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TWO-STAGE HEDONIC PRICE ANALYSIS OF FISH ATTRIBUTES AROUND LAKE VICTORIA, TANZANIA

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ABSTRACT
Landing price analysis of fish attributes remain undisclosed during the fish harvest landing to landing sites, although it is potential to the wellbeing of artisanal fisher. This study employed a cross-sectional research design and 289 artisanal fishers sampled to investigate fish attributes on landing prices around Lake Victoria, Tanzania, for selected fish species: Nile perch, Tilapia and Sardine species. Two-stage hedonic price model employed in the analysis. The results showed that freshness at island, quantity landed at island market, size, preserved fish, weight and freshness at mainland landing ground were examined to be statistically significant (p < 0.05) fish attributes affecting landing price of fishes. This study concluded that, important fish attributes influencing landing price were fish freshness on the island and mainland, quantity landed at onshore island market, preserved fish, weight and size. Therefore, artisanal fishers should join together and form cooperatives to improve preservation methods to maintain quality of fish attributes and use modern storage facilities to maintain freshness of the fish and employ fishing vessels that catch legally authorized fish size.

Keywords: *Hedonic price; fish attributes; landing price; artisanal fisher*
Paper type: *Research paper*
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1. INTRODUCTION

Worldwide, fish remains a source of food and employment in developing countries (Henson *et al.*, 2000). Fishes are the animals nearly around 34 000 species living in fresh and salty waters. Traded fish for consumption are fishes recognized by belonging features and quality or characteristics known as fish attributes during selling price decisions (Maciel *et al.*, 2013, FishBase, 2018). Nevertheless, the relationship between fish attributes and fish prices have remained viewed differently at the global level by scholars, for years. Various studies, including studies by Gobillon *et al.*,(2015), Hammarlund (2015), Lee (2014), McConnell and Strand (2000) provide different views regarding several fish attributes and their price influence by different fish species. For example, views of McConnell and Strand (2000) are on the argument that fish species, fat content, and type of handling are fish attributes influencing price. Views by Roheim *et al.* (2007) were focused on attributes such as species, size, brand, product, and administered forms.

Other attributes are given by Hammarlund (2015) who listed size and freshness of fish as fish attributes affecting the price of fish. Besides, a study by Lee (2014) found attributes such as fish size, storage, trip duration, freshness and gear of fish. Gobillon (2017) analysed fish species, fish size, time, sellers' and buyers' effects as attributes influencing the price of fish. With distinction to species-specific, a study by Lee (2014) focused on Atlantic cod; Hammarlund (2015) was on Baltic cod; and a study by Gobillon (2017) was on Sole and Monkfish species. Although these studies were restricted to diverse species on specific attributes and were country-specific about determining prices of fish, but there remains no empirical information on whether the mentioned fish attributes or similar attributes are relevant for selected fish species around Lake Victoria, Tanzania.

Despite the availability of different species around Lake Victoria, Tanzania, the dominant species caught and sold species are Nile perch, Nile tilapia, and Sardine (Matiya, 2010 and URT, 2014). With these reasons, these species were selected for the study on which this paper is based. Therefore, fish attributes of the selected species such as freshness, quantity landed and size of fish in determining landing prices at different market level or category as depicted by Gobillon (2017), Lee (2014) and McConnell and Strand (2000) were analysed. Landing price is defined as the fish price received at first-hand by artisanal fishers during landing, and it contributes to the income and wellbeing of artisanal fishers within the fishery sector (Janssen *et al*., 2001; Alapan *et al*., 2016). According to FAO (2014), artisanal fishers are fishers using comparatively insignificant amounts of wealth and resources whose fishing is principally for local consumption. A huge part of their catches is for resident markets within the landing sites (Hoof & Kraan, 2017).

Apart from income and wellbeing contribution of the fishery sector to individual artisanal fisher, 2.5% of real GDP has been contributed by the fishery sector and more than 4 000 000 people have been employed in related activities in Tanzania (FAO, 2014; BOT, 2017). There are various challenges related to variation of fish attributes documented by studies around Lake Victoria argue to discourage paid higher prices among artisanal. The challenges are exploitation of fishers by agent's, unequal power of negotiation, inadequate fishing gear accessibility, poor quality handling vessels, choice variations of buyers, lack of building fishing skills, obtaining and use of modern technology, and insufficient access to storage facilities (Kambewa, 2007; Luomba, 2013).

Subsequent to these challenges hindering artisanal fishers to obtain a higher landing price, the Tanzania government has facilitated the availability of storage and other fishing facilities to preserve fish and therefore artisanal fishers obtain higher paid landing prices for preserving fishes (URT, 2014a). Also, artisanal fishers were looking for profitable contract arrangements as part of efforts to acquire higher landing price (Mpenda, 2010). Consequently, there were still challenges found hindering higher prices received by artisanal fisher. These challenges are the persistence of falls information about onshore and offshore fish prices, the quantity of harvested fish, types of buyers and credit finances issued to fishers (Janssen *et al*., 2001; Phillips and Subasinghe, 2010). Study by Chandrashekar (2014) response to these challenges that artisanal fishers' cooperative strategy could improve fish quality while attracting and sustaining higher landing prices as a solution to these challenges.

