Over 49% of processors and fishers, and 37% of middlemen had alternative livelihoods. However, over 94% of all actors ranked fishery related livelihoods as the most important.

Results for all actor groups on ranking of constraints and opportunities are presented using radial polar plots (Fig. 4-Fig. 9). They show average scores for combined sites for each constraint, as shown in letter labels and as described on the side legend table. Shaded colour radiations represent value chain dimension for each corresponding constraint as also described on the top legend.

Fishers ranked value chain dimensions in the following order of decreasing severity of constraints; capital, markets, costs, equipment and infrastructure and training (Fig. 4). Inadequacy of capital and unaffordable credit were identified as the key constraints in the capital dimension. Fishers needed capital to purchase equipment and cover operational costs, but often relied on middlemen who dictate fish prices as a condition for support. They noted that although bank loans were available, lending conditions such as requirement for collateral, guarantors and high interest were not conducive to their fluctuating incomes. Lack of assets, religious beliefs and fear of losing investments due to non-payment also prevented access to credit.

Fluctuating fish prices and low demand were identified as the key constraints in the market dimension. They resulted from unpredictable seasonal changes and influx of local and foreign migrant fishers in the NEM season, leading to erratic supply and demand. High operational costs for supplies such as bait, food, fuel and ice were also identified as a key constraint, especially by offshore fishers who fished for several days before landing.

Lack of rescue equipment and enough fish preservation facilities were ranked as severe constraints in the equipment and infrastructure dimension. Fishers observed that they remained at risk since capsize accidents occurred regularly, yet there were no designated boats and organised rescue strategies at fish landing sites. They also considered lack of ice making machines, cold rooms and ice boxes as severe, since this limited their number of days at sea. Although the government had installed cold rooms at Malindi and Vanga and an ice making machine at Vanga, they were non-operational due to constant breakdowns. Fishers instead sourced ice from company agents who lowered fish prices to recover the cost. Inadequate fishing skills was also ranked as a key



	Label	Constraint
1	a	Capital inadequacy
2	b	Fluctuating prices
3	c	High costs
4	d	Inadequate means of rescue
5	e	Few preservation facilities
6	f	Low fish demand
7	g	Un-affordable credit
8	h	Poor hygiene and handling
9	i	Inadequate fishing skills
10	j	Expensive transport

Fig. 4. Fishers' ranking of constraints.

constraint amongst fishers. This was surprising coming from a fishing community. However, on further probing, they pointed out that reference to fishing skills was in relation to use of multiple gears and technology such as fish finders and GPS.

Fishers ranked value chain dimensions in the following order of decreasing priority of opportunities; capital, equipment and infrastructure, training, markets and governance (Fig. 5). Like constraints, capital was the highest ranked priority. Facilitation of affordable financing was proposed as a solution to inadequacy of capital and un-affordable credit. They proposed that interest free loans cognizant of seasonal nature of fishing and low asset base, was most appropriate.

Subsidizing cost of fishing equipment was ranked as a high priority amongst fishers. They suggested that this would make equipment affordable and thus gradually wean off dependence on middlemen. Development of sea rescue strategies and development of the cold chain to solve equipment and infrastructure constraints were also prioritized, though not highly. Installation of ice making machines was proposed as a solution to ice shortages, which could allow longer fishing and storage periods, leading to better prices.

Training in fish handling and hygiene was also proposed to improve skills in maintenance of fish quality. In the governance dimension, they requested government assistance in fixing prices or negotiating with middlemen for higher prices. This was particularly critical amongst Malindi fishers who targeted premium fish for processing and export, but sold it at low prices. In terms of markets, they proposed expansion of geographical reach beyond coastal regions. This would enhance demand and counteract short term over-supply, especially during migrant fishers' season. However, market interventions were lowly prioritized.

