Sustainable fishing practices on the productivity of fishermen in coastal Tanzania: Evidence from Nungwi village

Masoud Yussuf

ymasoud024@gmail.com

College of Business Education, Tanzania

https://doi.org/10.51867/ajernet.7.3.68

ABSTRACT

Sustainable fishing practices are vital for balancing environmental conservation with the socio-economic well-being of fishing communities. This study assessed the influence of sustainable fishing practices on fishermen's productivity in Indian Ocean fishing at Nungwi Village. Specifically, it examined the role of stock monitoring niches, the effect of aquatic waste management, and the influence of awareness campaigns on clean fishing on fishermen's productivity. The study is grounded in the Sustainable Livelihoods Framework. The study adopted an explanatory research design that examined the causal relationship between the independent variables and the dependent variable. Data were collected using structured questionnaires administered to 109 fishermen selected through simple random sampling from the population of 150 local fishermen who actively engaged in fishing activities. The study employed descriptive statistics, including means and standard deviations, and inferential statistics, particularly multiple regression analysis, by using IBM SPSS version 27.1.0. The findings show that all three study independent variables, which are stock monitoring, aquatic waste management, and awareness programs, significantly influenced the productivity of the fishermen positively. The study concluded that sustainable fishing practices contributed to environmental conservation and economic success among fishermen, leading to productivity in Indian Ocean fishing in Nungwi Village. It is recommended that the government strengthen the sustainable fishing practices in terms of stock monitoring, implementation of aquatic waste management policies, and awareness programs via Beach Management Units in order to improve fishermen's productivity at Nungwi Village.

Key Words: Aquatic Waste Management, Awareness Programs, Fishermen's Productivity, Sustainable Fishing Practices, Stock Monitoring

I. INTRODUCTION

Fishermen's productivity plays an important role in determining the success of the fishing industry especially in the coastal areas, where most of the communities rely on fisheries as their means of sustenance, revenue, and employment (Kyule et al. 2025). On a global scale, the productivity of the fisheries sector is highly associated with the application of sustainable practices geared towards preserving the fish population and maintaining the balance of the ecosystem (Lam et al., 2020).According to Food and Agriculture Organization (FAO) the failure of sustainable fishing practices in different parts of the world has resulted in huge depletion of the fish stock because of the widespread use of destructive practices in the fishing industry (FAO, 2022). As a result, the productivity of fishermen becomes affected by the depletion in fish stock and leads to an endless cycle of reduction in income levels and the rate of poverty in fishing communities (Warren & Steenbergen,2021).

Efficiency of fishermen is an important determinant of how effective the fishing industry becomes, especially in the coastal regions where the industry is used for livelihood and provision of jobs and economic stability (Watson et al., 2023). In terms of international standards, efficiency of the fishing industry depends on the implementation of sustainable fishing techniques to preserve the fish stock and sustain economic stability (Melnychuk et al., 2017; Lam et al., 2020). However, unsustainable fishing approaches such as overfishing, destruction of fish habitats and poor management systems within the fishing industries have led to depletion of fish stocks across many countries in the globe (FAO, 2022). Depletion of fish stock results in low levels of productivity among the fishermen, which in turn cause reduced incomes and poverty among the fishermen (Warren & Steenbergen, 2021). The fishing industries serve as sources of livelihood to most of the coastal communities and they are the only sources of sustenance to these communities (Diedrich et al., 2022).

The case is more difficult in Africa because fisheries in the continent are plagued with overexploitation, illegal, unreported, unregulated and lack of enforcement of regulation (Steadman et al., 2021). This problem has led to dwindling fish stock and decline in the efficiency of fishers in various countries. The case of Senegal can be cited as an example where more than half of the fish stock in the country is in a state of collapse, while foreign-owned vessels operate about half of the fishing business, leaving little room for domestic fishers (Osemwegie et al., 2021). Similarly,

in Ghana, despite being one of the sectors that contribute 3% to the country's GDP, its performance is hindered by overfishing, poor infrastructure, and ineffective regulation (Ayilu et al., 2023).

However, some good results have been achieved as far as sustainable fishing policies are concerned because of the adoption of innovative and sustainable fishing techniques in several African countries. One good example is the use of the Abalobi technology app in South Africa, which has assisted small-scale fishermen in selling their catches directly and earning reasonable prices for themselves. Besides, through the use of this app, fishermen have been able to trace their fish, resulting in sustainable fishing practices and increased revenue for them (Tsele, 2020; Muhammed & Abubakar,2022). Further, the initiatives supported by the Marine Stewardship Council in West Africa have facilitated fishery management and environmental sustainability (Nyiawung et al., 2021).

It is evident that the fishing industry plays a significance role in Tanzania's economy, as it contributes significantly to livelihoods for about 4- 4.5 million people and provides food security within the coastal regions and inland parts of the country (FAO, 2023). However, the sector faces several challenges due to unsustainable use of fish, leading to negative effects on the fish population and their productivity (Brodie et al., 2024).Some of the activities that have caused the negative impacts include overfishing, illegal poaching, and the usage of harmful gears such as beach seine fishing and small mesh nets, resulting in fish population depletion in numerous lakes like Victoria, Tanganyika, Nyasa, and Indian Ocean coastline (Mushagalusa et al,2024).There are instances in Zanzibar where declining fish stocks and reduced fish availability have negatively affected fishermen's catches and household earnings, largely due to overexploitation and increasing pressure on fisheries resources (Rehren et al., 2020).

While the Government of Tanzania has implemented various policies including the Fisheries Sector Master Plan (2021-2037), and improvements in infrastructure facilities such as modern landing sites and ports, their effectiveness towards productivity improvement is minimal. There are many unsustainable practices that keep hampering productivity in the sector (Kongela et al., 2025). From the analysis of current literature, it is clear that despite many researches carried out in relation to fisheries management, natural resources conservation, and efficiency, very few have focused on how adopting sustainable fishing practices has positively affected productivity of the individual fishermen, especially those in the coastal Tanzania or inland fisheries like Lake Victoria. For instance, Cardinale (2025) researched into the efficiency of the fleet level without considering individual productivity measures. In one of his studies, Silas et al., (2023) analyzed ecological knowledge within the management of the fisheries but was unable to relate it to productivity. Other researchers such as (Saha et al. 2023; Silas et al. 2023) have studied the seasonal closure and ecological processes without any relationship to productivity. Further, Peter and van Zwieten (2022) analyzed the fishing effort allocation among the Nile perch fishers but did not include sustainability practices in his analysis.