However, little, if any, a study has been conducted on the effects of fish attributes around Lake Victoria, Tanzania. Precedent, there are few kinds of literature similarly to the study area in Buchosa and Sengerema districts which have looked into effects of fish attributes on fish landing prices. Studies by Gobillon (2017); Hammarlund (2015); Lee (2014); McConnell and Strand (2000) focused on the attributes such as fat contents, freshness, storage facilities, grades and size in fish prices setting at different market categories of landing site. However there remains narrow information on whether the mentioned fish attributes or similar fish attributes persist around Lake Victoria, Tanzania. This paper focused on the price received by artisanal fishers during landing at all market categories which are local markets, offshore and onshore landing sites. The objective of the paper is to examine fish attributes effects on the fish landing price. Thus, study's result serves as a root source for recommendations concerning fish pricing and attributes among artisanal fisher around Lake Victoria, Tanzania. This paper answers two questions: (i) what are the fish attributes affecting fish price? (ii) How does the change of one attribute affects price of fish? It is hypothesized that there is no significant influence of fish attributes on the landing price.

2.0 LITERATURE REVIEW

2.1 Theory Underpinning the Study

The study on which this paper is based was guided by the Price Theory. The theory explored the relationship between the price for any specific product in connection with demand and supply of that product or commodity. In the basis of this theory, the price of the product is attained at a point which utility bearing attributes of that commodity is not only treasured to individual buyers' demands, but also it conforms to the sellers and is known as the optimal market price. The theory was put forward by Nguyen (2011) in demonstrating the association between prices of tours in a day at island and varied attributes related with them.

The foundation of product valuation for their utility-bearing attributes and prices of product vary with alteration in the number of attributes related with it, and they date back to validation by Rosen (1974), recognised as hedonic price theories. The importance of the association between product prices and quantities of attributes was also validated in demand and supply studies for various fish species with specific attributes. These studies include studies by Bronnmann and Hoffmann (2018), Brayden *et al*, (2018) and Johnston (2001), which were focused on fish attributes valuation based on the preferences of consumers by employing the demand theory. Others are studies on supplies of fishes, including studies by Kristofersson and Rickertsen (2004), Brummett (2000) and McConnell and Strand (2000) which focused on the supply theory.

It is assumed that a positive change in the supply of product with belonging specific attributes affects that product prices (Kristofersson and Rickertsen, 2004). Besides, during the fish supply, artisanal fishers may have the catch control and cost of fishing, but it is important to understand that the price of fish paid by artisanal fishers may also be associated with monopoly, strategic pricing, supply, and demand factors (Gordon and Hussain, 2015, Leiblein, 2017).

Further, following the assumptions that fish price paid to artisanal fishers by buyers is the optimal price which can alter when demand and supply vary (Gordon and Hussain, 2015), then price theory is a useful guide to evaluate effects of fish attributes on fish landing prices. This theory contextualizes how fish landing price is determined based on demand and supply of fish, considering attributes such as freshness, species, size, preserved fish from different methods of preservation and weight (Staniford, 1988; McConnell and Strand 2000; Kristofersson and Rickertsen, 2004; Roheim *et al.*, 2007, Gordon and Hussain, 2015; Alapan *et al.*, 2016). The methods of fish preservation include sun-drying, smoking and freezing (Matiya, 2010).

The specific product price is set by its interior and exterior factors, spotted and unobserved attributes (Nguyen, 2011). However, in price theory, the key feature is the assumption that price is a function of its essential attributes (Thrane, 2005). To understand fish attributes impacts on landing prices for quantity supplied at landing sites, it was important to understand how fish size, species, freshness, quantity landed at different offshore and onshore landing sites, preserved fish from different preservation methods and weights influencing landing price as dependent variables. Analysing those variables was the focus of this paper.

2.2 Empirical review

There are various studies that have looked into several fish attributes and fish price, including studies by Gobillion (2017), Lee (2014), Hammarlund (2015) and McConnell and Strand (2000). Many of these studies analysed data using a hedonic price function. Employing hedonic price function in relation to fish attributes, Lee (2014) and Hammarlund (2015) found that fish size, freshness, trip duration, storage, and gear type are fish attributes which have effects on the ex-vessel price for cod. Other studies which used hedonic price function include studies by McConnell and Strand (2000) and Gobillon (2017) who confirmed the influence of the attribute variables such as freshness, preserved fish and fish size in determining prices of fish at different market levels. However, these studies indicated the quality attributes which are related to fishery management and resale prices.

Several hedonic studies used different functional forms such as linear, semi-log, log-log, quadratic and log-linear in transforming variables of choices when estimating hedonic price functions (Nguyen, 2011; Mangion, 2004; Carroll, 2001; Slade, 2000). Studies by Nguyen (2011) and Mangion (2004) employed cross-sectional data in the analysis of log-linear regression model to examine the relationship between price and different attributes in terms of tourism competitiveness. Literature argues that the log-linear model is the most preferred specification for analysing hedonic price determinants and performs better than other models (Slade, 2000). Despite similar hedonic price functions used, different species were analysed in studies by Lee (2014) who focused on Atlantic cod, Hammarlund (2015) who focused on Baltic cod and Gobillon (2017) who focused on Sole and monkfish species. Given these findings, the log-linear form is used in the hedonic price analysis of fish attributes of Nile perch, Nile tilapia and Sardine fish species which were selected for the study on which this paper is based.

3.0 METHODS

3.1 Data source and sampling

The study was conducted in the area around Lake Victoria in Mwanza Region because is the 'leading fish market stop centre' with seven fish processing industries therefore surpasses other regions (Kagera, Geita, Simiyu and Mara) surrounding the lake in fishing, fish landing, trading and exporting of fish (URT, 2017). Also, around Lake Victoria, Mwanza region with a total of about 52,942 fishers is among the eight poor regions in Tanzania with high poverty rates of 34.6% indicated by existing highest number of poor people for rural dwellers including artisanal fishers who are living below the poverty line (URT, 2014; NBS, 2019). Two districts within Mwanza region; Sengerema and Buchosa were purposely selected, based on ranking with a high collection of fish catch and landing sites activeness in selling of landed fish (URT, 2017).