Middlemen ranked value chain dimensions in the following order of decreasing severity of constraints; capital, markets, fisheries resource, equipment and infrastructure, training, costs, labour and trust (Fig. 6). Like fishers, middlemen ranked inadequacy of capital as the most severe constraint. Low seasonal fish demand was ranked as a considerable constraint, and was linked to oversupply by migrant fishers. It was also blamed on the prolonged tourism slump from 2013, resulting in closure of hotels that often absorbed most of the fish. The dwindling tourism also resulted in non-payment of fish supplies particularly in Malindi, where some hotels ran bankrupt before payment. Adversarial price competition was also seen as a constraint triggered by fish scarcity, where some middlemen offered higher prices to win independent fishers.

Fish scarcity which contradicted the claim of low fish demand was identified as a key resource dimension constraint amongst middlemen. It occurred during the rough SEM season when fishing is limited and sometimes in brief periods in NEM season. Like fishers, middlemen also identified lack of enough preservation facilities, lack of ownership of equipment and poor fishing technology as key constraints in the equipment and infrastructure dimension. Ownership of equipment was considered vital, since it allowed regular access and storage of fish. Lack of access to modern fishing technology such as GPS and fish finders, limited upgrading of fishing operations.

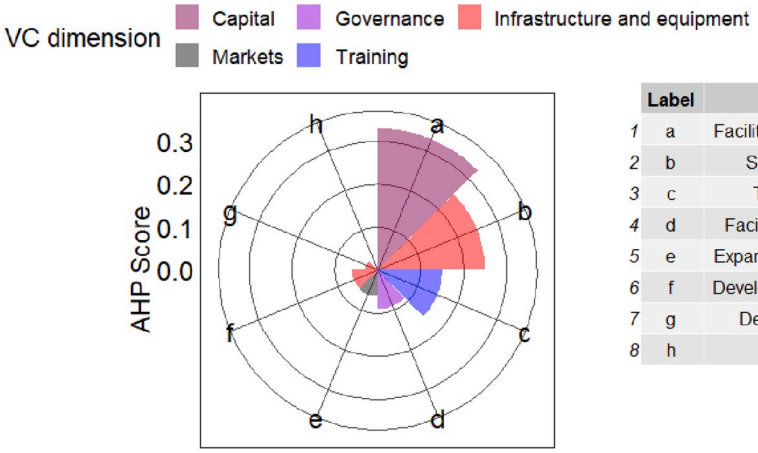
Inadequacy of business management and fish handling skills were cited as key constraints in the training dimension. Most middlemen had no formal training and thus inadequately equipped in business skills. Other constraints; expensive transport and rental premises, fishers' labour insufficiency and low levels of trust were ranked low, indicating lower severity. Notably, fisher labour insufficiency was in context of lack of superior fishing skills amongst local fishers, compared to foreign migrant fishers. Middlemen claimed that local fishers were insufficiently skilled and could not persevere in rough waters for long.

Middlemen ranked value chain dimensions in the following order of decreasing priority of opportunities; capital, markets, training, equipment and infrastructure and governance (Fig. 7). Facilitation of affordable financing was highly prioritized as a key solution to inadequacy of capital. Like fishers, middlemen proposed establishment of interest free loans cognizant of the seasonal nature of fishing and erratic incomes. They, like fishers, also suggested expansion of geographical reach to improve market demand. They also proposed training in business management and fish handling, quality and hygiene, as solutions to skills inadequacy.

Development of the cold chain, improvement of roads and fishing technology through modernization of equipment were proposed as solutions in the equipment and infrastructure dimension. The cold chain was considered important in provision of ice to fishing vessels and for storage during fish gluts. They suggested improvement of roads to facilitate quicker transportation to markets to avoid post-harvest losses. Except Malindi, all the other sites at the time of the study usually had impassable roads during rainy seasons. In the governance dimension, they proposed easing of migrant fishers' entry as a solution to fish scarcity. Middlemen who engaged migrant fishers, complained that fishers linked to them were frustrated when entering Kenya by immigration officials, yet the East African Common Market Protocol allowed free entry. However, member states restrict entry of some category of labourers, whose skills they deem locally available.