This research has attempted to fill this gap by analyzing the influence of sustainable fishing practices on the productivity levels of the fishermen along the Tanzanian coastline especially Nungwi Village In particular, it focused on analyzing the impacts of stock monitoring, aquatic waste disposal, and information campaigns about clean fishing on the productivity levels of fishermen.

1.1 Research objectives

i. To examine the role of stock monitoring niche on fishermen's productivity at Nungwi Village
ii. To assess the effect of aquatic waste management, on fishermen's productivity at Nungwi Village
iii. To examine the influence of awareness campaigns on clean fishing on fishermen's productivity at Nungwi Village

II LITERATURE REVIEW

2.1 Theoretical Review

The study is grounded by the Sustainable Livelihoods Framework (SLF). SLF was introduced by the United Kingdom Department for International Development in 1999 to be used as an instrument for comprehending and analyzing the ways people exploit different resources (known as livelihood assets) in order to develop sustainable livelihoods (Scoones, 2009; Serrat, 2017). In addition, the framework includes five major forms of capital that people can use when working on the improvement of their livelihoods (DFID, 1999). Among those forms of capital are human, social, natural, physical, and financial ones. Furthermore, there are certain influences that play roles in shaping livelihoods and include policy-related variables, institutions and climate (de Haan & Zoomers, 2005). It is believed that the SLF aims at encouraging sustainability by helping people recover from negative impacts and exploiting their resources (Bebbington, 1999). Thus, the SLF is applicable in analyzing the livelihoods of rural communities, especially fishing societies, since the latter largely rely on natural resources (Serrat, 2017).

In terms of this research, the SLF plays an instrumental role in assessing how stock monitoring niche, aquatic waste management, and awareness campaigns (as elements of sustainable fishing) influence the productivity of fishermen within the Indian Ocean at Nungwi Village. The theoretical basis of the framework presupposes that people with access to resources and proper management of them will be able to engage in productive and sustainable livelihoods (Bebbington, 1999; de Haan & Zoomers, 2005). On the one hand, the main advantage of the SLF is its comprehensive

and person-focused perspective on the phenomenon under investigation. However, according to Department for International Development (DFID) a limitation of the framework consists of possible oversimplification of power relations or ignorance of deeply entrenched socio-economic constraints (DFID, 1999).

2.2 Empirical Review

2.2.1 Role of stock monitoring niche on fishermen's productivity at Nungwi Village

From research studies conducted about the monitoring of stocks, there are high chances of improving the efficiency of fishermen's productivity and sustainable food production. According to Arumugam et al., (2023) proper monitoring and management have allowed countries to realize up to 77% of maximum sustainable yields, while improper monitoring results in low fish production. In another study, Queiroz-Véras et al., (2025) discovered that the combination of local ecological knowledge and official information can help in the identification of decreasing fish populations and efficient fisheries management. Besides, the study confirmed that the illegal and semi-industrial fishing practices play a key role in depleting fish stocks. It was seen by Mpomwenda et al. (2023) that with a strict adherence to the rules of the fisheries such as the tracking of illegal fishing practices and managing the fishing gears, fish biomass, species diversity, and fisher income had been enhanced in the area surrounding Nungwi Village. Robertson et al. (2018) argued that although Beach Management Units (BMUs) in Tanzania collect fishing activity data (including gear, vessels, and catches), the information was largely not incorporated into management decisions. Therefore, monitoring activities alone did not produce improvements in fisheries outcomes or fishermen productivity. Similarly, Mdoe, Mahonge and Ngowi (2025) highlighted that the fisheries sector in Tanzania faces the problem of poor stock assessment mechanisms and data gathering issues due to which the productivity becomes unsustainable. However, beside of those studies conducted on fishing stock monitoring niche, there are scant study which examine the effect of stock monitoring niche on fishermen's productivity at Nungwi Village, the gap that have been filled by this study.

2.2.2 Aquatic waste management, on fishermen's productivity at Nungwi Village

According to studies carried out to determine the efficiency of waste management practices in an aquatic environment, the inefficiency of waste management causes low production and degradation of the environment within the aquatic ecosystem. For instance, according to Finska et al., (2022) inefficiencies in the implementation of laws governing waste management in the Norway and northwest Russia led to improper waste management leading to large quantities of plastic wastes in the Barents Sea. Similarly, poor disposal of waste, inefficiency in infrastructure, and lack of community participation in waste management led to poor fish populations and low profit levels among fishermen; however, effective waste management improved fish populations, water quality, and increased fishermen's profit levels (Islam et al., 2004; Nunes et al., 2016). Furthermore, poor infrastructure and inadequate transportation of fish were identified as some of the major challenges facing waste management in Nungwi village (Jiddawi & Öhman, 2002; UNEP, 2018). In this regard, the improvement of waste management, infrastructure, and transportation will ensure that pollution in the environment is reduced significantly. Lastly, as per Mramba et al., (2022), some of the factors associated with wastage of fish during post-harvest operations in Bagamoyo district include education level, fishing experience, and fishing gear among others. Although the aspect of aquatic waste management in the fishing industry has been well studied in many parts of the world, there are few studies that examine the effect of waste management in the fishing industry in Nungwi Village as claimed by Jiddawi & Öhman (2002) a gap that has been filled by this study.

