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Modelling White Shrimp (*Nematopalaemon hastatus*) Value Chain Using Combined SWOT and AHP

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ABSTRACT

The objective of this study is to model white shrimp (Nematopalaemon hastatus) value chains in the Coastal areas of Ondo State, Nigeria using a *strength, weakness, opportunities and threat (SWOT) analysis* in combination with an *analytical hierarchy process (AHP)*. Nineteen (19) participants in the value chain comprised of shrimpers, processors, marketers, consumers, fishery managers, and resource economists identified and prioritized the SWOT factors at each stage of the *N. hastatus* value chain including shrimping (fishery), processing, marketing, and the consumption level. The results provide the base for recommendations for policy and research in Nigeria and other developing nations aimed at ensuring sustainable shrimping, efficient processing and marketing as well as improvements in consumers' awareness and satisfaction through the development of standards and sustainable operation procedures for fishery, the development of cheaper and safer processing technology, the modernization of markets, and the development of value-added shrimp products.

Keywords: shrimp, value chain, SWOT, analytic hierarchy process, coastal areas, Nigeria

1. Introduction

The sustainability and utilization of shrimps and other aquatic resources depend on the ability to manage the nexus between end-users, the ecosystem, and the availability of physical resources (Glass et al., 2015). This is more important for developing countries where the shrimp industry is characterized by unregulated and uncontrolled fishery (Cochrane and Garcia, 2009). Hence, there are increasing demands for broader engagement of relevant stakeholders in developing strategies for the management of the shrimp species. According to Glass et al. (2015), the integration of various actors in the value chain of aquatic resources has become institutionalized into ecosystem-based management. Such strategies help in identifying barriers that can hinder the growth of the different segments of the value chain as well as understand how the fragmented nature of the value chain segments could affect product quality, and the effectiveness and competitiveness of the sector (Araya et al., 2015). Despite the importance of white shrimp to local and international markets, there is sparse information on stakeholders' prioritization of management objectives at various segments of the *N. hastatus* fishery in Nigeria. This study aims at gathering baseline information of the current status of management prioritization of objectives at different segments of the *N. hastatus* value chain. This would aid in projecting management actions for sustainable and effective utilization of the marine shrimp in Nigeria and in other developing countries. The paper is structured as follows: the next section discusses the background to the white shrimp industry in the study area and the application of multi-criteria decision analysis tools such as the analytical hierarchy process (AHP) in prioritizing SWOT factors dealing with strength, weaknesses, opportunities, and threats (risks) in the value chain. Section 3 provides information on the study area, the source of data and the methodology, section 4 presents the results of the order of prioritized SWOT factors, section 5 discusses the results while section 6 concludes the article with relevant recommendations for policy and research.

2. Background

Shrimps are exploited mainly for commercial purpose in the Nigerian shrimping ground that lies east of longitude 5 degrees east to the Nigerian/Cameroon border, principally in the Niger Delta and off river mouths, in estuaries and lagoons with soft mud deposits along the Nigerian continental shelf (United States Agency for International Development, 2012). The continental shelf cuts across states like Ogun, Lagos, Delta, Bayelsa, Rivers, Akwa Ibom, Cross Rivers and Ondo State (United States Agency for International Development 2012). Marine shrimp species of economic importance exploited in the continental shelf of the country include *Penaeus notialis, Parapenaeopsis atlantica, Parapenaeus longirostics, Penaeus kerathurus* and *Nematopalaemon hastatus*. Considering the length of the coastline by states, Ondo has the longest coastline of over 180 km where artisanal fishermen fish within 0 to 5 nautical miles off coast while the trawlers fish from 5 nautical miles outwards (Alhaji et al., 2015). Analysis of shellfish catches at landing among fishermen in coastal areas of Ondo State revealed that the species of *N. hastatus* was the most frequent one with about 75% of catches (Olawusi and Ajibare, 2014). The shrimp is exploited in marine waters using stow nets and wooden boats powered with outboard engines. At landing, processors buy the fresh shrimp, sun/smoke-dry them traditionally and subsequently sell to market agents from the Southern and landlocked States (Ekiti, Ogun, Osun, Oyo and Edo etc.) Substantial quantities of the *Palaemon* shrimp are exported to international markets in Canada, Japan and the European Union (Figure 1).

The value chain of the species entails activities that include sourcing inputs, shrimping, processing, marketing and consumption of the shrimp and its by-products. It provides a source of livelihood for participants in the value chain and has the potential to substantially improve the income of small-scale producers, who are responsible for 100 per cent of the production. However, due to the importance of shrimp in the diets of Nigerians, the artisanal characteristics of the fishery, the traditional methods of processing and marketing as well as the need to appraise consumers' satisfaction and awareness of the species, there is a need to

a) identify management objectives for improving sustainability in production, processing, improved quality, marketing, and consumption as well as to

b) increase the value chains' contribution to livelihood by assessing and improving the knowledge of the different stakeholders about the *N hastatus* value chain.

These needs can be dealt with by identifying the strengths and weaknesses of the fishery at each segment of the value chain together with the opportunities and threats in the market it operates (Srinivas, 2013; Yidan, 2009). This analysis, known as SWOT analysis supports exploring current constraints and future possibilities of any sector through a systematic approach of introspection into both positive and negative concerns (Akca et al., 2006; Ommani, 2011). In another context, Helms and Nixon (2010) described SWOT analysis as a tool used by consultants, researchers, and managers for strategic planning purposes. Policy makers can better understand how the strength of the fishery can be leveraged to realize new opportunities and understand how weaknesses can slow progress or magnify threats to the fishery.