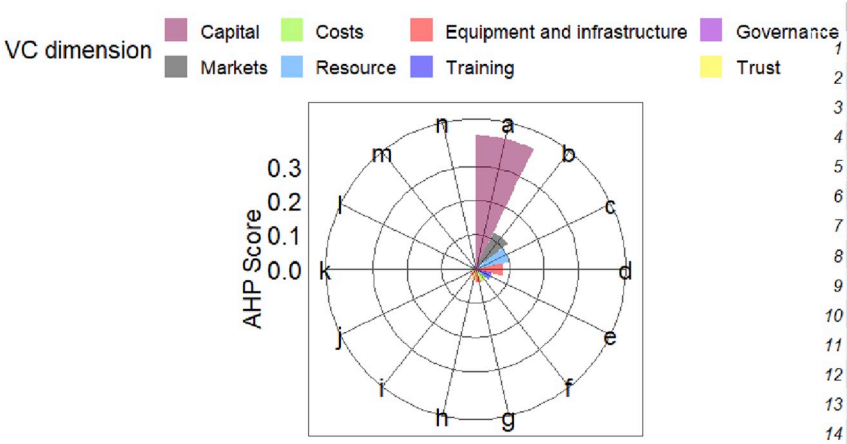
Fish processors ranked value chain dimensions in the following order of decreasing severity of constraints; capital, fisheries resource, markets, training, infrastructure and equipment and costs in decreasing order of severity (Fig. 8). Like fishers and middlemen, processors ranked unaffordable credit as the most severe constraint. Although most processors participated in local rotating credit and savings groups popularly known as "merry-go-rounds", they were keen to get larger loan amounts from formal financial institutions. They however faced conditional bottlenecks such as lack of collateral and high interest.

Fish scarcity in the resource dimension was ranked as the second



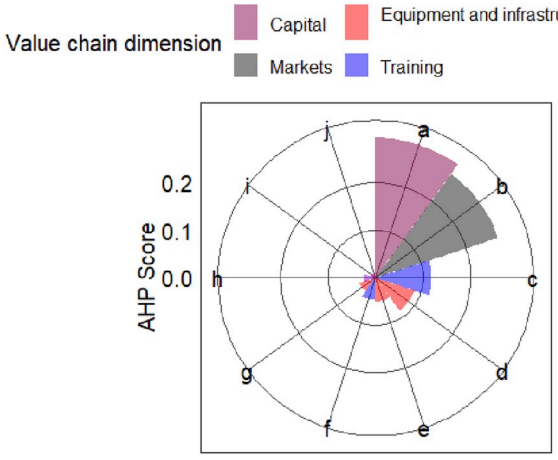
	Label	Opportunity
1	a	Facilitate affordable financing
2	b	Subsidize equipment
3	c	Train on fish quality
4	d	Facilitate price negotiating
5	e	Expand markets and demand
6	f	Develop sea safety strategies
7	g	Develop the cold chain
8	h	Improve roads

Fig. 5. Fishers' ranking of opportunities.



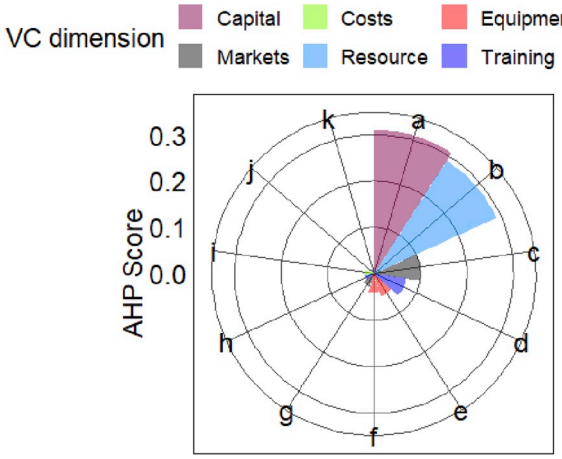
	Label	Constraint
1	a	Capital inadequacy
2	b	Low fish demand
3	c	Fish scarcity
4	d	Few preservation facilities
5	e	Inadequate business skills
6	f	Expensive transport
7	g	Lack of equipment ownership
8	h	Insufficient fisher labour
9	i	Poor fishing technology
10	j	Low level of trust
11	k	Adversarial price competition
12	l	Expensive rental premises
13	m	Poor hygiene and handling
14	n	Non-payment for supplies

