



Solutions To Logistics Challenges Faced By Fishmongers In Handling And Distributing Processed Fish. A Case Study Of Anyanui And Keta Districts Of Ghana

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ABSTRACT

The study sought simple indigenous logistics solutions to challenges faced by fishmongers with respect to the handling and distribution of processed fish in the Anyanui and Keta Districts of Ghana. It aimed at designing a handling and distribution unit (HADU) to substitute the conical frustum shaped basket (kenten), which is traditionally used for the purpose. This was a follow-up to a research that sort to curtail identified challenges, including improper stowage, perceived overloading, listing of cargo on transport vehicle, crushing and contamination of the processed fish during transit. Observation, simple mathematical calculations, interviews and experimental testing were employed in the study. The researchers' considered designing a HADU with characteristics similar to the intermodal ISO container. The HADU was to be appropriate for transporting the processed fish by standard tricycles, trucks, and water crafts. Its volume was calculated to be equivalent to that of the kenten, so as to preserve the measurements of products per unit traditionally supplied to customers, thus not complicating the pricing of contents per unit HADU for the traders. With height 40 cm, length 43 cm and width 56 cm, the resultant cuboidal shaped HADU, had handles, corner posts with extensions and corner fitting spaces. The HADU could be loaded in larger numbers on various sizes of trucks and tricycles compared to the kenten. It also solved the in-transit logistics challenges when stacked at a recommended

maximum height of three. Upon its acceptance by the fishmongers, the HADU's concept was recommended to be sold to basket weavers, to try raw materials other than cane, which will lower its production cost.

Keywords: Handling and distribution unit (HADU), conical frustum shaped basket (kenten), indigenous logistics solutions.

INTRODUCTION

World small-scale fishing industry

"From ancient times, fishing has been a major source of food for humanity and a provider of employment and economic benefits to those who engaged in this activity" [1]. It was reported that small-scale or artisanal fishing industry generated significant profits and made meaningful contributions to poverty alleviation and food security in developing economies [1]. Small-scale fisheries industry described, was an evolving sector which employed labor intensive harvesting, processing and traditional distribution techniques to exploit maritime fishery resources [1].

The main activity of fishing gave rise to other downstream fish processing activities such as smoking, salting, drying, packaging, transportation and marketing. Processed products from the small-scale fishing industry was often sold in local and domestic markets. However, export-oriented production from that industry was noted to be a growing feature in the last three or more decades, where export values globally rose from US\$ 15 billion through US\$ 56 billion during the period [1]. The application of prudent logistics systems, including the use of suitable packaging and transportation units; could no doubt have contributed to the successes stories of the export of fish products from the main producing economies to international markets.

Small scale fishing in Ghana

Small scale fishing in Ghana has been a traditional occupation for a significant population in the country. For decades, fishmongers serving in this artisanal industry along river banks and on the coastline have been key players in the processing, distribution, and trade of the harvested fish. Their services accounted for a significant proportion of fish products that could be found in the markets of the country. Fish products from this industry is also exported to neighboring countries [2]. Yet this industry does not appear to have developed much in terms of their practices and procedures. Fishmongers may not maximize earnings from their hard work as there appear to be very little improvement in their logistics processes over the years.

A follow-up research was conducted by [3] on findings of Quarcoo's et al in 2014, whose research advocated for the development of a good logistics system to support the indigenous industry of fishmongers in the Keta and Anyanui areas of the Volta Region, Ghana. According to [3], Quarcoo's team noted that the fishmongers encountered problems with storage and distribution of dried and smoked fish. Furthermore, improper packaging and stowing of the processed fish on the various mode of transport was a cause of breaking and crushing of the processed fish whilst in transit to various points of sale. Other problems were contamination of fish products with dust and/or mold. All the above lowered the value of the processed fish at the markets. [3] captured a recommendation made by Quarcoo's team, which was: - the need to design and construct a cuboidal shaped basket to replace the conical frustum shaped basket (kenten), traditionally used for storing and transporting processed fish. This particular recommendation propelled the desire of [3] to design a workable

unit with unique features comparable to the ISO shipping container, which should eradicate the challenges associated with the transportation and distribution of processed fish from the Keta and Anyanui districts to markets in the Greater Accra Region of Ghana. Further expectations were for the unit to make the logistics processes more professional and appealing.