SWOT analysis determines what may assist the fishery in accomplishing its objectives, and what obstacles must be overcome or minimized to achieve the desired results (Singh, 2010).

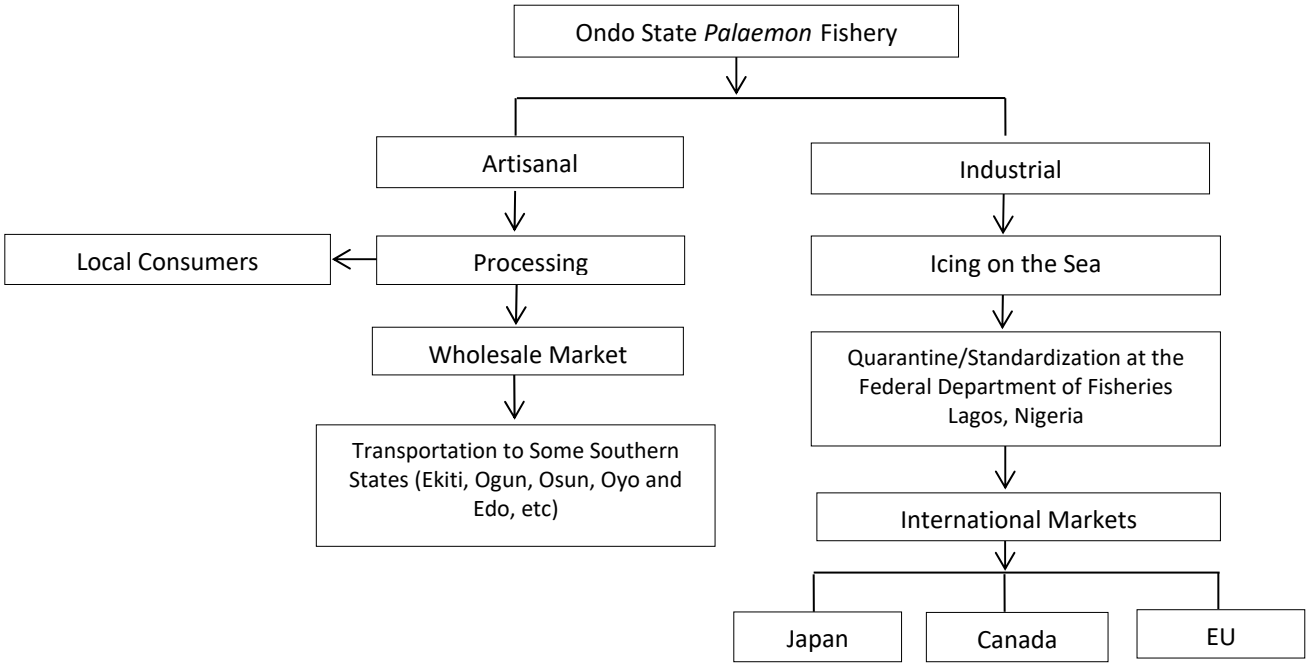

Figure 1. Supply Chain of *Palaemon* Shrimp to Local and International Markets

While SWOT anaylsis aids in a decision-making process, it does not support prioritization of issues that were identified as strengths, weaknesses, opportunities or threats. This is where the utilization of the Analytic Hierarchy Process (AHP) can assist. It builds on a tranformation of a decision process into a decision hierarchy and performs pairwise comparisons of decision variables at each level of the decision hierarchy that allow to determine the relative priority of the variables (Tuzmen and Sipahi, 2011). In a SWOT analysis, the relative weights of factors are not quantified regarding the factors' effects on the proposed strategy alternatives (Yüksel and Dağdeviren, 2007). This deficiency can be overcome by linking the SWOT framework with the AHP methodology (Wickramasinghe and Takano, 2010; Kangas, 2003). The approach has been used in management decisions in different enterprises including fisheries and aquaculture (Estévez and Gelcich, 2015; Zeraatkish, 2016; Abba et al*.,* 2013; Suwasono and Nurul, 2013; Gallego-Ayala and Juízo, 2011; Arnette et al*.,* 2010; Garfi et al*.,* 2009; Wattage and Mardle, 2008; Soma, 2008; Leung et al*.,* 1997). However, there is a paucity of information on its utilization in weighing SWOT factors identified by major stakeholders in the white shrimp value chain. This paper aims at modelling SWOT factors at various stages of the *N. hastatus* value chain using the Analytical Hierarchy Process. This would serve as baseline information for its utilization in shrimp fishery in Nigeria and helps in formulating policies and strategies for a sustainable white shrimp value chain in other developing nations.

3. Materials and Methods

3.1 Study Area

The study was conducted in coastal areas of Ondo State, Nigeria (Figure 2). The area has a shoreline of over 180 km making it the longest coastline in Nigeria (Bayode et al*.*, 2011) with a population of 290,615 (National Population Census, 2006). The major occupation of the populace is fishing, canoe building, lumbering, farming and trading while the major forms of transportation are motorized boats and paddled canoe (Alhaji et al*.,* 2015). The area is rich in aquatic biodiversity that includes fish, shellfish (shrimps, crabs, lobster, gastropods and cephalopods), reptiles an,d other living organisms (Solarin et al*.,* 2010).