Fig. 6. Middlemen's ranking of constraints.



	Label	Opportunity
1	a	Provision of affordable financing
2	b	Expand markets and demand
3	c	Train on business skills
4	d	Develop the cold chain
5	e	Improve fishing technology
6	f	Train on fish quality
7	g	Improve roads
8	h	Ease migrant fishers' movement
9	i	Assist in debt recovery
10	j	Innovative energy solutions

Fig. 7. Middlemen's ranking of opportunities.

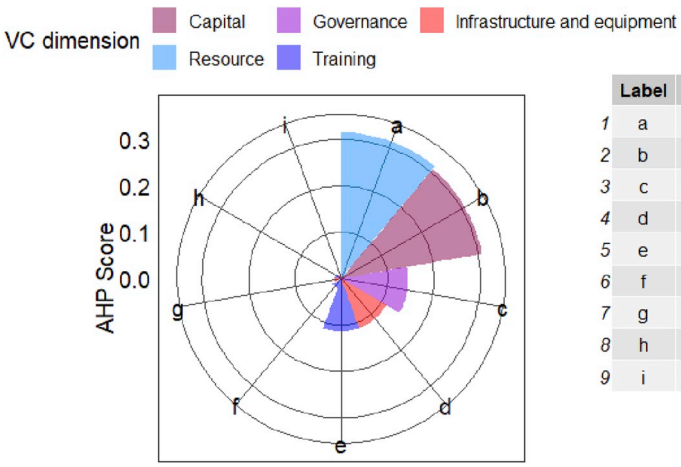


	Label	Constraint
1	a	Un-affordable credit
2	b	Fish scarcity
3	c	Fluctuating prices
4	d	Inadequate business skills
5	e	Lack of business premises
6	f	Few preservation facilities
7	g	Low fish demand
8	h	Poor hygiene and handling
9	i	High operational costs
10	j	Expensive fish
11	k	Inadequate processing skills

Fig. 8. Processors' ranking of constraints.

most severe constraint amongst processors. It was reported to be severe in SEM season and occasionally in NEM season. Processors also faced challenges in accessing fish, since fishers preferred middlemen who bought bulk quantities with less price negotiation. On the contrary, most processors bought small quantities, bargained, and bought fish on credit. Due to fish scarcity, processors occasionally returned home without fish, and thereby eroding their capital due to transport costs.

Fluctuating fish prices and low fish demand in the markets dimension were also identified as key constraints. Processors reported experiencing low demand for processed fish, especially during NEM season when fish was abundant. They also cited harsh economic times leading to low uptake of processed fish. Price fluctuations, sometimes occurred even within the same day. For example, at Mayungu where processors frequented, prices fluctuated depending on presence or absence of



	Label	Opportunity
1	a	Improve fish catches and access
2	b	Provision of affordable financing
3	c	Ease migrant fishers' movement
4	d	Develop the cold chain
5	e	Training on fish quality
6	f	Training in fish processing
7	g	Improve market infrastructure
8	h	Train on business skills
9	i	Provide fish handling equipment

Fig. 9. Processors' ranking of opportunities.

middlemen who got lower prices, but not processors. They explained that processors caused them losses by purposely purchasing small quantities repeatedly using improperly calibrated weighing balances. Hence, they had to sell at higher prices to cover for shortfalls.