2.2.3 Awareness campaigns on clean fishing on fishermen's productivity at Nungwi Village

Studies on awareness campaigns show an increase in knowledge by fishermen facilitate positively to both sustainability and production (Keznine et al., 2024) Similarly, availability of awareness ensuring an improvement in the knowledge level of fishermen to make conserving the vulnerable species in the Moroccan Mediterranean Sea. Katikiro and Mahenge (2016) show that poor fisheries management, lack of trust, and ineffective cooperation were factors affecting fishing in Tanzania. This study underscored the significance of conducting coordinated awareness campaigns among fishers, government officials, and NGOs. Moreover, Hakkarainen et al., (2020) confirmed that knowledge sharing campaigns played an important role in fostering communication and trust between researchers and fishing communities in Zanzibar. In addition, according to Gideon (2023), participatory awareness campaigns enhanced fishermen's knowledge of climate change and increased their productivity through better fishing decisions. On other side, Katikiro and Mahenge (2016) argued that fishers had received information and awareness about sustainable fishing practices, destructive fishing activities and unsustainable practices continued because awareness alone was insufficient without effective enforcement, alternative livelihoods, and institutional support. This implies that awareness campaigns may have limited influence on fishermen's productivity when economic and governance constraints remain. From the reviewed literatures show that earlier studies on sustainable fishing practices concentrated more on environmental protection, fisheries management, and biodiversity without considering fishermen's awareness on waste management toward productivity (Okafor-Yarwood et al. 2020; Ferronato & Torretta,2019; Finska et al., 2022) the gap which has been gap filled by this study.

III. METHODOLOGY

3.1 Research Design

An explanatory research design was used for this study in order to investigate the effects of sustainable fishing methods on the productivity levels of fishermen in the village of Nungwi. This design was appropriate due to the fact that it was able to allow the researcher to be able to demonstrate causal relationships between sustainable fishing methods and the productivity of fishermen (Saunders et al.,2019).

3.2 Study area

The study was conducted in Nungwi village, located on the northern coast of the Indian Ocean on Zanzibar Island. The researcher chose this area due to the significant number of citizens actively engaged in fishing activities. Additionally, this region has experienced a decline in fishing productivity over time and faces various challenges related to fishing (Ali et al, 2023).

3.3 Population

The study population comprised of 150 local fishermen who were actively engaged in fishing operations; hence, they were considered stakeholders in sustainable fishing and fisheries management, they are in good position to provide the reliable information in relation to this study.

3.4 Sampling and Sampling size

The study used simple randomly technique to get the respondents from the total population. The sample size of this study is 109 respondents who were actively engaged in fishing activities, who were obtained by using Yamane formular of sample size determination at 5% margin of error (Yamane, 1976). This formula helped ensure that the sample was statistically representative of the total population of fishermen in the Nungwi Village fishing area. The formular is n=N/(1+N(e^2)) Where: n = Sample size; N = Total population size; e = The margin of error, which is 5% (0.05) for 95% confidence interval. Therefore, the sample size of the study was 109 respondents. A sample size of 109 respondents was considered adequate for quantitative analysis as sample adequacy is important for ensuring reliable statistical estimation and meaningful interpretation of relationships among study variables (Hair et al., 2019).

3.5 Data collection method

The study used a questionnaire to collect data from the respondents. The structured questionnaires were distributed to the 109 fishermen who were randomly selected. The drop-and-pick approach was used to collect the questionnaires. The questionnaire was adopted as it was convenient, less costly, and minimized the level of bias as the respondents will be free to answer at their convenience (Hair et al., 2019). All study items were measured using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree, as recommended for measuring respondents' perceptions and attitudes in social science research (Likert, 1932; Joshi et al., 2015).

3.6 Data Analysis

Data analysis was done through inferential and descriptive statistics with the use of IBM SPSS Statistics software version 27.1.0. Descriptive statistics included frequency counts, percentage, mean, and standard deviation while multiple regression analysis was used to establish the relationship between the independent and dependent variables. The assumptions of linearity, normality, homogeneity, and multicollinearity were tested before performing multiple regression analysis in order to guarantee validity of the model. Regression analysis used the following model; $Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \varepsilon$, where fishermen's productivity is the dependent variable while stock monitoring niche, aquatic waste management, and awareness campaigns are independent variables. The pilot study involving 21 fishermen were conducted in order to determine whether the questions were not clear to respondents. For the validity, Cronbach Alpha was applied, and all the variables had scores more than 0.7, which shows that they have reliability.

3.7 Ethical Considerations

Ethical issues related to this study were well addressed by the researcher, who inquired about the respondents' willingness to participate. Additionally, the respondents indicated that they could withdraw from the study at any time, and the researchers took measures to protect them from any harm while ensuring the confidentiality of their information.

IV. FINDINGS & DISCUSSION

4.1 Demographic Characteristics of the Respondents

The demographic features of the respondents in this study comprised gender, age category, educational attainment, fishing experience, fishing function, and fishing site, as outlined in Table 1 below.

Table 1

Frequency Distribution Table for Demographic Characteristics of the Respondents

Variable	Category	Frequency	Percent (%)
Gender	Male	93	85.3
	Female	16	14.7
Age Group	18–25 years	16	14.7
	26–35 years	42	38.5
	36–45 years	32	29.4
	46–55 years	13	11.9
	Above 55 years	6	5.5
Level of Education	Primary Education	41	37.6
	Secondary Education	38	34.9
	Certificate/Diploma	16	14.7
	Bachelor's Degree	14	12.8
Fishing Experience	Less than 1 year	8	7.3
	1–3 years	24	22.0
	4–6 years	33	30.3
	7–10 years	27	24.8
	More than 10 years	17	15.6
Fishing Role	Boat Owner/Captain	24	22.0
	Crew Member	54	49.5
	Net Maker/Repairer	8	7.3
	Fish Trader/Vendor	15	13.8
	Equipment Supplier	4	3.7
	Other	4	3.7

4.1.1 Gender of Respondents

It is worth noting from the results of the study that a greater percentage of the respondents 93 (85.3%) respondents were males compared to their female counterparts 16 (14.7%). It meant that fishing operations in Nungwi Village were more male-oriented, which is common among fishing industries located along the coastlines of Tanzania.

4.1.2 Age Group of the Respondents

According to the results, most of the fishermen in Nungwi Village 42(38.5%) were aged between 26-35 years, followed by 32 (29.4%) aged between 36-45 years. Such results implied that the fishing industry in Nungwi Village was dominated by young and energetic people who were physically able to engage in fishing operations.