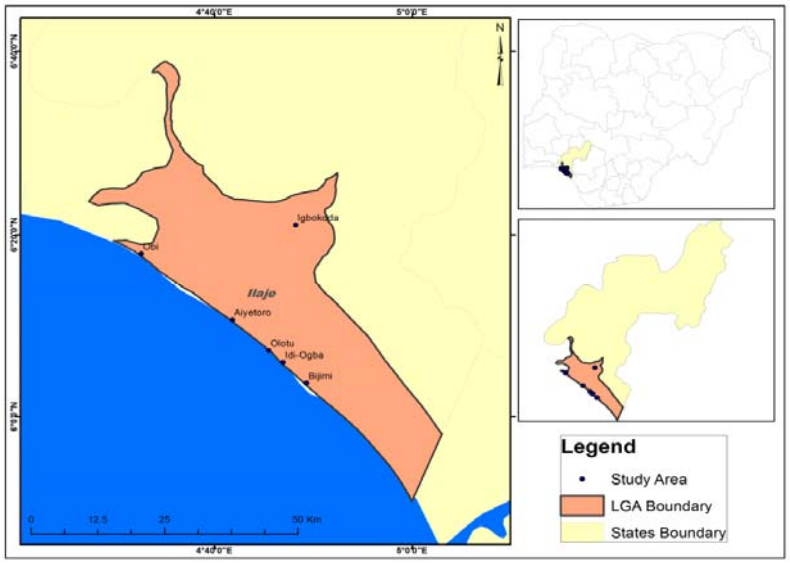

Figure 2. Map of Study Area.

3.2 Identification of SWOT Factors

The SWOT factors were identified using a multi-stage approach. The first stage involved a field survey that was primarily conducted to assess information on production activities, economic performance, efficiencies and challenges in four segments (fishery, processing, marketing and the consumption level) of the white shrimp value chain in the coastal areas of Ondo State, Nigeria. The sample included 120 respondents from shrimpers, processors, and marketers from various locations, and 40 consumers from a population centre in the state. They provided primary data on the activities and challenges at the different stages of the value chain between January 2015 and January 2017. In a second phase, a group of experts used the results of the field survey to identify SWOT factors for each stage of the value chain. The experts included representatives from research, fishery, the Department of Fisheries and Aquaculture (natural resource economist), and the Federal University of Technology Akure, Nigeria (agricultural and resource economist). The results are presented in tables 3-6 in line with the approach proposed by Ehsan et al., (2015).

3.3 AHP Modelling

The SWOT factors were subsequently prioritized by a 19-member panel, using the Analytical Hierarchy Process (AHP). AHP is a tool for multi-criteria decision analysis that offers decision makers with the opportunity to handle multiple objectives and subjective data (Saaty and Peniwati, 2008). De Felice *et al.* (2015) defined AHP as a mathematical method for analysing and organizing complex decisions hierarchically and weighing them using ratio scale measurement based on experts' opinion. It allows the possibility of considering various qualitative and quantitative criteria and helps in checking the consistency of decision makers' evaluations, thus reducing the bias in the decision-making process (Saaty, 2008). In our study, the AHP was utilized within the SWOT framework to systematically quantify the SWOT factors and equate their intensities (Wickramasinghe and Takano, 2010). The following steps described by Kunasekaran and Krishnamoorthy (2018) and Gallego-Ayala and Juízo (2011) were used for this study:

a. statement of overall objectives;
b. pairwise comparisons to capture the weights of each SWOT group;
c. pairwise comparisons to derive the relative priorities of each factor within the SWOT groups;
d. overall factor weight is obtained by multiplying the factors local weights by the specific group weight; and
e. determination of consistency ratio.

Using the step described above, the panel set the overall objectives of the AHP modelling for this study. These include: ensuring sustainable shrimping enterprises, efficient shrimp processing and marketing and enhanced consumers' awareness and satisfaction. Towards these goals, the panel systematically appraised the SWOT factors presented in tables 3-6 to make them commensurable as regards their relative weights (Kangas et al., 2003) using Saaty's comparison scale (table 1). The random index of numbers used in determining the consistency of the factors is presented in Table 2. AHP of SWOT factors was analysed using the Excel model designed by Barnard (2012).

Table 1.
Saaty's Pairwise Comparison for AHP preference.

Scale	Numerical Rating	Reciprocal
Extremely Importance	9	1/9
Very to Extremely strongly Importance	8	1/8
Very strongly Importance	7	1/7
Strongly to very strongly Importance	6	1/6
Strongly Importance	5	1/5
Moderately to Strongly Importance	4	¼
Moderately Importance	3	1/3
Equally to Moderately Importance	2	½
Equally Importance	1	1

Source: Kunasekaran and Krishnamoorthy (2018).

Table 2.
Random Index of Factors.

N	3	4	5	6	7	8	9	10
RI	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Source: Kunasekaran and Krishnamoorthy (2018).

4. Results of Priorities in SWOT Factors Using AHP

Results of the pairwise comparisons of SWOT factors at each stage of the value chain are presented in tables 7-10 in the appendix while tables 11-14 in the appendix provide information on the priorities of the various SWOT factors within each group.