A cross-sectional research design was used. The design entails collection, organisation and analysing data from selected cases around Lake Victoria at a single point in time. This design is also in favour of both quantitative and qualitative data to fit the selected variables of this study (Saunders *et al*, 2016). Therefore, cross-sectional research design was used in this study not only because duration of study was limited in terms of time, but also in order to examine different variables at the same time (Saunders *et al*, 2016; Bajpai, 2011; Kothari, 2009). A sample of 300 fishers was selected (Table, 1), from the 1200 total fishers' population of the two districts (URT, 2014), using a formula by Israel (2013) with 95% confidence level and a precision level of $\leq$ 5%, which is an acceptable sampling error. Israel (2013) formula is given as $n = N \Big/ \left(1 + N\left(e^2\right)\right)$ where n is the sample size, N population size and e is the level of precision. From an estimated total population of 1200 fishers from two districts, then $n = 1200 / \left(1 + 1200\left(0.05^2\right)\right) = 300$.

In order to collect pertinent information from respondents, purposive, proportionate, and simple random sampling techniques were utilized. Purposive sampling technique was used to select three active landing sites on landing and selling of fish with non-overlapping trading by artisanal fishers between landing sites in each district. Therefore, a total of six landing sites were included in this study. To obtain the respective sample size per landing site, a proportionate sampling technique was used with a sampling fraction of 0.25 (Table, 1). Sampling frame per landing site was obtained with an assistant from District fishery officers and Ward executive officers. The computation is such that n = Σn_i but $n_i = \frac{1}{4} \times N_i$ where by $i = 1,2 \ldots 6$.

Table 1: Sample size determination

Landing Site	Busisi (1)	Kijiweni (2)	Nyakalilo (3)	Kanyala (4)	Itabagumba (5)	Bulyaheke (6)	Total
Sampling frame	$N_1 = 254$	$N_2 = 184$	$N_3 = 118$	$N_4 = 296$	$N_5 = 156$	$N_6 = 192$	N=1200
Sample size	$n_1 = 63$	$n_2 = 46$	$n_3 = 30$	$n_4 = 74$	$n_5 = 39$	$n_6 = 48$	n=300

Simple random sampling was used to select respondents per each landing site using a lottery approach. A questionnaire was used to collect quantitative data to obtain information related to fish attributes and fish landing price of the selected species, but before full enumeration, pre-testing of the questionnaire was done by administering it to 15 randomly selected respondents for the purpose of identifying and rectifying unfamiliar terms used therein, checking the clarity and ambiguity of questions and duration of interviewing one person. Then the questionnaire was improved accordingly before it was used for actual data collection. During the actual data collection, out of 300 fishers, 289 completed the questionnaire, a 96% response rate, and were used in the analysis. The remaining incomplete questionnaire copies were discarded. This was in line with the suggestion by Evans (1991) that a high response rate (> 80%) from a sample is preferable.

Focus group discussion (FGD) guide was also used to support the questionnaire whereby six FGDs, one at each landing site consisting of eight artisanal fishers, with the ability to elicit information on fish quality, features of fish species, fish attributes, landing prices, and determination of landing price was conducted. Moreover, twelve key informant interviews (KII) were held from one buyer from Sengerema district, three purposefully selected leaders from fishers, two Beach Management Unit (BMU) leaders, one agent from Buchosa district, two District fishery officers, two Village Executive Official sand one representative from the Tanzania Fisheries Research Institute (TAFIRI). Since varying vessels catch more than one species of different fish sizes, collected data were based on survival, commercial and quantity marketed for more than one species (Hoof & Kraan, 2017).

3.2 Description of variables

Theoretical instruction for choosing the independent variables for the hedonic pricing model is missing (Andersson, 2000); there is difficult when selecting them. Therefore, uses of questionnaire-based surveys, focused group discussions, key informant interviews and literature are important to gain an in-depth understanding of fish attributes. This led to the identification of explanatory variables used in this study. Also, selection of the variables that were used in this paper was based on consensus among prominent scholars that they affect fish price and they have marginal price effects. Some of those scholars are Abila (2015), Gordon and Maurice (2015), Hammarlund (2015), Lee (2014), Roangead (2013), Bergman (2012) and Mitullah (2003).

The freshness is one of the attribute variable correlating with landing price variation (Lee, 2014). In this paper, due to a challenge of measuring nautical miles travelled, the freshness of the fish is measured in terms of hours spent in a distance trips to reach either offshore or onshore landing sites, termed as "trip duration" (Lee, 2014; Lokina, 2014). Therefore, in the scope of this study, freshness is defined as retained quality taste of the harvested fish from the lake before spoiled to the time it purchased by a primary buyer. To analyse the relationship between freshness and landing price, it was considered to establish a freshness benchmark in artisanal fisheries. Therefore, during FGD, a consensus was reached that, taking other factors remain constant, freshness last for four hours at ambient temperature, and thereafter fish start to deteriorate and spoiled. The island freshness variable applies to fish sold on islands, while the mainland freshness variable applies to fish originally sold at mainland landing sites. Landing sites have different structures, conduct and performance that cause variance in fish landed price. Quantity of fish landed at different market category is included as an attribute variable to account for the catches landed at different landing sites, either offshore landing sites, onshore landing sites or local markets, during analysis. Table 2 shows a summary of the variables used in this paper.