Inadequacy of business management and processing skills were identified as key constraints in the training dimension. Like middlemen, most processors lacked formal business training and had difficulties in calculating profitability. Most didn't account for some costs, for example own-labour. Lack of skills in processing was in context of lack of other innovative value addition methods.

Lack of preservation facilities and business premises were identified as key constraints in the infrastructure and equipment dimension. Unavailability of ice during transportation and storage at landing sites, as processors waited to accumulate sufficient amounts resulted in post-harvest losses. Most processors also prepared fish in the open at landing sites, before frying and selling at home or roadsides. This led to exposure to harsh weather conditions and increased risks of fish contamination. High operational costs and expensive fish were also identified as constraints, but ranked low.

Processors ranked value chain dimensions in the following order of decreasing priority of opportunities; resource, capital, governance, equipment and infrastructure and training in decreasing order of priority (Fig. 9). Processors, unlike fishers and middlemen, highly prioritized resource (availability of fish supply), compared to capital. They suggested that facilitation of access to fish supplies e.g. provision of boats would regulate supply and prices.

The capital dimension was ranked as the second most important intervention, where processors also similarly proposed interest-free loan

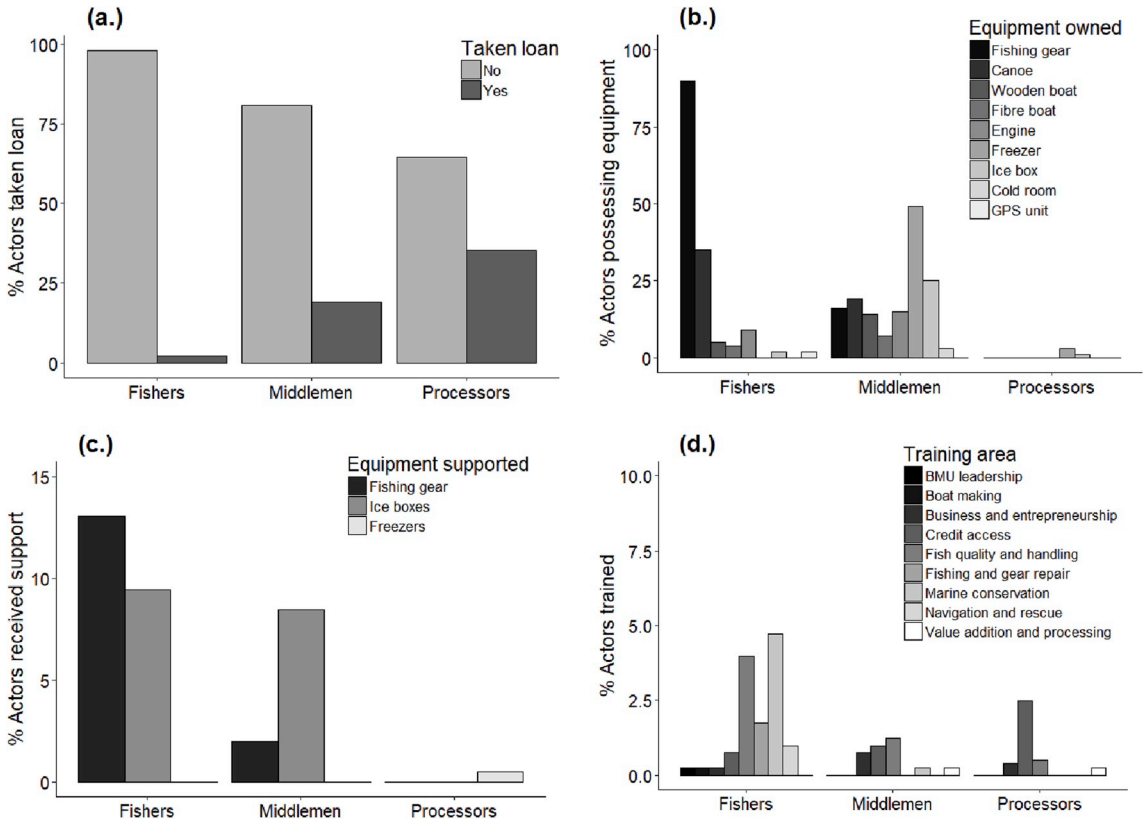


Fig. 10. a) Actors' access to bank loans, b) ownership of equipment, c) equipment support and d) training support.

schemes.