In the *shrimping segment* (table 11) of the value chain the highest rated SWOT factors were (1) abundance of *N. hastatus* in the coastline, (2) lack of standards and sustainable operating procedure for the fishery, (3) development of SSOP for the fishery, and (4) free access to the white shrimp fishery. while the SWOT factors with the least priorities were (1) beneficial fishing association, (2) less beneficial fishing association, (3) increased shrimping during off-peak months, and (4) seasonality of catches respectively.

In the *processing segment* (table 12) the SWOT factors with the highest priorities included (1) easy accessibility to processing areas by marketers and consumers, (2) health hazards associated with traditional smoking, (3) development of cheaper and safe processing technology, and (4) lack of infrastructure for large scale processing while the SWOT factors with the least priorities included (1) positive return on investment, (2) reduced volume of processed shrimp in off-peak months, (3) increased sanitation of processing environment, and (4) supply of un-dried wood.

in the *marketing segment* (table 13) the highest rated SWOT factors were (1) the availability of large shrimp markets, (2) inadequate storage facilities, (3) modernization of markets and (4) production of undesirable sensory properties while the SWOT factors with the lowest priorities included (1) positive return on investment, (2) lack of product labelling, (3) development of cheap storage facilities, and (4) the large volume of by-catch in processed shrimp.

At the *consumption level* (table 14) the SWOT factors with highest priorities included (1) high awareness of the nutritional benefits of the species, (2) increased quantity of by-catch, (3) development of value-added products, and (4) the supply of undesirable smoked shrimp in market places while the SWOT factors with the lowest priorities included (1) the absence of an allergy in the majority of consumers, (2) seasonality of catch, (3) assessment of consumers outside the study area, and (4) supply of smoked shrimps with undesirable sensory attributes.

Table 3: SWOT Matrix of shrimping factors.

	Strengths		Weaknesses
S1	Availability of Shrimping materials at Igbokoda	**W1**	Less Beneficial Fishing association
S2	Large consumer base	**W2**	Lack of governance for monitoring shrimping input and catch
S3	Beneficial fishing Association	**W3**	High cost of outboard engines
S4	High return on investment	**W4**	Reduced volume during the off-peak months
S5	High catch volume in peak months	**W5**	High tide and sea turbulence during raining season
S6	Abundance of the species in the coastline	**W6**	Low/non-availability of shrimping input in shrimping areas
S7	Large household size	**W7**	Inadequate infrastructural facilities in coastal communities
S8	Availability of economically active Inhabitants	**W8**	High cost of fuel
	Opportunities		**Threats**
O1	Increased shrimping during off-peak months	**T1**	Positive resource rent
O2	Development of selective shrimping gear	**T2**	Free access to white shrimp fishery
O3	Development of SSOP for the fishery	**T3**	Seasonality of shrimp catches
O4	Development of a tax system based on shrimping effort	**T4**	Excessive rainfall and bad weather
O5	Development of responsive fishing organizations	**T5**	Trawling operations
O6	Diversification of the coastal economy		
O7	Investment into fishery input sales		

Table 4: SWOT Matrix of shrimp processing factors.

	Strengths		Weaknesses
S1	Positive return on investment	**W1**	Reduced volume of processed shrimp during off-peak months
S2	Availability of cheap processing materials	**W2**	Lack of product standardization
S3	Large consumer base for white shrimp	**W3**	High level of by-catch at landing
S4	Easy accessibility to processing areas	**W4**	Low-value addition
S5	High volume of processed shrimp	**W5**	Health hazard associated with traditional smoking
S6	Weekly sanitation of processing areas		
S7	Large house size		
	Opportunities		**Threats**
O1	Standardising the processing environment	**T1**	Lack of infrastructure for large scale processing
O2	Development of value-added shrimp products	**T2**	Seasonality
O3	Development of cheaper and safe processing technology	**T3**	Supply of un-dried wood
O4	Development of shrimp storage facilities		
O5	Increased sanitation of processing environment		

Table 5: SWOT Matrix of shrimp marketing factors.

	Strengths		Weaknesses
S1	Large consumer base in Southern, Nigeria	**W1**	Lack of product labelling
S2	Availability of processed shrimp	**W2**	Inadequate value addition
S3	Availability of large shrimp markets	**W3**	Inadequate storage facilities
S4	Positive return on investment	**W4**	Lack of standardization
	Opportunities		**Threats**
O1	Standardization of white shrimp products	**T1**	Production of un-dried white shrimps by processors
O2	Modernization of Igbokoda and Obi markets	**T2**	Large volume of by-catch in processed shrimp
O3	Marketing of value-added and labelled shrimps	**T3**	Production of shrimp with undesirable sensory properties
O4	Development of cheap storage facilities		

Table 6: SWOT Matrix of Shrimp Consumption factors.