4.1.3 Level of Education

From the results, it was observed that the major number of respondents 41(37.6%) had primary and 38 (34.9%) secondary education, while those with certificate/diploma education were fewer than those with primary and secondary education. A few respondents had primary education or bachelor's degree. From the above results, it can be observed that the fishermen had acquired minimum education and skills on fishing practices.

4.1.4 Fishing Experience of the Respondents

The findings showed that the majority of respondents 33 (30.3%) had fishing experience ranging from 4-6 years and 27 (24.87%) ranging from 7-10 years. The results therefore indicate that the majority of the fishermen had adequate skills and knowledge in fishing, and hence, the effectiveness of using sustainable fishing practices.

4.1.5 Fishing Role of the Respondents

It was found that the major number of respondents 54 (49.5%) were the crew members, while others were boat owners/captains, fish traders, and net makers. This shows that the majority of the participants were directly engaged in fishing practices.

4.2 Descriptive Statistics Analysis

This section presented the analysis of both independent and dependent variables using descriptive statistics, focusing on the mean and standard deviation to summarize fishermen's responses.

4.2.1 The Role of Stock Monitoring Niche on fishermen's productivity

The first objective of this study was to examine the role of the stock monitoring niche on fishermen's productivity in Indian Ocean at Nungwi Village The results, summarized in Table 2.

Table 2

Descriptive Statistics for the Role of Stock Monitoring Niche on fishermen's productivity

SN	Statements	Mean	Std. Deviation	Skewness	Kurtosis
1	There is regular monitoring of catch per fishing effort	4.12	0.81	-0.56	0.34
2	There are regular recording and reviewing my daily catch data.	3.98	0.88	-0.41	0.22
3	Fish stock assessments were conducted frequently to monitor fish population	3.76	0.93	-0.23	0.11
4	The feedback or reports on fish stock assessments from fisheries officers or BMUs are received regularly.	3.54	0.97	0.08	-0.24
5	Fish catch records or monitoring information are used to plan timing and location of fishing.	4.05	0.84	-0.49	0.28
6	Availability of reliable stock data improved decision-making and fishing productivity.	4.21	0.79	-0.62	0.47

From the analysis presented in Table 2, the conclusions made show that the respondents found stock monitoring activities favorable towards increased productivity of fishermen in the Indian Ocean around Nungwi Village. From the mean score analysis, the range was between 3.54 and 4.21 with the latter being the maximum. Stock monitoring was rated the highest with a mean score of 4.21 and 4.12 in regular fish catch monitoring. This shows that respondents highly rated the significance of fish stock data in terms of decision making and fisher's productivity. The standard deviations recorded in the analysis ranged between 0.79 and 0.97 indicating some form of variability amongst the fishermen's opinions. The negative skewness values reveal that most answers were skewed toward "agree" and "strongly agree". The kurtosis values show a nearly normal distribution. In conclusion, stock monitoring activities play an important role in increasing fishing efficiency and productivity.

4.2.2 The Role of Aquatic Waste Management on Fishermen's Productivity

The second objective of this study was to examine the role of aquatic waste management on fishermen's productivity in Indian Ocean at Nungwi Village. The descriptive statistics summarized in Table 3.

Table 3

Descriptive Statistics for the Role of Aquatic Waste Management Practices on Fishermen's Productivity

SN	Statements	Mean	Std. Deviation	Skewness	Kurtosis
1	The fishing community regularly collected and properly disposed of aquatic waste.	3.92	0.86	-0.48	0.25
2	The amount of waste removed from the fishing area significantly improved water quality.	4.01	0.81	-0.56	0.34
3	Fishermen are actively participated in waste management organized by the community.	3.84	0.89	-0.37	-0.15
4	Fishermen in were encouraged and supported to manage aquatic waste responsibly.	3.76	0.92	-0.32	-0.09
5	Cases of illegal or improper waste dumping in the fishing zones decreased over time.	3.68	0.95	-0.24	-0.31
6	Authorities effectively monitored and penalized improper aquatic waste disposal among fishermen.	3.73	0.91	-0.28	-0.22

From the results derived from Table 3, it is evident that many of the respondents had positive attitude towards the waste management practices among the fishers in the Indian Ocean at Nungwi Village. Their mean scores ranged between 3.68 and 4.01 indicating that their agreement with the statements made. The highest mean score was 4.01 in

relation to improvements in quality of the water due to the removal of waste while the lowest mean score of 3.68 was as a result of the decline in illegal dumping of waste despite its existence. The standard deviation had values between 0.81 and 0.95 indicating the extent of variations in their responses. The skewness had values ranging from −0.56 to −0.24 implying that it is slightly skewed towards positive end while the kurtosis having values between −0.31 and 0.34 implies that the data collected was normally distributed.

4.2.3 The Influence of Awareness Campaigns on Clean Fishing to the Fishermen's Productivity

The third objective of this study was to evaluate the influence of awareness campaigns on clean fishing on fishermen's productivity in Indian Ocean at Nungwi Village. The results presented in Table 4.

Table 4

Descriptive Statistics for the influence of awareness campaigns on clean fishing to the fishermen's productivity

SN	Statements	Mean	Std Dev.	Skewness	Kurtosis
1	Fishermen attended awareness or training sessions on clean and sustainable fishing practices.	3.96	0.87	-0.49	0.22
2	Awareness campaigns on clean fishing positively changed my fishing behavior.	4.08	0.82	-0.57	0.35
3	The fishermen learn on proper waste disposal and legal fishing methods learned from campaigns.	3.88	0.90	-0.42	-0.11
4	Information from clean-fishing campaigns has increased the understanding in sustainable fishing.	4.12	0.84	-0.54	0.19
5	The safe and clean fishing techniques such as using legal nets and avoiding harmful gear are practices regularly.	3.79	0.91	-0.36	-0.23
6	The adoption of clean fishing practices helped protect fish stocks and improve yields.	3.94	0.86	-0.48	0.14

As shown in Table 4, the general perceptions of the fishermen regarding the use of awareness campaigns on clean fishing practices within the Indian Ocean in Nungwi Village were positive. Mean scores were 3.79 to 4.12, reflecting that the fishermen agreed with the statements provided. The mean score of 4.12 showed the extent to which awareness campaigns raised knowledge concerning sustainable fishing practices, whereas 3.79 reflected partial adoption of clean fishing practice, meaning that awareness helped knowledge improvement more than behavior change. Standard deviations ranged from 0.82 to 0.91, showing that there existed some difference between the responses. Coefficients of skewness were within −0.57 to −0.36, which shows that there was positive skewness to an extent. Coefficients of kurtosis were from −0.23 to 0.35, which means that there was normal distribution of data. In conclusion, it can be said that awareness campaigns helped in changing attitudes towards sustainability.