Local market places are inland locations near the sea with easy access for artisanal fisher where additional commodities are sold. Another variable is the preserved fish included to consider quality of fish in different forms of preservation. This variable was constructed to account for fish perishability and its effect on the price that a buyer was willing to pay. Also, fish size was included to account for various sizes of fish.

Table 2: Variable description and meaning

S/N	Variable Description	Variable Name	Type of Variable	Meaning of Variable
1	Landing Price	LP	Continuous	Price per kg of a fish in TZS at the on-spot market
2	Island Freshness	SF	Continuous	Hours spent in a distance trip to reach the island
3	Mainland Freshness	IF	Continuous	Hours spent in a distance trip to reach mainland
4	Quantity landed on Island	QL_i	Dummy	Quantity of fish landed, equals to 1 if catches were landed on Island landing site and 0, otherwise
5	Quantity landed on mainland	QLm	Dummy	Quantity of fish landed, equals to 1 if catches were landed on mainland landing site and 0, otherwise
5	Preserved fish	PF	Dummy	Equal to 1 if fish preserved in freezer storage and 0 otherwise.
6	Fish Size	FZ	Continuous	Fish size equal to quantity of fish in kg, per artisanal fisher
7	Weighted Measured	WM	Dummy	Equal to 1 if weighted scale results are acceptable and 0 otherwise.

3.3 Data analysis

According to (Nguyen, 2011), the fundamental theory of hedonic price explains the price (p) of a commodity as a function of its attributes (x). Thus, on examination of the effects of fish attributes on landing price, two stages approach of the fundamental theory of hedonic price function was employed (Hammarlund, 2015). In the first stage, the price (p) of a commodity is the function of its attributes such that:

$$p = f(x)$$
(1)

and the second stage is the implicit price of a commodity, that is, how changes in each of commodity attributes will change in the price. Ordinary Least Square (OLS) was used to estimate hedonic regression analysis of landing price on fish attributes. Therefore, the fish attributes extracted and used in this study were freshness, size, species, preserved fish, quantity landed at given market category and the weight measured. Therefore, multiple regression analysis was done using the equation:

$$p_j = \beta_i x_i + \mu \quad (2)$$

where:

x_i is the i^{th} attribute of fish x,

p_j is the price of j^{th} fish per kilogram,

β_i are the coefficients of the attributes, and

μ is a random factor influencing the price of the fish.

With the change of fish attributes in quantities during the supply of the fish, then inverse attributes demand estimation is possible using the following equation:

$$\beta_m = V q_m + \mu_m \quad (3)$$

where:

β_m is the observed fish price of m^{th}attribute,

V is a coefficient of quantities supplied of different fish attributes,

q_m are quantities supplied of different fish attributes, and

μ_m are unobserved factors influencing the price of the fish attributes

and the two equations (2) and (3) are estimated simultaneously in equation (4) by using a random coefficient model (RC) (Hammarlund, 2015):

$$p_j = \rho x_i + V x_i q_i + x_i \mu_i + \varepsilon_i \quad (4)$$

Where by:

$V_i = \frac{\Delta p_j}{\Delta x_i q_i}$ is the marginal implicit price for any attribute of the fish (Taylor, 2003)

$x_i \mu_i + \varepsilon_i$ is the random part of the estimated model

$\rho x_i + V x_i q_i$ is the interaction part of the fish attributes for the amount of catches

Random Coefficient (RC) model was also employed to consider the inverse attributes demand estimations. Therefore, equation (5) is a formed multiple regression equation and transformed to natural log regression (log-linear model) which is a simpler form used in this study and is more accurate for unobserved influential variables, measurement errors, extracting outlaying data and creating normality among variables (Slade, 2000).

$$\ln LP = \beta_0 + \beta_1 \ln IF + \beta_2 \ln SF + \beta_3 QL + \beta_4 PF + \beta_5 \ln FZ + \beta_6 WM + \varepsilon \quad (5)$$

With reference to price theory, all the three selected fish species are valued differently during supply and demand; hence each has its own valid landing price. Let's say $Lp_{NP_i}$is Nile perch price; Lp_{NT_i} Nile tilapia price and Lp_{SA_i} is the price of sardine. Then, hedonic regression analysis at the time of landing price per specie is possible as depicted in equation (6). Each landing price per species is not comparable with another. Therefore, equation (6) is a formed multiple regression equation and transformed to natural log regression (Log-linear model), which is the simpler form that was used in this paper and is more accurate for unobserved influential variables, measurement errors, extracting outlaying data and creating normality among variables (Slade, 2000). Therefore, the regressed equation was generated using the operational definitions of variables given in Table 2 as it appears as follows:

$$\ln \begin{cases} LP_{NP_i} \\ LP_{NT_i} \\ LP_{SA_i} \end{cases} = \beta_0 + \beta_1 \ln IF + \beta_2 \ln SF + \beta_3 QL + \beta_4 PF + \beta_5 \ln FZ + \beta_6 WM + \varepsilon \quad (6)$$

The estimated constant, β_0, represents the value of the baseline transaction, while the other βs represent parameters of estimated coefficients and ε is an error terms. Robustic White-Huber standard errors were employed to structure heteroscedasticity following a White test for heteroscedasticity. The coefficient of each dummy variable was calculated by using $D_i = \left(e^{\beta_i} - 1\right)100$. Since a change in the log of a variable is a relative change, 100 is a percentage change (Gujarat, 2003). Therefore, β_i approximates the relative change to the landing price for dummy variables. For continuous variables, the estimated coefficient β_i is interpreted as the relative effect on the landing price due to a change in the variable.