	Strengths		Weaknesses
S1	Easy accessibility by consumers	**W1**	Increased quantity of by-catch
S2	Highly rated desirable sensory properties and acceptability	**W2**	Seasonality of Catch
S3	High awareness of the nutritional benefits of the species	**W3**	Mould Growth
S4	Less expensive in coastal communities		
S5	High acceptability of food flavoured with dried shrimp		
S6	High consumption level among consumers		
S7	High satisfaction with shrimp quality market places		
S8	High utilization as a supplement in weaning foods		
S9	No allergy reactions in the majority of consumers		
	Opportunities		**Threat**
O1	Development of value-added white shrimp products	**T1**	Supply of undesirable white shrimp in market places
O2	Assessment of consumers preferences outside study area	**T2**	Consumption allergies in some children and adults
O3	Development of domestic storage for smoked shrimp	**T3**	Inflation

5. Discussion and Policy Recommendations

The SWOT analysis is one of the most effective tools used in assessing the level or the development of a given sector (Meyo and Liangand, 2012). The shrimp sector embodies many opportunities and has its strengths but it also has to deal with weaknesses and threats which need to be minimized. The strengths of the different segments will toughen if some of the policies recommended in the opportunities are adopted and applied to reduce the weaknesses. The strengths' results revealed the abundance of shrimp in coastal waters of Ondo State, particularly in Ilaje LGA. To consolidate this strength, there is the need for the development of standards and sustainable operation procedures (O3) at the shrimping stage to ensure that the major threat to the fishery (free access; T2) is effectively curtailed (Meyo and Liang, 2012). Presently, shrimpers in the study area operate in an unregulated, uncontrolled and illegal fishing (UUI) environment which is characteristic of developing countries and under-developed fishery environments. Fishing that falls into the categories of UUI is estimated to have a value of between $9 and $23 billion per year and without doubt, a growing global concern for fishery managers, producers, traders, consumers and the fishers themselves (Cochrane and Garcia, 2009).

The study area's geographical location is a valuable opportunity but the high cost of shrimping inputs needed to be tackled efficiently. Tackling the high cost of shrimping input, the Government could subsidize the input market which will enable individuals with limited financial resources to boost shrimp production. Providing subsidies to small scale shrimpers, prospective investors and increasing processing capacity in the study area will increase the availability of white shrimp in market places and contribute to the coastal economy. However, this may negatively affect the long-term sustainability of the fishery and ecosystem due to overcapacity (Heymans et al., 2011). Therefore, the provision of subsidy and increasing investment in the white shrimp fishery should be accompanied by the development of a suitable shrimp management model. This includes the monitoring, control and surveillance of gear use, size of vessels, number of shrimpers, shrimping hours and size of outboard engines. This is all about ensuring compliance with fishery management measures (Cochrane and Garcia, 2009).

Due to the free access nature of the fishery (T1) at the shrimping segment, there is need to develop a co-management approach to change the behaviour of shrimpers to save the resource and also to maintain a positive economic return (Garza-Gil et al*.,* 2016). This can be achieved by taxation which is one of the means by which the demand for harvest, fisheries violation and fishing pressure can be reduced (Salgado and Chávez, 2015). The ultimate goal of this approach is to manage the fishery and increase its contribution to government revenue. This includes the development of a tax system that could be based on shrimping effort (numbers of fishing hours, horsepower of outboard engines) or output (weight of fresh shrimp).

Shrimp is classified as an aquatic resource with high resource and economic rent. This is a major strength of the species in the Nigerian aqua food market. However, due to the effects of seasonality (T3 and T2) at the shrimping and processing stages, participants at each stage of the value chain usually have high economic rent particularly during the dry months while consumers buy at higher prices. There is a need to develop storage facilities at the marketing stage (O4) that would increase the shelf life and availability of processed white shrimp, particularly in the dry months to increase access by low-income earners.

Though the processing stage of the value chain is profitable, the major threats to the segment are health hazards (coughing, headache and reedling of the eye) and stress associated with the traditional smoking method (T5) adopted in the study area. Therefore, there are opportunities for Agricultural Engineers and Food Scientists to development cheaper and safeer processing technologies (O3) that could reduce processing hours, reduce/eliminate hydrocarbons, and eliminate stress and health hazards associated with the shrimp smoking enterprise.

Results from the study show that the major weaknesses of shrimp processing enterprises are the high level of by-catches at landing with low-value. The non-availability of selective gear and small mesh size of stow nets utilized in the study area could be the reasons for the large volume of by-catches at landing and in processed shrimp at market places (Udoh and Ukpatu, 2017). To reduce by-catches, there is a need for the development of selective shrimping gear and the monitoring of mesh size used by shrimpers linked to the third opportunity at the shrimping stage. This is supported by the assertions of Kalayc and Yeşilçiçek (2014) who stated that sustainable fishery and a reduction of by-catches could be achieved by modifications in fishing gears.

Presently, the utilization of white shrimp in the study area and beyond is limited to consumption/flavouring of food in dried/grounded form and to utilization in weaning food with no allergic reactions (Okayi et al*.,* 2013). However, there is a need for increased value addition to make processed white shrimp competitive in local and international markets. The cost of value addition includes standardization of shrimp products at the processing and marketing stages of the value chain. There are opportunities for food regulatory bodies in the country to control the quality and standard of shrimp products in market places as well as the state of hygiene in processing and marketing. Ensuring environmental standards will boost consumers' confidence in the hygienic status of dried shrimps production. The advantages of standardization are that product classification and/or grading could build consumer confidence and bring about greater market transparency. Consumer can expect a product of

consistent quality when purchasing a specific grade or class allowing white shrimp products to compete on an equal footing with other aquatic products (South Africa Department of Agriculture, 2017).