In the governance dimension, processors also proposed easing migrant fishers' entry as an additional solution to fish scarcity. They feared being run out of business if migrant fishers were completely stopped entry. In the infrastructure and equipment dimension, they proposed development of cold chain facilities and provision of fish preservation and handling equipment. They also proposed construction of sheds at central markets to reduce exposure to harsh weather. Training in fish handling, fish processing and business management was also proposed.

4.1. Actor's loan uptake, training, ownership of equipment and support received

Analysis of loan uptake showed that only 2% of fishers, 19% of middlemen and 36% of processors had taken business loans (Fig. 10a). This reflects actors' constraints in accessing capital. The higher loan uptake by processors is linked to loans taken under informal merry-go-round finance schemes, and loans from quasi-financial institutions dedicated to financing women.

In terms of ownership of equipment, most fishers (90%) owned their fishing gear (Fig. 10b). However, only few owned vessels, where 35% owned canoes, 5% owned wooden boats, 4% owned fibre boats, while only 9% owned engines. Middlemen's ownership of larger vessels (fibre and wooden boats) was slightly higher than fishers, 16% and 7% respectively. A higher percentage (15%) of middlemen also owned engines compared to fishers. Most middlemen also owned fish preservation equipment (cold rooms, freezers and ice boxes) compared to other actor groups.

In terms of equipment support, less than 15% of actors in each actor group had been supported (Fig. 10c). However, fishers received more support in fishing gear and ice boxes than other actors. No actor group from sampled respondents had been supported with boats or engines. The low levels of equipment support also corroborates results on constraints that indicated that, actors had insufficient capital and equipment. In terms of training, several actors had been trained on; leadership (with emphasis on BMU management), boat making, business and entrepreneurship, fish handling, quality and hygiene, fishing and gear repair, marine conservation, navigation and rescue, value addition, processing and credit access (Fig. 10d). However, less than 5% of actors had been trained, confirming results from FGDs that showed inadequate training was a constraint.

5. Discussion

The present study sought actors' knowledge, experience and perspectives in identification and ranking of constraints and opportunities in SSFs. They identified 23 constraints and 18 opportunities, categorized in nine broad value chain dimensions. Financial capital emerged as the top constraint across all sites and actor groups. This is consistent with other studies singling capital as a major value chain bottleneck in fisheries and coastal livelihoods (Fowowe, 2017; Kashangaki, 2017). Access to capital has potential to solve most constraints faced, for example, to cover cost of operations and purchase of equipment.

Challenges of access to financial capital were partly linked to poor access to loans. Often, lack of ownership of critical assets such as land and equipment for use as collateral, is a major barrier of access to credit in fisheries and coastal livelihoods (Emdad Haque et al., 2015; Kashangaki, 2017). Many actors being Muslims, also faced religious restrictions that prohibit paying interest on loans. This limits their credit access in non-religious financial institutions. Distance from financial institutions as also noted in the present study excludes most actors from accessing financial services (Iqbal and Sami, 2017). These compounded barriers, discourage actors from accessing credit, even when interest rates are low (Emdad Haque et al., 2015).

However, even with improved loan access, not all actors are likely to take loans. Findings from the study showed that some actors were apprehensive about getting loans and preferred direct grant and equipment support. They argued that loans will still have to be repaid under unpredictable business environments. Actors feared defaulting on monthly loan repayments due to erratic catches and cashflows. Such unpredictability in SSFs hinders savings, financial planning and consistent loan repayments (Platteau, 1984). On the other hand, reliance on external support for equipment was unreliable, since less than 15% of actors had been supported.