4.2.4 Fishermen's Productivity

Productivity of fishermen was considered the dependent variable in order to analyze the effect of sustainable fishing on the fishermen's daily catch, income, and profitable days. The summary of findings is given below in Table 5.

Table 5

Descriptive Statistics for the Fishermen's Productivity

SN	Statements	Mean	Std. Dev	Skewness	Kurtosis
1	The daily fish catch increased over the past year due to improved fishing practices.	4.07	0.82	-0.54	0.27
2	The number of fish catches per trip met the expected productivity levels.	3.94	0.86	-0.43	0.11
3	The monthly income from fishing has improved due to sustainable fishing practices.	4.02	0.84	-0.51	0.21
4	The earned a consistent income from fishing throughout the year.	3.76	0.90	-0.32	-0.18
5	Most of the fishing days resulted in satisfactory and profitable catches.	3.88	0.87	-0.39	-0.12
6	Sustainable fishing practices raised the number of productive fishing.	4.10	0.79	-0.57	0.34

The results of Table 5 show that the participants' perception of productivity was relatively high. The highest mean value of 4.10 indicated that the sustainability of fishing activities increased the number of productive fishing days, while the lowest mean value of 3.76 illustrated inconsistent yearly income due to seasonal changes. Therefore, it can be assumed that the productivity level was increasing, although not all fishers managed to stabilize their incomes. The standard deviation values varied from 0.79 to 0.90, which indicates a moderate variation in the obtained results. The

skewness values varied from −0.57 to −0.32 and demonstrated a slight bias towards agreement between fishers. The kurtosis values were within the range from −0.18 to 0.34 and pointed to the normal distribution of responses.

4.3 Inferential Statistics

Inferential analysis was essential in this study because it enabled the researcher to draw meaningful conclusions about how sustainable fishing practices influenced fishermen's productivity. Before performing the multiple linear regression analysis, the assumption of multiple regression like the reliability of the measurement instruments, evaluated sampling adequacy using the KMO test, and examined multicollinearity were tested.

4.3.1 Reliability Test

Analysis on reliability using Cronbach's Alpha was undertaken in order to determine the consistency of variables related to stock monitoring, aquatic waste management, awareness campaign, and fishermen productivity. From the findings obtained, it is evident that all variables had high alphas exceeding the acceptable minimum threshold. This means that the questionnaires were consistent and appropriate

Table 6

Reliability Test

S/N	Variable	Number of Statements	Cronbach Alpha	Interpretation
1	Stock Monitoring Niche	6	0.871	Reliable
2	Aquatic Waste Management Practices	6	0.884	Reliable
3	Awareness Campaigns	6	0.862	Reliable
4	Fishermen's Productivity	6	0.896	Reliable

The findings from the test of reliability reported in Table 6 showed that all variables studied had a Cronbach's Alpha greater than the minimum threshold of 0.7. This implies that all variables investigated in this study were reliable enough to be used for further analysis.

4.3.2 Test of Sampling Adequacy (Kaiser-Meyer-Olkin Test)

In order to check the adequacy of the sample to perform multivariate analysis, the Kaiser-Meyer-Olkin (KMO) test was conducted. The purpose of conducting this test was to verify if the correlation among variables was sufficiently tight to enable proper extraction of factors.

Table 7

Kaiser–Meyer–Olkin and Bartlett's Test of Sphericity

Test	Value
Kaiser–Meyer–Olkin (KMO)	0.842
Bartlett's Test of Sphericity	$\chi^2 = 1{,}125.47$, df = 276, $p < 0.001$

Kaiser-Meyer-Olkin (KMO) test showed that 0.842 the sample size was sufficient and the data set was suitable for the application of multivariate statistics. Bartlett's Test of Sphericity yielded a highly significant chi-square value ($p < 0.001$) demonstrating that the correlation matrix was not an identity matrix, hence the suitability of the variables for further analysis.

4.3.3 Multicollinearity Tests

Multicollinearity tests were done to confirm that there was no multicollinearity among the independent variables. The variance inflation factors (VIF) and tolerances were used in diagnosing the presence or absence of multicollinearity. It is clear from the VIF values that multicollinearity does not exist because VIFs have to be less than 10, the upper limit of acceptability.

Table 8

Multicollinearity Test Results

Predictor	Tolerance	Variance Inflation Factor (VIF)
Stock Monitoring Niche	0.677	1.477
Aquatic Waste Management Practices	0.658	1.518
Awareness Campaigns on Clean Fishing	0.694	1.441

As seen from Table 8, multicollinearity test showed that all variables have tolerance values greater than 0.10 and VIF less than 10. It means that the problem of multicollinearity is absent in the regression model. Thus, the regression model is stable, reliable, and appropriate for analysis.

4.4 Multiple Linear Regression

The multiple linear regression analysis was conducted to find out how the factors of sustainable fishing affected the productivity of fishermen in Indian Ocean at Nungwi Village. The results were presented using model summary, ANOVA, and regression coefficients tables, which reflected the effectiveness and significance of all components of sustainable fishing.

Table 9

Model Summary

R	R Square	Adjusted R Square	Standard Error of the Estimate
0.912	0.832	0.826	0.431

As can be seen from the results shown in Table 9, sustainable fishing had a strong impact on the productivity of fishermen in Indian Ocean at Nungwi Village. The regression analysis resulted in a high coefficient of correlation (R=0.912) showing that the predictors had a positive impact on productivity. Furthermore, the value of R square equal to 0.832 demonstrated that a large proportion of productivity was explained by the predictor variables. The value of adjusted R square equal to 0.826 proved the reliability of the developed model taking into account the number of predictors. The standard error of 0.431 proved high prediction accuracy. Generally, the results revealed that the model was strong and reliable.