The availability of large markets at Igbokoda and Obi in the coastal areas for prospective local and international marketers and consumers is a major pointer to the strength of shrimp marketing in the study area and beyond. However, there is still the need for market modernization to make them competitive among national, regional and global seafood markets. The presence of white shrimp with highly rated desirable sensory properties and awareness of the nutrient composition of white shrimps should support attracting consumers within and outside the study area.

6 Conclusion

The aim of the combined SWOT and AHP method was to improve the quantitative side of the strategic planning of *N. hastatus* value chain in the study area. The technique has proved to be of great help in understanding how AHP could be used to set priority for white shrimp value chain SWOT factors. The weaknesses and threats of the four stages in the value chain (shrimping, processing, marketing and consumption level) could be drastically reduced by utilizing the opportunities with the highest priorities. These include the development of SSOP for the fishery, development of cheaper and safer processing technology, modernization of shrimp markets and development of value-added shrimp products. The Federal Department of Fisheries and researchers in Nigeria and other developing nations can use this information to formulate programmes and policies that would ensure sustainable fishery, efficient processing and marketing as well as consumers' awareness and satisfaction.

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Appendix

Table 7.
Pairwise Comparison of Shrimping SWOT Factors.

Strength	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**CR**
Availability of Shrimping materials at Igbokoda	1.000	4.000	7.000	5.000	3.000	0.500	6.000	3.000	
Large consumer base	0.250	1.000	4.000	0.500	0.500	0.200	3.000	0.200	
Beneficial fishing Association	0.143	0.250	1.000	0.333	0.200	0.111	2.000	0.167	
High return on investment	0.200	2.000	3.000	1.000	0.333	0.167	2.000	0.250	
High catch volume in peak months (June and October)	0.333	2.000	5.000	3.000	1.000	0.250	4.000	0.500	
Abundance of the species in the coastline	2.000	5.000	9.000	6.000	4.000	1.000	7.000	3.000	
Large household size	0.167	0.333	0.500	0.500	0.250	0.143	1.000	0.333	
Availability of economically active Inhabitants	0.333	3.000	6.000	4.000	2.000	0.333	3.000	1.000	0.07
Weaknesses	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	
Less Beneficial Fishing association	1.000	0.111	0.167	0.250	0.143	0.333	0.500	0.200	
Lack of governance for monitoring shrimping input and catch	9.000	1.000	3.000	5.000	2.000	6.000	7.000	4.000	
High cost of outboard engines	6.000	0.333	1.000	3.000	0.500	4.000	5.000	2.000	
Reduced volume during the off-peak months	4.000	0.200	0.333	1.000	0.250	2.000	3.000	0.500	
High tide and sea turbulence during raining season	7.000	0.500	2.000	4.000	1.000	5.000	6.000	3.000	
Low/non availability of shrimping input in shrimping areas	3.000	0.167	0.250	0.500	0.200	1.000	2.000	0.333	
Inadequate infrastructural facilities in coastal communities	2.000	0.143	0.200	0.333	0.167	0.500	1.000	0.250	
High cost of fuel	5.000	0.250	0.500	2.000	0.333	3.000	4.000	1.000	0.04
Opportunities	**O1**	**O2**	**O3**	**O4**	**O5**	**O6**	**O7**		
Increased shrimping during off peak months	1.000	0.200	0.111	0.167	0.333	0.250	0.500		
Development of selective shrimping gear to reduce by-catch	5.000	1.000	0.333	0.500	3.000	2.000	4.000		
Development of SSOP for the fishery	9.000	3.000	1.000	2.000	5.000	4.000	6.000		
Development of a tax system based on shrimping effort	6.000	2.000	0.500	1.000	4.000	3.000	5.000		
Development of a responsive and idea oriented fishing organizations	3.000	0.333	0.200	0.250	1.000	0.500	2.000		
Diversification of coastal economy	4.000	0.500	0.250	0.333	2.000	1.000	3.000		
Investment into fishery input sales	2.000	0.250	0.167	0.200	0.500	0.333	1.000		0.03
Threat	**T1**	**T2**	**T3**	**T4**	**T5**				
Positive resource rent	1.000	0.500	4.000	2.000	3.000				
Free access to white shrimp fishery	2.000	1.000	5.000	3.000	4.000				
Seasonality of shrimp catches	0.250	0.200	1.000	0.333	0.500				
Excessive rainfall and bad weather	0.500	0.333	3.000	1.000	3.000				
Trawling operations	0.333	0.250	2.000	0.333	1.000				0.03

*CR = Consistency ratio

Table 8.
Pairwise Comparisons of Shrimp Processing SWOT Factors.