Although Kenya has a vibrant financial sector, where over 75% of Kenyans have access to financial services (Kashangaki, 2017; Ouma et al., 2017), it falls short of addressing the above financial needs in the fisheries sector. Often it is assumed that financial instruments designed for the agricultural small-holder sector would work well for the fisheries sector (Emdad Haque et al., 2015; Platteau, 1984), but this has not succeeded and needs targeted policy rethinking. For example, the government can incentivize the financial sector by establishing loaning schemes administered by private banks at a fee, for example PRONAF loaning scheme in Brazil (Emdad Haque et al., 2015; Westercamp et al., 2015). Such schemes, can consider accommodating spread out repayments consistent with incomes.

Market demand and supply constraints were twinned problems, dependent on seasonal shifts. Migrant fishers who are considered better equipped and possess superior skills (Wanyonyi et al., 2016a; Wanyonyi et al., 2016b), were key drivers of oversupply during NEM season. On the other hand low demand from a weakened tourism sector since 2013 (Gari, 2019), compounds the problem. Consequently, scarcity and oversupply resulted in broader implications in terms of price fluctuations and sometimes a source of disaffection. For example, local fishers complained about low prices linked to migrant fishers, and requested government assistance to negotiate prices with middlemen. In Malindi for example, middlemen had raised prices after such negotiations but quickly overturned them, citing market difficulties of maintaining high prices. On the other hand, processors and middlemen advocated for easing entry of migrant fishers, to maintain fish supplies and low prices.

Fish scarcity had further implications to small-scale fish processors who were primarily women. They experienced discrimination in accessing fish and pricing during scarcity periods, and thus highly prioritized measures to improve fish catches. Their capital was also low, and only enabled purchase of small fish quantities. Previous research in Kenya has shown that, purchase of larger fish quantities gave actors leverage in prices and access (Matsue et al., 2014; Wamukota et al., 2015). Nevertheless, such price discrimination against low-capitalized female processors, raises gender dimensions and illustrates difficulties also faced by women in fish trade elsewhere (Fröcklin et al., 2013; Matsue et al., 2014).

In the face of such erratic nature of fish supplies, actors' solutions tend to revolve around increased catches to overcome scarcity (Cinner et al., 2009) and market expansion to overcome oversupply. Similar proposals were made in the present study. This requires infrastructure improvement such as roads and provision of preservation and fishing equipment. Such improvements, for example the cold chain, can help in regulation of supplies and stabilization of prices (Platteau, 1984). However, management of the cold chain infrastructure in Kenya's coast, has been marked by inefficiencies, widespread breakdowns and disuse. Many boats and preservation equipment donated to fishers in the past, have also been mismanaged or sub-optimally used (pers. comms.). For example, donated ice boxes in Shimoni and Vanga have barely been used, due to insufficiency of ice (Fisheries officer, Vanga). On the contrary, equipment run by private operators for example in Malindi, worked efficiently. Thus, involvement of organised private sector through incentives, can help in joint management of public infrastructure and equipment. This for example can include management of the cold chain at a cost, through fish storage fee and sale of ice.

However, improvements in infrastructure, upgrading of equipment

and market expansion can also drive exploitation further and lead to stock declines (Jaini et al., 2017; Rodríguez-Garcia and Villasante, 2016; Stevens et al., 2014). Moreover, Kenya's inshore fisheries have shown signs of decline in the last two decades (Samoilys et al., 2017). Thus, resource users' solutions to resolve scarcity problems should be treated with caution to avoid overexploitation of resources. Furthermore, they may not agree that their actions are a contributing factor to resource declines (Rochet et al., 2008). Their solutions may also be incongruent with those of conservationist, managers and scientists who advocate for sustainability approaches (Verweij et al., 2010).