It is important to note that OLS may violate constant correlation assumptions for data that were closer and others that were collected far apart during a day. Therefore, the RC model allows joint estimation method of a price attributes function and inverse demand function. It also solves the problem of heteroscedasticity and takes into account the constant correlation among multiple measurements. Finally, model inferential results were triangulated by the analysed contents from focus group discussions and key informant interviews from key issues related to fish attributes and their influence on landing price. Participants' quotes were chosen according to their relevance to the research objective.

4.0 RESULTS AND DISCUSSION

4.1 Demographic features of selected fish species

The study established demographic features of selected fish species which are Nile Perch, Nile Tilapia and Sardines in terms of price of fish species per kilogram, quantity of fish per kilogram and the size in length of fish species landed in centimetres. The descriptive statistics for analysis of data show that the average landing price of Nile perch was TZS 3 225 per kilogram, TZS 2 780 per kilogram for Nile tilapia and TZS 324 per kilogram for sardines. The average quantities of fish catches landed by artisanal fisher were found to be 16 kilogram of Nile perch, 23 kilogram of Nile tilapia and 18 kilogram of sardines. It was difficult to count the length of all species per catch, but it was found that the largest identified Nile perch fish had a maximum length of 90 centimetres and the largest Nile tilapia fish had a maximum length of 43 centimetres. Further details are shown in Table 3.

Table 3: Demographic features of selected fish species

		Descriptive Statistics			
Variables	**Sub-Variables**	**Mean**	**Std Deviation**	**Min.**	**Max**
Nile perch	Landing price per kg	3225	553.7	2800	7500
	Quantity in kg per artisanal fisher	16	6	12	34
	Size in centimetres per fish	-	-	30	90
Nile tilapia	Landing price per kg	2780	423.4	2500	6500
	Quantity in kg per artisanal fisher	23	4	21	48
	Size in Centimeter per fish	-	-	13	43
Sardine	Landing price per kg	324	43	300	450
	Quantity in kg per artisanal fisher	18	2.7	15	25
	Size in centimetre per fish	-	-	-	-

4.2 Fish attributes influencing landing price

The effect of fish attributes on fish landing price was established by computing fish attributes which were understood by artisanal fisher to be useful for better-received landing price. Inferential analysis results were obtained by regressing landing price of each fish species on the independent variables that were selected. The results in Table 4 indicate that about 84% of the artisanal fisher respondents understood fish size is measured in kilograms as one of the criteria preferred by middlemen and fishmongers. This aligns with the observable situation that currently exists; fish species of larger size are the ones that are highly valuable and are preferred for inter-trade at regional markets. These findings concur with the assumption that market changes for example in terms of increasingly purchasing of fish with certain attributes, they create higher demand and cause price increase in accordance with the price theory. The findings concur with arguments by Abila (2015) that smaller fish are sold locally within the Mwanza region, leaving other regional markets and retailers in Tanzania to trade mostly with larger species like Nile Perch and Tilapia.

Table 4: Fish attributes affecting landing price (n = 289)

Fish Attributes		**Per cent**	
Criteria	**No**	**Yes**	**Total**
Fish size	15.3	83.7	100
Fish days spent onshore	68.9	31.1	100
Fish days spent offshore	70.8	29.2	100
Availability of different species	33.0	67.0	100
Fish stored for many days before reaching landing centres	64.5	35.5	100
Fish stored in a boat freezer before landing	48.0	52.0	100

The availability of these species and others, as reported by 67% of artisanal fisher, is one of the attributes preferred by buyers. The consumers' willingness to pay depends on preferences and choices pertaining to available species and sizes, thus affecting the price of those fish. Descriptive statistics further indicated that about 68.9% and 70.8% of respondents argued that the number of days spent on onshore and offshore landing sites do not influence landing prices. Days spent storing fish between harvest and landing impact fish deterioration, implying that artisanal fisher do not spend more than a day between harvest and landing. This finding concurs with comments given during focus group discussions that artisanal fishers are not spending more than a day because of inadequate fishing storage vessels which prevent them from reaching deeper waters (FGD, at Itabagumba, April 2017).

Looking at the effects of fish attributes on landing price, three hedonic regression analyses were run, one with the dependent variable of landing price of Nile perch, the second one with the landing price of Nile tilapia and the third one with the dependent variable of landing price of sardine, and the results are presented in Tables 5, Table 6 and Table 7. The multiple regression analysis results of the landing price of Nile perch is in Table 5.The explanatory power of the model is also shown by R^2 range between 0.911 and 0.893 respectively, giving a good model fit. This is above 80% of the total variation in the dependent variable which is explained by the explanatory variables. The coefficient(s) results of the OLS and RC models in Table 5 show a similar change of landing price in TZS per kilogram. However, it should be noted that the log-linear form models affect the actual change of landing price in TZS per kilogram as shown in Table 8.