Strength	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**CR**
Positive return on investment	1.000	0.167	0.200	0.111	0.250	0.500	0.333	
Availability of cheap processing materials	6.000	1.000	2.000	0.500	3.000	5.000	3.000	
Large consumer base for white shrimp within and outside the study area	5.000	0.500	1.000	0.333	2.000	4.000	3.000	
Easy accessibility to processing areas by marketers and consumers	9.000	2.000	3.000	1.000	4.000	6.000	5.000	
High volume of processed shrimp particularly during the peak months	4.000	0.333	0.500	0.250	1.000	3.000	2.000	
Weekly sanitation of processing areas	2.000	0.200	0.250	0.167	0.333	1.000	0.500	
Large house size	3.000	0.333	0.333	0.200	0.500	2.000	1.000	0.03
Weaknesses	**W1**	**W2**	**W3**	**W4**	**W5**			
Reduced volume of processed white shrimp off peak months	1.000	0.500	0.250	0.333	0.200			
Lack of standardization by food standard organizations in the study area	2.000	1.000	0.333	0.500	0.250			
High level of by-catch in fresh N. *hastatus* at landing	4.000	3.000	1.000	2.000	0.500			
Low value addition	3.000	2.000	0.500	1.000	0.333			
Health hazard associated with traditional smoking	5.000	4.000	2.000	3.000	1.000			0.02
Opportunities	**O1**	**O2**	**O3**	**O4**	**O5**			
Standardising of processing environment	1.000	0.333	0.250	0.500	2.000			
Development of value added shrimp products	3.000	1.000	0.333	2.000	4.000			
Development of cheaper and safe processing technology	4.000	2.000	1.000	3.000	5.000			
Development of shrimp storage facilities	2.000	0.500	0.500	1.000	3.000			
Increased sanitation of processing environment	0.500	0.250	2.000	0.333	1.000			0.02
Threat	**T1**	**T2**	**T3**					
Lack of infrastructure for large scale processing	1.000	2.000	3.000					
Seasonality	0.500	1.000	2.000					
Supply of un-dried wood	0.500	1.000	2.000					0.01

*CR = Consistency ratio

Table 9.
Pairwise Comparison Matrix of Shrimp Marketing SWOT Groups.

Strength	**S1**	**S2**	**S3**	**S4**	**CR**
Large consumer base in Southern, Nigeria	1.000	0.500	0.333	2.000	
Availability of processed shrimp particularly during the peak months	2.000	1.000	0.500	3.000	
Availability of large shrimp markets at Igbokoda and Obi	3.000	2.000	1.000	4.000	
Positive return on investment	0.500	0.333	0.250	1.000	0.01
Weaknesses	**W1**	**W2**	**W3**	**W4**	
Lack of product labelling	1.000	0.333	0.250	0.500	
Inadequate value addition	3.000	1.000	0.500	2.000	
Inadequate storage facilities	4.000	2.000	1.000	3.000	
Lack of standardization	2.000	0.500	0.333	1.000	0.01
Opportunities	**O1**	**O2**	**O3**	**O4**	
Standardization of white shrimp products	1.000	0.500	2.000	3.000	
Modernization of Igbokoda and Obi markets	2.000	1.000	3.000	4.000	
Marketing of value added and labelled shrimp products	0.500	0.333	1.000	2.000	
Development of cheap storage facilities	0.333	0.250	0.500	1.000	0.01
Threat	**T1**	**T2**	**T3**		
Production of un-dried white shrimps by processors	1.000	2.000	0.500		
Large volume of by-catch in processed shrimp	0.500	1.000	0.333		
Production of white shrimp with undesirable sensory properties	2.000	3.000	1.000		0.01

*CR = Consistency ratio

Table 10.
Pairwise Comparison Matrix of Shrimp Consumption SWOT Groups.

Strength	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**CR**
Easy accessibility by consumers	1.000	2.000	0.500	3.000	6.000	4.000	5.000	7.000	8.000	
Highly rated desirable sensory properties and acceptability	0.500	1.000	0.333	2.000	5.000	3.000	4.000	6.000	7.000	
High awareness of the nutritional benefits of the species	2.000	3.000	1.000	4.000	2.000	5.000	6.000	8.000	9.000	
Less expensive in coastal communities	0.333	0.500	0.250	1.000	4.000	2.000	3.000	5.000	6.000	
High acceptability of food flavoured with dried white shrimp	0.167	0.200	0.500	0.250	1.000	0.333	0.500	2.000	3.000	
High consumption level among consumers	0.250	0.333	0.200	0.500	3.000	1.000	2.000	4.000	5.000	
High satisfaction with shrimp quality market places	0.200	0.250	0.167	0.333	2.000	0.500	1.000	3.000	4.000	
High utilization as supplement in weaning foods	0.143	0.167	0.125	0.200	0.500	0.250	0.333	1.000	2.000	
No allergy reactions in majority of consumers	0.125	0.143	0.111	0.167	0.333	0.200	0.250	0.500	1.000	0.07
Weaknesses	**W1**	**W2**	**W3**							
Increased quantity of by-catch	1.000	3.000	2.000							
Seasonality of Catch	0.333	1.000	0.500							
Mould Growth	0.500	2.000	1.000							0.01
Opportunities	O1	O2	O3							
Development of value-added white shrimp products	1.000	3.000	2.000							
Assessment of consumers preferences outside the study area	0.333	1.000	0.500							
Development of domestic storage for smoked white shrimp	0.500	2.000	1.000							0.01
Threat	**T1**	**T2**	**T3**							
Supply of undesirable white shrimp in market places	1.000	3.000	2.000							
Consumption allergies in some children and adults	0.333	1.000	0.5000							
Inflation	0.500	2.000	1.000							0.01

*CR = Consistency ratio

Table 11.
Overall Priority Scores of Shrimping SWOT Factors.