OVERVIEW OF LOGISTICS OPERATIONS

The common goal of logistics activities is to facilitate the movement of international or local traded commodities in ways that stakeholders will realize satisfaction derived from time, form, place or possession utilities [4]. In a much broader sense, logistics is widely used in the business sector to refer to how traded commodities are handled and moved along supply chains. Supply chains are set in motion with orders from suppliers for raw materials, passing through semi-finished processing to finished production, consumption and the disposal of generated wastes in sustainable ways [4]. Logistics activities include but are not limited to the packaging, storage, transportation and distribution of products in supply chains, incorporating the appropriate 'just – in – time' principles. Once the activities are optimally coordinated, customers derive value for money and maximum satisfaction [4].

Principles and researches associated with logistics so often point to, or are applied in formal international business transactions. But noting that many of the world's largest multinational businesses started as informal micro businesses and further noting that small antique shops are able to sell their products globally, it brought to light the importance of introducing innovations tied up with professionalism into the logistics aspects of supply chains for indigenous industries mostly found in developing economies. Those were thought to be the main strategy to experience the much required sustainability and growth of the industries and the economies. In such instances, value addition could be realized that may make the local products more appealing to home customers and further increase their demand on international markets. The culminating impacts on an economies could be expanded businesses, more jobs and wealth creation for the sustenance and growth.

PROCESS WITHIN THE SUPPLY CHAIN OF GHANA'S SMALL-SCALE FISHING INDUSTRY

Appendices *a* demonstrate how some producers package, stack and stow fish products from small scale producing communities and transport them to markets in other regions of Ghana. Though the contents of the packages are expertly processed and of qualities that are comparable to similar products traded worldwide, the approaches to the management of the related logistics highly reduces the value of the products at the markets. The unprofessional haphazard logistics approach significantly contributes to the breakage, contamination of fish product, low loading capacity of packaged product on transporting vehicles as well as the instability or listing of transport vehicles whilst in transit. In fact, the appearance of some of the loaded trucks as they arrive in the markets made the very nutritious fish products simply unappealing for human consumption. So many buy such products to be used for animal feed.

Proposed solutions to the logistics challenges

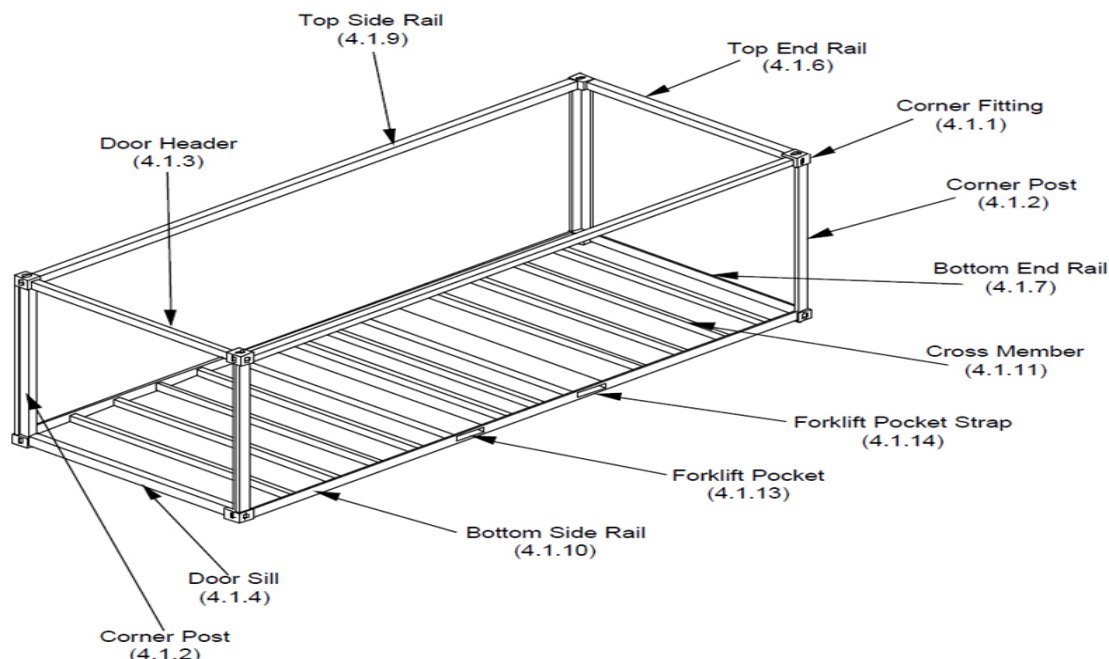
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To address the challenges encountered with storage, stowage and distribution of fish products to markets, a new transport handling and distribution unit (HADU), cuboidal in shape was proposed to be designed and constructed to replace the conical frustum shaped basket (kenten) which was traditionally used. In view of that recommendation, the features of the ISO shipping container were thought as being most suitable to be adopted in the design of the HADU to provide the solutions to all the challenges encountered in the distribution of fish products.