Table 5: Effects of fish attributes on the landing price of Nile perch (n =289)

Variables	OLS Coefficients	OLS Std. Error	OLS P-Value	RC model	RC Std. Error	RC p-value
(Constant)	0.049	0.542	0.928	0.069	0.671	0.918
Island freshness	0.013	0.001	0.000*	0.017	0.006	0.005*
Mainland freshness	-0.065	0.005	0.000*	-0.048	0.022	0.030*
Preservation Methods	0.109	0.044	0.014*	0.171	0.064	0.007*
Quantity landed at island	0.047	0.029	0.105	0.066	0.018	0.000*
Quantity landed at mainland	-0.067	0.042	0.120	-0.051	0.023	0.027*
Fish size	0.150	0.047	0.001*	0.173	0.029	0.000*
Weighted Measure	-0.125	0.099	0.213	-0.109	0.09	0.226

Number of observation (n) =289, OLS R-squared = 0.911, RC R-squared 0.893, ** Statistically significant at $P < 0.01$, * Statistically significant at $P < 0.05$.

The fish attributes for Nile perch: island freshness, preservation methods, quantity landed on island, and size of fish are significantly ($p < 0.05$) and positively affected landing price. Another fish attribute is the mainland freshness of fish, as well as quantity landed on mainland markets, were significantly ($p < 0.05$), but negatively influencing the landing price (Table 5).

Table 6 reveals the hedonic regression results such that fish attributes for Nile tilapia: island freshness, fish size, preservation methods, and offshore islands were positive and significant ($p < 0.05$) affected landing price. Others are mainland freshness and quantity landed on mainland markets which were found significant ($p < 0.05$) but negative affected landing price. The unit change in each of coefficient also indicates a change of landing price in TZS per kilogram of Nile Tilapia.

Table 6: Effects of fish attributes on the landing price of Nile tilapia (n = 289)

Variables	OLS Coefficients	OLS Std. Error	OLS p-value	RC model	RC Std. Error	RC p-Value
(Constant)	0.0401	0.3371	0.905	0.046	0.5795	0.936
Island freshness	0.0041	0.0016	0.0109*	0.0035	0.0015	0.0203*
Mainland freshness	-0.0739	0.023	0.0014*	-0.071	0.0105	0.00001*
Preservation methods	0.1001	0.067	0.136	0.141	0.0713	0.0489*
Quantity landed on island	0.0381	0.009	0.000*	0.037	0.0013	0.00001*
Quantity landed on mainland	-0.0759	0.032	0.018*	-0.08	-0.112	0.475
Fish size	0.1411	0.017	0.001*	0.143	-0.106	0.178

Weighted Measure	-0.1339	0.053	0.012	-0.138	-0.045	0.0023

Number of observation (n) =289, OLS R-squared 0.894, RC R-squared 0.807, ** Statistically significant at P < 0.01, * Statistically significant at P < 0.05.

The model's explanatory power is also shown for the OLS and RC models, whereby the R^2 ranged between 0.894 and 0.807 respectively, giving a good model fit. In summary, Nile tilapia fish attributes were found to have similar effects as Nile perch fish attributes, although the difference was on the units of change of each coefficient, thus confirming the differences in landing prices of the two species. Table 7 presents hedonic price regression results of fish attributes for Sardine, indicating that island freshness, weighted measure, onshore mainland market and mainland freshness were significant (p < 0.05) but negative affected landing price. The model coefficient results of sardine's fish attributes are different from the coefficients of fish attributes of Nile perch and Nile tilapia which are shown in Table 5 and Table 6 respectively.

Table 7: Effects of fish attributes on the landing price of Sardine (n = 289)

Variables	OLS Coefficients	OLS Std. Error	OLS P-Value	RC model	RC Std. Error	RC p-value
(Constant)	0.011	0.495	0.982	0.0195	0.671	0.976
Mainland freshness	-0.025	0.011	0.024*	0.032	0.016	0.046*
Island freshness	-0.103	0.014	0.000*	-0.019	0.007	0.007*
Preservation methods	0.073	0.054	0.177	0.093	0.064	0.147
Quantity landed at island	0.009	0.015	0.548	0.039	0.021	0.064
Quantity landed at mainland	-0.103	0.02	0.000*	-0.081	0.013	0.000*
Fish size	0.112	0.073	0.126	0.133	0.081	0.101
Weighted Measure	-0.147	0.086	0.088	-0.096	0.037	0.009*

Number of observation (n) =289, OLS R-squared 0.912, RC R-squared 0.865, ** Statistically significant at P < 0.01, * Statistically significant at P < 0.05.

The difference was in the coefficients of fish attribute(s); preservation methods, offshore island and fish size were found insignificantly affected landing price of Sardines, but significantly influencing landing price of Nile perch and Tilapia. The model's level of significance was 5% for the OLS and RC models with R^2 ranging between 0.912 and 0.865 respectively, giving a good model fit.

Therefore, island freshness of fish was found to increase fish landing price by TZS 0.013per kg of Nile perch and by TZS 0.0041per kg of Nile tilapia. This implies that the increase in price was caused by buyers arriving at the island from the mainland to get freshness qualities. This reduced hours that could be spent on distance towards the mainland that could lead to deterioration of freshness of fish and therefore leading to low paid landing price. Moreover, other buyers are communities living around and nearby islands who have a traditional preference for consuming fresh quality fish; this causes fresh fish demands increase at islands. This was clarified during FGD that hours spent transporting fish to the mainland with a lack of quality storage facilities encounters artisanal fisher to fall on the risk of fish spoilage which leads to deterioration of landing price paid. Sometimes buyers found at mainland tend to collude for low price settings (FGD, Kanyala Ward, April 2017). It is because of this argument that artisanal fisher expect to be paid more on islands.