Despite shortcomings related to equipment support and infrastructural developments in terms of stock declines, they can also be beneficial if well targeted. Such improvements can lead to faster transportation, rise in producer prices and incomes, maintenance of fish quality and low post-harvest losses (Olsson, 2009; Rodríguez-Garcia and Villasante, 2016; Schmitt and Kramer, 2009). Furthermore, infrastructural development and support in equipment can open exploitation of relatively unexploited stocks. For example, as outlined in the draft tuna strategy, Kenya seeks to build capacity for offshore tuna fishing, currently undertaken by distant water fishing nations (Government of Kenya, 2013).

Previous estimates indicate that stocks of the major commercial tuna species are stable (Gordon and Hussain, 2015; Government of Kenya, 2013). A recent hydro acoustic survey by the Kenya Fisheries and Marine Research Institute (KMFRI) indicated a biomass level that is worth USD 1.34 billion, under conservative exploitation rate of 20% (Kimani et al., 2019). This indicates development potential for tuna fishing capacity amongst small-scale actors, similar to Asian countries (Digal et al., 2017; Digal and Placencia, 2017; Duggan and Kochen, 2016; Gordon and Hussain, 2015). This goal is captured in Kenya's draft tuna strategy (Government of Kenya, 2013), which seeks to improve tuna fishing through development of the local fleet, infrastructure and service provision, creation of incentives and favourable market access regime. This strategy aligns with actor's proposals in the present study—to diversify to offshore fishing to relieve pressure in overexploited inshore stocks and reduce fish scarcity.

Apart from hardware solutions, actors also proposed soft measures such as training. Building of skills and technology transfer have potential to transform traditional fisheries to modern commercial ones with support of government, donor agencies and the private sector (Jaini et al., 2017; Jensen, 2007; Platteau, 1984). Training in business management can help in identification of inefficient business processes and cost-reduction strategies (Bettiol and Marchi, 2018). Training on fish handling and hygiene can improve product quality and enhance customer trust, and thereby enable penetration to better-paying markets. Kenya is a good market for such products since it has a relatively large expatriate presence and an upcoming middle class in major cities (Spronk, 2014). Training fishers in use of modern fishing technologies, such as fish finders and GPS units can lead to fuel cost-reduction by improving fish targeting (Suuronen et al., 2012). These trainings need to be systematically designed and delivered. Evidence from the present study showed that training interventions were ad-hoc and uncoordinated.

Promotion of horizontal integration in the value chain through revitalised fisher cooperatives can also help overcome most of the highlighted constraints. Cooperatives can also be instrumental in promoting vertical integration by linking and retaining only critical players and functions, while bypassing middlemen to improve fishers' economic gains. They are also useful in promoting market access, loans and savings facilities, provision of equipment and asset building and training (Amarasinghe and Bavinck, 2017). County governments in Kenya have recently been promoting revival of collapsed cooperatives and creation of new ones. The cooperative movement in Kenya is not new (Zeleza, 1990), and most cooperatives for example Malindi and Vanga fisher cooperatives collapsed due to mismanagement. Thus, any revival efforts should be accompanied by capacity building programmes to avoid past failures. The present study did not explore past constraints and future potential role of cooperatives in promoting vertical and horizontal integration. The study also did not explore extent of constraints in influencing individual actor's performance. These remain as research gaps.

6. Conclusion

Findings from the present study on analysis and ranking of constraints and opportunities, provides information on a subject that has been scantily addressed in Kenya. Lack of access to capital emerged as the most severe constraint amongst all actor groups as is also confirmed by the low level of loan uptake. Suggested solutions included designing loaning conditions, that conform to erratic fishing and income cycles. Fish scarcity and oversupply constraints were also highly ranked and were linked to other dimensions such as equipment and infrastructure, where only few actors had received support. Findings of this study are useful in informing and shaping policies and interventions by government and value chain development agents.

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Declaration of competing interest

None.

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