The ISO shipping container is a multimodal transport unit known to have contributed to the revolutionizing of international shipping and trade to its current level such that today, almost every manmade commodity that can be found on markets and shops world-wide [4] could have been transported in a shipping container as it travelled from its source to a destination. Though they come in different sizes and forms for specialized usage, ISO shipping containers have certain standard frameworks common to them all. The standard framework makes it possible for standardized handling and stowage procedures; ease of stowing of containers on all modes of transport vehicles, as well as stacking in port storage areas without destroying or crushing self or their contents. The standard framework of the ISO container is as seen in the diagram below:

**Fig 1**

Source: <http://www.residentialshippingcontainerprimer.com> [5]

Essential parts of the framework of the ISO container that were considered for adoption in the construction of the HADU included the corner posts, top end and side rails, the bottom end and side rails as well as the corner fittings (*also referred to as corner castings*). The corner fittings or castings are structures which enables one container to stably sit on top of other containers and further connect to other containers horizontally. The corner castings also aid in the fastening of the containers to various transport modes including ship, rail and road [5].

RESEARCH

Research problem

The absence of a properly designed transport handling and distribution unit for indigenous fishmongers in the Keta and Anyanui Districts in Ghana's Volta Region was the cause of problems encountered during the transportation and distribution of fish products. The problems included over and improper stowage of traditional packages on transport vehicles leading to vehicular instability. They also included contamination, which packages were placed on the ground. Also the traditional packaging was the source of breakage of large quantities of fish products. The traditional package referred to as kenten, was a conical frustum shaped basket woven from cane or palm fronds.

Research objectives

The researchers sought to design and construct a workable HADU, which was not to be very different from the kenten, but which would eradicate the challenges that they posed to the logistics activities of storage, transportation and distribution of fish products, thereby preserving the value of the fish products at every stage of the supply chain. Having in mind the principles of intermodal transport and containerization, the researchers assessed the possibility of designing the HADU to

mimic the features of the ISO 'shipping container' which has successfully contributed to revolutionize of international trade today. The specific objectives of the study were: -

- To determine appropriate dimensions for the HADU, making it equivalent to that of the kenten traditionally used for the storage, transportation and distribution of processed fish by fishmongers from the Keta and Anyanui areas to other regions in Ghana.
- To determine the **features, design** and **construct** a HADU, which would provide the standard benefits derived from the ISO container including: -
 - Easy and efficient handling without damaging the contents or goods,
 - Preservation of contents of the unit from contamination,
 - Loading stability, efficient stacking and minimum broken stowage on vehicles.
 - Intermodal carriage on all land haulage transport types ranging from tricycles, road trucks to rail trucks. Also on canoes and barges engaged in coastal shipping and inland water transport.
- To test for the acceptance and usability of the derived HADU amongst stakeholders in the Keta and Anyanui districts and in some markets where the processed fish products were sold.

Scope of research

The research sort solutions to the downstream logistics challenges encountered by fishmongers in the Anyanui and Keta Districts in Ghana and further assessed the acceptance of the solutions to stakeholders in markets at Ashaiman and Tema in the Greater Accra region of Ghana.

Justification of research

Innovations in the traditional logistics facilities used by indigenous enterprises in developing countries such as Ghana have the propensity to add value to traditional products and thereby create more demand for them beyond local markets. This should also create confidence in the use of local logistics systems manufactured with cheap local resources abundantly available in the domain of indigenous craftsmen. It should further lead to the creation of jobs, wealth, enhance their living standards and ultimately improve the GDP of developing economies.