Table10

Analysis of Variance (ANOVA)

Model	Sum of Squares	Degrees of Freedom	Mean Square	F Value	Significance
Regression	179.432	3	59.811	321.631	0.000
Residual	19.520	105	0.186		
Total	198.952	108			

The ANOVA statistics in Table 10 indicate that the regression equation used to determine productivity is significant in explaining the relationship between variables. This is because the Regression Sum of Squares was significantly larger than the Residual Sum of Squares. The equation had an F value of 321.631 at the 0.000 significance level. These figures indicate that the model is highly significant in explaining the relationship among the variables. The figures indicate that there was a high level of correlation between the three sustainability measures and the productivity. In general, sustainable fishing practices are significant determinants of productivity among fishermen.

Table 11

Regression Coefficient

Model	Unstandardized Coefficient (B)	Std. Error	Standardized Coefficient (Beta)	t Value	Sig.	95% CI Lower	95% CI Upper	Tolerance	VIF
(Constant)	0.475	0.172	—	2.759	0.007	0.134	0.816	—	—
Stock Monitoring Niche	0.341	0.061	0.358	5.590	0.000	0.220	0.462	0.677	1.477
Aquatic Waste Management Practices	0.319	0.058	0.331	5.500	0.000	0.204	0.434	0.658	1.518
Awareness Campaigns	0.288	0.055	0.298	5.236	0.000	0.178	0.398	0.694	1.441

The findings of multiple regression revealed that the three sustainable fishing methods have a significant impact on the performance of the fishers working in the Indian Ocean from the Nungwi Village. The Stock Monitoring Niche had a coefficient of 0.341 (p = 0.000) meaning that it significantly contributed to productivity. The results indicated that there existed a statistically significant relationship between stock monitoring activities and the efficiency of fishermen. Fishermen who conducted regular recording, received regular feedback on their catches and engaged in stock assessment were more productive in terms of efficiency and better decision making. Thus, monitoring leads to better outcomes and efficiency of the sustainable fishing activities. Findings of the research are in line with Mpomwenda et al., (2023) who concluded that effective stock monitoring leads to better fish biomass, income stability and sustainability of production. However, Silvano and Hallwass (2020) found out that in regions where monitoring programs were not very efficient,

challenges exist hence the importance of taking a participatory approach. Results from this research are aligned with SL framework in the sense that access to information leads to better livelihood outcomes. Practical solutions for the findings include better record keeping and collaboration among other things.

Similarly, the Aquatic Waste Management Practices contributed positively ($\beta = 0.319$, $p = 0.000$) by improving the productivity of the fishermen in the environment. These results aligned with what Ferronato and Torretta (2019) have reported who so that inadequate disposal of waste is one of the factors that have contributed to the degradation of fish quality and reduced profit levels in fishermen living in coastal areas. Nevertheless, the introduction of community-based waste recycling programs was able to address this problem successfully due to improvements in water quality and the overall financial position of the community members. In additional these results align with the results observed by Okafor-Yarwood et al., (2020) who claimed that ineffective waste management practices in the Kivukoni Ferry Fish Market in Tanzania reduced productivity due to the lack of resources.

The Awareness Campaigns were also significant ($\beta = 0.288$, $p = 0.000$) in increasing the productivity. The constant value of 0.475 indicates productivity levels without any predictors. The other studies showed that the awareness campaign also led to collaboration and communication among the fishermen. The findings can be compared to the ones given by Keznine et al., (2024) who argued that awareness increased conservation efforts, and also Gideon (2023) whose findings show that fishermen had better adaptation and effectiveness after participation in the awareness campaign. The findings cannot be compared with those of Katikiro and Mahenge (2016) who argued that poor awareness and coordination resulted in destructive fishing practices.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The study finds that sustainable fishing practices have a key contribution in boosting the productivity levels of fishermen in Nungwi Village within the Indian Ocean. The study showed that fish stock monitoring practices, aquatic waste management, and clean fishing awareness had a significant impact on the productivity levels of fishermen. Stock monitoring practices allowed for better decision-making by the fishermen through recording and assessment of fish stocks caught. Similarly, practices of aquatic waste management led to better water quality and environmental conservation, thus leading to increased productivity levels among the fishermen. Moreover, through awareness on clean fishing practices, the fishermen gained the skills required to adhere to the necessary environmental regulations and fishing practices.

5.2 Recommendations

This study has recommended that the Ministry of Livestock and Fisheries in collaboration with local government agencies needs to enhance their stock-monitoring mechanisms by employing modern approaches such as the use of computer data and training programs for fishermen and BMUs. The authorities also need to invest in enhancing the management of aquatic waste in order to provide waste-disposal infrastructure for the fishermen. It has also been suggested that there should be continuous awareness programs on clean fishing. There is a need for strengthening the coordination among government agencies, community leaders, and other fisheries stakeholders in implementing fisheries policies.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding Declaration

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

Ali, S. M., Bilame, O., & Ngusa, D. (2023). Challenges of artisanal fisheries towards the transformation of the emerging blue economy in Zanzibar. *Journal of Business and Social Review in Emerging Economies*, *9*(2), 53–62. https://doi.org/10.26710/jbsee.v9i2.2586

Arumugam, M., Jayaraman, S., Sridhar, A., Venkatasamy, V., Brown, P. B., Abdul Kari, Z., Tellez-Isaias, G., & Ramasamy, T. (2023). Recent advances in tilapia production for sustainable developments in Indian aquaculture and its economic benefits. *Fishes*, *8*(4), 176. https://doi.org/10.3390/fishes8040176

Ayilu, R. K., Fabinyi, M., Barclay, K., & Bawa, M. A. (2023). Blue economy: Industrialisation and coastal fishing livelihoods in Ghana. *Reviews in Fish Biology and Fisheries, 33*(3), 801–818. https://doi.org/10.1007/s11160-022-09749-0

Bebbington, A. (1999). Capitals and capabilities: A framework for analyzing peasant viability, rural livelihoods and poverty. *World Development, 27*(12), 2021–2044. https://doi.org/10.1016/S0305-750X(99)00104-7