The negative coefficients for sardine fish attributes (island freshness, weighted measure, onshore mainland market type and mainland freshness) were mainly due to demand driven by buyers' quality preference of sardine that were dried by the sun. It was quoted during focus group discussions that "…. if artisanal fisher want to be paid better for sardine catches, sun drying on the grass is most preferred by buyers than fresh catches during landing, and because sardines can also be dried on the sand, unfortunately, most of the artisanal fisher do not have time to wait for the sardines sun drying process…" (FGD, Bulyaheke, April-2017). In general, availability of dried catches of sardines at islands paired with on-site buyers could positively impact landing prices paid in the first hand to artisanal fisher than the landed freshness of this species.

Contrary to the island freshness, the mainland freshness of fish was found to demonstrate a decrease of fish landing price to selected species relative to the other fish attributes. This concurs with the findings by Matiya (2010), and by implication, artisanal fisher around Lake Victoria have inadequate storage facilities and best preservation techniques, factors that may contribute to transported fish spoiling. This is an indication that artisanal fisher are still having inadequate storage facilities to maintain freshness of fish from the harvesting area at the mainland. Likewise, as the fish grading procedures are built on the freshness quality of fish on the mainland, there is a likelihood that unpreserved fish due to lack of cold storage facilities could be graded as being of low-quality during landing and therefore negatively affecting the price to be paid during the selling.

Meanwhile preserved fish was found to acquire an increase of landing price by TZS 0.109 per kg and TZS 0.0713 per kg for Nile perch and tilapia. These results concur with findings by Alapan *et al*. (2016). By implication, the results mean that, since fish are perishable, if they are to be sold in good condition they must be taken to market within the shortest possible time or they must be preserved. This was supported by a comment from a BMU leader who said that: "Most of fishers' canoes have missing storage facilities; that is why the fishers are likely to be paid low for landed fish which is not well preserved" (Busisi Ward Office, April 2017). They are forced to bear the costs during a contractual arrangement, which also lowers landing prices. Henceforth, if low-cost preservation facilities can be provided with improved technologies, they could reduce spoiling and increase the landing price for fresh fish supplied at the mainland.

With the influence of fish quantity landed in Islands, this study found that fish price increased by TZS 0.047per kg of Nile perch and by TZS 0.038 per kg of Nile tilapia when the quality of of fish were landed on Island, unless otherwise. Landing price also decreased by TZS 0.051 per kg and TZS 0.0759 per kg of Nile perch and Nile tilapia respectively when these quantities are landed on onshore mainland. By implication, trading of fish quantity in various islands is an advantage to artisanal fisher, not only because they are likely to suffer dominance behaviour associated with grading procedures at mainland and in other local markets, but also because fishes are the perishable commodities that could lead to a better-paid landing price if sold fresh at nearby landing sites.

More so, artisanal fisher who took advanced loans through agreements with buyers, when arrived at the mainland, have to compensate the loans acquired via paid landing price, and other costs incurred by fish vessel sponsors. Therefore, using offshore islands for trading fish as a market base for fishers is better than onshore mainland or local market prices.

Another attribute is the fish size when increases, it was found to cause the fish price to increase by approximately TZS 0.141 per kg and TZS 0.150 per kg of Nile perch and Nile tilapia respectively, both at offshore islands. Brummett (2000) and Lokina (2014) stated that accepted legal-size of fish fetches a better price to fishers. During a KII with a fishers' leader of Itabagumba ward, different fish pieces of various sizes were sold/bought at different prices, but most of the fishers focused on large size of fish, which caused earning of higher paid landing price (Itabagumba, April 2017). This indicated that the probability of catching fish of large size could influence landing price at landing sites. This is because buyers are willing to pay for large-sized fish as foretold by the utility theory (Hammarlund, 2015). More so, the government of Tanzania has set legal parameters defining the accepted legal size of fish for sale. The parameters include 25 centimetres in length for Nile tilapia and 50 to 85 centimetres for

Nile perch (Sengerema Fishery Officer, April 2017). Artisanal fisher who violate these criteria opt to sell their fish catches outside markets and end up with lower paid landing prices. The findings support the assumptions of the price theory. Mainly during the supply of harvested fish at legally acceptable sizes, are resulting in a better optimal paid landing price by the buyers than small fish sizes, given that the demand constant.

In view of the author of this paper, fishers have poor fish landing price negotiation skills pertaining to fish attribute. Therefore, as a result, they accept any given landing price even if it is 'low pay', by always hoping that fishes are plenty to be harvested on the next day. From the findings of this paper, this is one of the reasons why poverty persists among fishers (Luomba, 2013; NBS, 2019). The low income due to low pay can be mitigated by improving market structure, conduct and performance which seem to be reinforced by imperfect competition (middlemen monopoly) and relatively low investment of the fishery economy by the government as depicted by the structural theory and poverty (Bradshaw, 2007).

4.3 Variation of fish landing price caused by the change of fish attribute

The marginal effect results in Table 8 showed that, an increase in quantities of Nile perch, Nile tilapia and sardines led to probability of an increase in prices of the freshness of fish at offshore landing sites in the islands, and are statistically significant (P < 0.05). Result showed that, for a positive action taken in preserving fish during an increase of quantities of Nile Perch landed, lead to probability increase of landing price by 0.051and was statistically significant (P < 0.05). With respect to increasing the quantity of sardines landed, it will lead to a probability decrease of landing price by 0.054 and was statistically significant (P < 0.05), when landed at mainland landing sites. This indicates that, despite the small changes in fish attributes as shown in Table 7, the changes of fish attributes are paramount to the variation in landing prices.