SWOT Group	Group Priority	SWOT Factors	Factor Priority within Group	Overall Priority of Factor
		Availability of Shrimping materials at Igbokoda	0.239	0.088
		Large consumer base	0.064	0.023
		Beneficial fishing Association	0.030	0.011
		High return on investment	0.061	0.022
		High catch volume in peak months (June and October)	0.107	0.039
		The abundance of the species in the coastline	0.326	**0.120**
		Large household size	0.031	0.011
Strength	0.367	Availability of economically active Inhabitants	0.142	0.052
		Less Beneficial Fishing association	0.023	0.003
		Lack of SSOP for the white shrimp fishery	0.330	**0.048**
		High cost of outboard engines	0.156	0.023
		Reduced volume during the off-peak months	0.073	0.011
		High tide and sea turbulence during raining season	0.227	0.033
		Low/non-availability of shrimping input in shrimping areas	0.050	0.007
		Inadequate infrastructural facilities in coastal communities	0.034	0.005
Weaknesses	0.146	High cost of fuel	0.107	0.016
		Increased shrimping during off peak months	0.030	0.011
		Development of selective shrimping gear to reduce by-catch	0.157	0.057
		Development of SSOP for the fishery	0.358	**0.131**
		Development of a tax system based on shrimping effort	0.236	0.086
		Development of a responsive fishing organizations	0.069	0.025
		Diversification of coastal economy	0.104	0.038
Opportunities	0.365	Investment into fishery input sales	0.046	0.017
		Positive resource rent	0.258	0.032
		Free access to white shrimp fishery	0.412	**0.051**
		Seasonality of shrimp catches	0.062	0.008
		Excessive rainfall and bad weather	0.176	0.022
Threat	0.123	Trawling operations	0.092	0.011

Table 12.
Overall Priority Scores of Shrimp Processing SWOT Factors.

SWOT Group	Group Priority	SWOT Factors	Factor Priority within Group	Overall Priority of Factor
		Positive return on investment	0.030	0.011
		Availability of cheap processing materials	0.228	0.084
		Large consumer base for white shrimp within and outside the study area	0.159	0.058
		Easy accessibility to processing areas by marketers and consumers	0.360	**0.132**
		A high volume of processed shrimp particularly during the peak months	0.105	0.039
		Weekly sanitation of processing areas	0.046	0.017
Strength	0.367	Large house size	0.072	0.026
		Reduced volume of processed white shrimp off-peak months	0.062	0.009
		Lack of standardization by food standard organizations in the study area	0.099	0.014
		High level of by-catch in fresh N. *hastatus* at landing	0.262	0.038
		Low value addition	0.161	0.024
Weaknesses	0.146	Health hazard associated with traditional smoking	0.416	**0.061**
		Standardising of processing environment	0.099	0.036
		Development of value added shrimp products	0.262	0.096
		Development of cheaper and safe processing technology	0.416	**0.152**
		Development of shrimp storage facilities	0.161	0.059
Opportunities	0.365	Increased sanitation of processing environment	0.062	0.023
		Lack of infrastructure for large scale processing	0.539	**0.066**
		Seasonality	0.297	0.037
Threat	0.123	Supply of un-dried wood	0.164	0.020

Table 13.
Overall Priority Scores of Shrimp Marketing SWOT Factors.

SWOT Group	Group Priority	SWOT Factors	Factor Priority within Group	Overall Priority of Factor
		Large consumer base in Southern, Nigeria	0.161	0.059
		Availability of processed shrimp particularly during the peak months	0.277	0.102
		Availability of large shrimp markets at Igbokoda and Obi	0.466	**0.171**
Strength	0.367	Positive return on investment	0.096	0.035
		Lack of product labelling	0.096	0.014
		Inadequate value addition	0.277	0.040
		Inadequate storage facilities	0.466	**0.068**
Weaknesses	0.146	Lack of standardization	0.161	0.024
		Standardization of white shrimp products	0.277	0.101
		Modernization of Igbokoda and Obi markets	0.466	**0.170**
		Marketing of value-added and labelled shrimp products	0.161	0.059
Opportunities	0.365	Development of cheap storage facilities	0.096	0.035
		Production of un-dried white shrimps by processors	0.297	0.037
		Large volume of by-catch in processed shrimp	0.164	0.020
Threat	0.123	Production of white shrimp with undesirable sensory properties	0.539	**0.066**

Table 14.
Overall Priority Scores of Shrimp Consumption SWOT Factors.

SWOT Group	Group Priority	SWOT Factors	Factor Priority within Group	Overall Priority of Factor
		Easy accessibility by consumers	0.221	0.081
		Highly rated desirable sensory properties and acceptability	0.157	0.058
		High awareness of the nutritional benefits of the species	0.285	**0.105**
		Less expensive in coastal communities	0.111	0.041
		High acceptability of food flavoured with dried white shrimp	0.050	0.018
		High consumption level among consumers	0.078	0.029
		High satisfaction with shrimp quality market places	0.054	0.020
		High utilization as supplement in weaning foods	0.026	0.010
Strength	0.367	No allergy in the majority of children and adults	0.019	0.007
		Increased quantity of by-catch	0.539	**0.079**
		Seasonality of Catch	0.164	0.024
Weaknesses	0.146	Mould Growth	0.297	0.043
		Development of value added white shrimp products	0.539	**0.197**
		Assessment of consumers preferences outside the study area	0.164	0.060
Opportunities	0.365	Development of domestic storage for smoked white shrimp	0.297	0.108
		Supply of undesirable white shrimp in market places	0.539	**0.066**
		Consumption allergies in some children and adults	0.164	0.020
Threat	0.123	Inflation	0.297	0.037