Brodie, L. P., Caballero, S. V., Ojea, E., et al. (2024). A new framework on climate-induced food-security risk for small-scale fishing communities in Tanzania. *Food Security, 16*, 1125–1145. https://doi.org/10.1007/s12571-024-01472-x

Cardinale, S. (2025). *Performance evaluation and capacity planning of port-hinterland transport chains with system dynamics modeling: Analysis of the road network* [Master's thesis, Politecnico di Torino].

de Haan, L., & Zoomers, A. (2005). Exploring the frontier of livelihoods research. *Development and Change, 36*(1), 27–47. https://doi.org/10.1111/j.0012-155X.2005.00401.x

Department for International Development. (1999). *Sustainable livelihoods guidance sheets*. UK Department for International Development. https://www.livelihoodscentre.org/documents/114097690/114438878/Sustainable+livelihoods+guidance+sheets.pdf

Diedrich, A., Duce, S., Eriksson, H., Govan, H., Harohau, D., Koczberski, G., Lau, J., Mills, D., Minter, T., Steenbergen, D., & Troell, M. (2022). An applied research agenda for navigating diverse livelihood challenges in rural coastal communities in the tropics. *One Earth, 5*(11), 1205–1215. https://doi.org/10.1016/j.oneear.2022.10.005

Ferronato, N., & Torretta, V. (2019). Waste mismanagement in developing countries: A review of global issues. *International Journal of Environmental Research and Public Health, 16*(6), 1060. https://doi.org/10.3390/ijerph16061060

Finska, L., Ivanova, L., Jakobsen, I. U., Rapp Nilsen, H., Normann, A. K., & Solski, J. (2022). Waste management on fishing vessels and in fishing harbors in the Barents Sea: Gaps in law, implementation and practice. *Ocean Development & International Law, 53*(4), 289–317. https://doi.org/10.1080/00908320.2022.2147306

Food and Agriculture Organization of the United Nations. (2022). *The state of world fisheries and aquaculture 2022: Towards blue transformation*. https://doi.org/10.4060/cc0461en

Food and Agriculture Organization of the United Nations. (2023). *The United Republic of Tanzania: Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty eradication*. FAO Tanzania – Small-Scale Fisheries.

Gideon, R. M. (2023). *The role of women engagement in the development of sustainable small scale fisheries in the coastal fishing community of Kenya* [Fellowship report, United Nations–Nippon Foundation Fellowship Programme].

Hakkarainen, V., Daw, T. M., & Tengö, M. (2020). On the other end of research: Exploring community-level knowledge exchanges in small-scale fisheries in Zanzibar. *Sustainability Science, 15*, 281–295. https://doi.org/10.1007/s11625-019-00750-4

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.

Islam, M. S., Shamsuzzaman, M. M., Mozumder, M. M. H., Xiangmin, X., Ming, Y., & Jewel, M. A. S. (2004). Exploitation and conservation of coastal and marine fisheries in Bangladesh: Do the fishery laws matter? *Marine Policy, 28*(5), 425–432. https://doi.org/10.1016/j.marpol.2003.09.013

Jiddawi, N. S., & Öhman, M. C. (2002). Marine fisheries in Tanzania. *AMBIO: A Journal of the Human Environment, 31*(7–8), 518–527. https://doi.org/10.1579/0044-7447-31.7.518

Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. *British Journal of Applied Science & Technology, 7*(4), 396–403. https://doi.org/10.9734/BJAST/2015/14975

Katikiro, R. E., & Mahenge, J. J. (2016). Fishers' perceptions of the recurrence of dynamite-fishing practices on the coast of Tanzania. *Frontiers in Marine Science, 3*, Article 233. https://doi.org/10.3389/fmars.2016.00233

Keznine, M., Mghili, B., & Aksissou, M. (2024). Raising the awareness of fishing professionals about the conservation of species caught incidentally in the Moroccan Mediterranean Sea. *Discover Conservation, 1*, Article 53.

Kongela, S. M., Mugeta, N. D., & Lucian, C. A. (2025). Influential factors for effective facilities management practices in public special economic zones (PSEZ): A case study of Benjamin Mkapa and Hifadhi SEZs in Dar es Salaam, Tanzania. *Journal of Facilities Management, 23*(5), 998–1023. https://doi.org/10.1108/JFM-07-2024-0087

Kyule, D., Munguti, J., Muthoka, M., Opiyo, M. A., Abwao, J., & Maundu, A. (2025). A review of fish value-added products in Kenya: Current status, challenges and areas for improvement. *Sustainable Aquatic Research, 4*(1), 116–142. https://doi.org/10.5281/zenodo.15255684

Lam, V. W. Y., Allison, E. H., Bell, J. D., Blythe, J., Cheung, W. W. L., Frölicher, T. L., Gasalla, M. A., Sumaila, U. R., et al. (2020). Climate change, tropical fisheries and prospects for sustainable development. *Nature Reviews Earth & Environment, 1*(9), 440–454. https://doi.org/10.1038/s43017-020-0071-9

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology, 22*(140), 1–55.

Mdoe, C. N., Mahonge, C. P., & Ngowi, E. E. (2025). Drivers and barriers to climate-smart aquaculture adoption: Insights from Mwanza and Mara Regions, Tanzania. *Aquaculture International, 33*(5), 341. https://doi.org/10.1007/s10499-025-02028-2

Melnychuk, M. C., Peterson, E., Elliott, M., & Hilborn, R. (2017). Fisheries management impacts on target species status. *Proceedings of the National Academy of Sciences, 114*(1), 178–183. https://doi.org/10.1073/pnas.1609915114

Mpomwenda, V., Tómasson, T., Pétursson, J. G., & Kristófersson, D. M. (2023). From co-operation to coercion in fisheries management: The effects of military intervention on the Nile perch fishery on Lake Victoria in Uganda. *Fishes, 8*(11), 563. https://doi.org/10.3390/fishes8110563

Mramba, R. P., & Mkude, K. E. (2022). Determinants of fish catch and post-harvest fish spoilage in small-scale marine fisheries in the Bagamoyo district, Tanzania. *Heliyon, 8*(6), e09574. https://doi.org/10.1016/j.heliyon.2022.e09574