The marginal effect of the variable weights measured, and onshore mainland for a fish landing centre were found to have a negative sign but not statistically significant. This implies that any increase in quantities of fish landed leads to a decrease of scales of weighted measure which tends to decrease the probability of the fish price selling. This result was evident in an FGD where fishers agreed with a comment made by one member that measurement weighted scale used by buyers, provides wrong weighted results, usually less than the actual amount of catch landed, thus artisanal fisher ended being paid a lower price (FGD, Kanyala, April 2017). The findings support the assumption of price theory that when supplies of quantities of fishes exceed demand, they lower the price of that commodity. Thus, weighted scales measurement of fish is an essential attribute of fish landing price.

Table 8: Random coefficient model results of the quantity effect of one attribute on the landing price of fish for other attributes (n = 289)

	IS	WM	IF	PM	OFI	ONL
Quantity of Nile Perch	0.021*	-0.157	-0.189	0.051**	0.001***	-0.091
Quantity of Nile Tilapia	0.192*	-0.162	-0.036	0.028**	0.0291**	-0.171
Quantity of Sardine	0.049**	-0.094**	-0.028	1.327	0.000**	-0.054**

***Statistically significant at P < 0.01, **Statistically significant at P < 0.05, *Statistically significant at P < 0.1

The inferential analysis results in Table 8 were also supported by the descriptive results in Table 9 and Table 10. Table 9, indicates that fish species were found to have different prices per scale, measured by an increase in length and weight. The variation of these fish attributes was also observed to benefit first-hand buyers when compared to artisanal artisanal fisher who are the primary producers. This affirms that there are neither common criteria for evaluation of fish attributes nor pricing regulations procedures existing for attributes specificity for price allocation supervised by the responsible authority.

Table 9: Variation of fish species in size and respective prices

Type of Specie	Size (cm)	Size (kg)	Landing Price (TZS)	Agents/Middlemen/Retailers selling price (TZS)
Nile	Smaller than 50	Less than 1	3 000	Between 4 000-4 500 per piece
Perch	Greater than 50	Between 1 and 4	Between 4 000 – 4 500	Between 10 000-12 000/Kg
		Greater than 5	Between 6 000 – 7 000	
		Greater than 10	Greater than 7 000	
Nile		Greater than 1	Between 5 000-6 200	Between 8 000-10 000/Kg
Tilapia	Smaller than 50	Less than 1	3 000	Between 4 000-4 500 per piece

Preserved fish by different methods are empirically shown in Table 10 to affect fish landing prices. The findings reveal that one 20-litre bucket of preserved sardines could be purchased at a landing price between TZS 6 000 - 9 000 in 2016. Some of the preserving methods were listed during focus group discussions, and also they were observed at the time of enumerating; they include sun drying, smoking, salting and frying in oil. Frying in oil is done at home for consumption. These methods vary and, as a result, affect those fish that were preserved and prices (FGD, Nyakalilo, April 2017).

Table 10: Fish Price by Storage Mechanism and Preservations Techniques

Species	Methods of Preserving	Unit of Measurement	Landing Price (TZS)	Agents/Middlemen/Retailers Selling Price (TZS)
Sardine				
	Sun-sand Drying			Not below 7 000
	Wire mesh Drying	1 Bucket of 20lt	Between 6 000 – 9 000	Between 15 000-18 000
	Smoking			Between 15 000-18 000
	Dried but affected with rainfall			Not below 9 000
Nile Perch				
	Smoking	Under 50 cm	3 000	Between 4, 000 - 4 500
	Freezer	Equal or greater than 50cm	5 000-6 200	Between 10 000-12 000
Nile Tilapia				
	Smoking	Under 50 cm	3 000	Between 4 000-4 500
	Freezer	Equal or greater than 50cm	5 000-6 200	Between 10, 000-12 000

5. CONCLUSIONS AND RECOMMENDATIONS

Regarding the effects of fish attributes on landing price around Lake Victoria, in Tanzania, it is concluded that freshness at island and mainland, quantity landed at onshore island market, preserved fish, size and weights are the main fish attributes influencing fish landing price of the selected fish species. These findings are similar with McConnell and Strand (2000); Lee (2014); Hammarlund (2015) and Gobillon (2017). However, preserved fish and weighted measures were unique fish attributes found by this paper influencing fish landing price. The fish attributes listed above had significant influence on fish landing price of the selected fish species. Therefore, the null hypothesis that there is no significant influence of fish attributes on the landing price was rejected; it is evident that fish attributes affect landing price.

From the conclusion that fish attributes significantly influence fish landing price, it is recommended that artisanal fishers should instantly sell their fish at the nearest market place which reduces the cost of preservation and fish deterioration. Fishers are also recommended to value each attribute of the fish that influence landing price determination when selling fish. Furthermore, the marginal effect evidenced that the change of one attribute affects the landing price of fish; henceforth it is paramount to consider the influence of each attribute found by this study in strategic interventions for landing price determination. Therefore, it is recommended that the supplies of fresh, well preserved, and large-sized fish to meet optimal price as per demand requires the provision and availability of fishing vessels as well as an installed storage mechanism. This storage mechanism should have associate with quality preservation techniques, and the establishment of cooperative strategies. This can be done through artisanal fisher joining together and forming cooperatives for collective purchasing of fishery equipment that can accommodate reasonable sizes of fishes caught. Also, participating in contractual agreements to ensure buyers' purchases of the harvest at better agreeable landing prices is recommended. Furthermore, through research, it is recommended researchers to incorporate other factors such as taste, nutritional value, fish processing, grading, branding, packaging, marketing and other fish species which were out of scope of this study.

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