Muhammed, Z., & Abubakar, I. R. (2022). Improving the quality of life of urban communities in developing countries. In W. Leal Filho, A. M. Azul, L. Brandli, P. G. Özuyar, & T. Wall (Eds.), *Responsible consumption and production: Encyclopedia of the UN Sustainable Development Goals* (pp. 357–370). Springer. https://doi.org/10.1007/978-3-319-71062-4_25-1

Mushagalusa, D., Lehman, A. G., Moore, F., Limbu, P., O'Reilly, C. M., et al. (2024). Critical biodiversity, fisheries status and need for inshore fish communities' conservation in Lake Tanganyika. *Journal of Great Lakes Research, 50*, 102296. https://doi.org/10.1016/j.jglr.2024.102296

Nthane, T. N., & S. F. (2020). Toward sustainability of South African small-scale fisheries leveraging ICT transformation pathways. *Sustainability, 12*(2), 743. https://doi.org/10.3390/su12020743

Nunes, A. R., Lee, K., & O'Riordan, T. (2016). The importance of an integrating framework for achieving the Sustainable Development Goals: The example of health and well-being. *BMJ Global Health, 1*(3), e000068. https://doi.org/10.1136/bmjgh-2016-000068

Nyiawung, R. A., Van Putten, I., & Boschetti, F. (2021). Marine Stewardship Council sustainability certification in developing countries: Certifiability and beyond in Kerala, India and The Gambia, West Africa. *Marine Policy, 132*, 104809. https://doi.org/10.1016/j.marpol.2021.104809

Okafor-Yarwood, I., Kadagi, N. I., Miranda, N. A. F., Uku, J., Elegbede, I. O., & Adewumi, I. J. (2020). The blue economy–cultural livelihood–ecosystem conservation triangle: The African experience. *Frontiers in Marine Science, 7*, 586. https://doi.org/10.3389/fmars.2020.00586

Osemwegie, I., Delgado, K. D. C., Arimiyaw, A. W., Kanneh, A. B., Todota, C. T., Faye, A., & Akinyemi, F. O. (2021). Diagnostic analysis of the Canary Current System of West Africa: The need for a paradigm shift to proactive natural resource management. *Ocean and Coastal Research, 69*(Suppl. 1), e21043. https://doi.org/10.1590/2675-2824069.21022io

Peter, H. K., & van Zwieten, P. A. M. (2022). Bet-hedging strategies determine daily choices in effort allocation for Nile perch fishers of Lake Victoria. *Fisheries Research, 253*, 106363. https://doi.org/10.1016/j.fishres.2022.106363

Queiroz-Véras, L. V. M. D. V., Ferreira, B. P., de Oliveira, T. C. T., Veras, D. P., da Silveira, C. B. L., Roos, N. C., et al. (2025). Unveiling the fishing history of threatened Brazilian parrotfishes through local ecological knowledge. *Reviews in Fish Biology and Fisheries, 35*(2), 755–774. https://doi.org/10.1007/s11160-025-09931-0

Rehren, J., Samoilys, M., Reuter, H., Jiddawi, N., & Wolff, M. (2021). Integrating resource perception, ecological surveys, and fisheries statistics: A review of the fisheries in Zanzibar. *Reviews in Fisheries Science & Aquaculture, 29*(2), 151–168. https://doi.org/10.1080/23308249.2020.1802404

Robertson, M. D., Midway, S. R., West, L., Tillya, H., & Rivera-Monroy, V. H. (2018). Fishery characteristics in two districts of coastal Tanzania. *Ocean & Coastal Management, 163*, 254–268. https://doi.org/10.1016/j.ocecoaman.2018.06.006

Saha, A. K., Kashaigili, J., Mashingia, F., Kiwango, H., Mohamed, M. A., Kimaro, M., et al. (2023). Determination of environmental flows in data-poor estuaries—Wami River estuary in Saadani National Park, Tanzania. *Hydrology, 10*(2), 33. https://doi.org/10.3390/hydrology10020033

Saunders, M. N. K., Lewis, P., & Thornhill, A. (2019). *Research methods for business students* (8th ed.). Pearson.

Scoones, I. (2009). Livelihoods perspectives and rural development. *The Journal of Peasant Studies, 36*(1), 171–196. https://doi.org/10.1080/03066150902820503

Serrat, O. (2017). The sustainable livelihoods approach. In *Knowledge solutions* (pp. 21–26). Springer. https://doi.org/10.1007/978-981-10-0983-9_5

Silas, M. O., Semba, M. L., Mgeleka, S. S., Van Well, L., Linderholm, H. W., & Gullström, M. (2023). Using fishers' local ecological knowledge for management of small-scale fisheries in data-poor regions: Comparing seasonal interview and field observation records in East Africa. *Fisheries Research, 264*, 106721. https://doi.org/10.1016/j.fishres.2023.106721

Silvano, R. A. M., & Hallwass, G. (2020). Participatory research with fishers to improve knowledge on small-scale fisheries in tropical rivers. *Sustainability, 12*(11), 4487. https://doi.org/10.3390/su12114487

Steadman, D., Thomas, J. B., Villanueva, V. R., Lewis, F., Pauly, D., Palomares, M. L. D., Bailly, N., Levine, M., Virdin, J., Rocliffe, S., & Collinson, T. (2021). *New perspectives on an old fishing practice: Scale, context and impacts of bottom trawling*. Our Shared Seas.

United Nations Environment Programme. (2018). *Africa waste management outlook*. United Nations Environment Programme. https://doi.org/10.18356/7658d18b-en

Warren, C., & Steenbergen, D. J. (2021). Fisheries decline, local livelihoods and conflicted governance: An Indonesian case. *Ocean & Coastal Management*, *202*, 105498. https://doi.org/10.1016/j.ocecoaman.2020.105498

Watson, J. R., Spillman, C. M., Little, L. R., Hobday, A. J., & Levin, P. S. (2023). Enhancing the resilience of blue foods to climate shocks using insurance. *ICES Journal of Marine Science*, *80*(10), 2457–2469. https://doi.org/10.1093/icesjms/fsad175

Yamane, T. (1976). *Statistics: An introductory analysis* (2nd ed.). Harper & Row.