RESEARCH METHODOLOGY

Dimension, design and construction of the HADU

The work involved experimental testing, observations, discussions and interactions. These approaches were thought to be most appropriate for the discovery and interpretation of data and theories for practical application to the determination of the design of new products and their acceptance by potential users. In – depth methods were as outlined below: -

- Experimentation, basic mathematical measurements and analysis were used to derive the volume of the cuboidal HADU from the conical frustum shaped traditional kenten. This was done so as not to alter the standard measurements of products traditionally transported per unit kenten. In so doing, it was presumed that the pricing of fish products per HADU would not vary much from the pricing of same per kenten.
- Determination of a standard height, breadth and length of the HADU were by measurements and analytical calculations of the dimensions of the carrying buckets of haulage vehicles.
- The features of the HADU were derived by studying the technical features of the ISO container that were expected to be adopted for the construction HADU, so as to overcome

the challenges poses by the traditional kenten. They included optimizing stowage and stability of the trucks when loaded with cargo. There was also the study of the locking system of the ISO containers to develop a customized locking systems for the HADU.

- Experimental testing, predictions and observations were techniques use to derive solutions in the design of the HADU which would ensure whole fish products, free from contamination whilst packaged products were in transit till they reached the end of the supply chain.
- Very significantly testing, predictions and observations were necessary to ensure that the HADU was constructed using indigenous raw materials and in a manner that would provide an appealing and 'professional logistics impression' of packaged products whilst loaded on the transport vehicles.
- Focus group interactions and discussions were used to derive the design of the HADU and experimental construction of same. Two (2) indigenous basket weavers, purposively sampled from the population of the association of basket weavers in the Accra Airport area in Ghana were used. The approach was adopted for the reason of ensuring proximity between the manufacturers and researchers so that regular interactions and discussions would yield the best output for the HADU.

Usability and acceptance of the HADU

To test the usability and acceptance or otherwise of the HADU, qualitative methods including interviews, focus group discussions and observations were used to gather data from a sample of fishmongers in the Anyanui and Keta areas, transporters of fish products to markets centers as well as fish traders in the markets. They were offered the opportunity to observe the features of the derived HADU, test it by loading it with processed fish products, stack one HADU on the other and make their comments. The views a sample of basket weavers in the Anyanui area on mass production of the HADU were also sought.

Transporters, were also offered the opportunity to observe the features of the derived HADUs and furthermore, test the stowage efficiency, locking effect and potential vehicle stability whilst transporting fish products in the HADUs.

FINDINGS, DATA PRESENTATION AND ANALYSES

Dimensions of the HADU

To derive the dimensions of the HADU, the following estimations were made: -

Volume of the HADU

Taking the dimensions of a standard kenten used by fishmongers in the target group, i.e. height (h) of 40cm, top (R) and bottom (r) radii of approximately 30cm and 25cm respectively, a volume (V) of **95, 247cm³** for the kenten was derived using the mathematical formula of a conical shaped frustum that is:

$$V = \left[\frac{1}{3} \right] \times \pi \times h [R^2 + r^2 + Rr]$$

This same volume was adopted for the determination of the dimensions of the HADU, to make it commensurate with that of the kenten. The objective was to maintain the quantity of fish traded per unit package, whether kenten or HADU. In so doing, the possible new challenges such as: - price reviewing by traders and furthermore, variation of quantities to be acquired by buyers (which can cause complex logistics challenges) were eradicated.

Height of the HADU

Just as the height of kenten, the height **40cm** was adopted for the HADU.

Width of the HADU

The determination of the width of the HADU was based on the dimensions of the bucket of a JAC truck model, which is a vehicle popularly used in transporting of fish products from the production areas in Keta and Anyanui to the markets in Tema and Ashaiman in the Greater Accra region of Ghana.

- With the width of the JAC truck's bucket measuring 174cm and simple mathematical estimation of three (3) HADUs per row across it, the width of a HADU was pegged at **56cm**.

This dimension created permissible broken stowage of 6cm per HADU, which was distributable between the HADUs and the side walls of the truck's bucket. This broken stowage space was to facilitate the handling and stowage of HADUs on the horizontal axis of truck.

Length of the HADU

With height (h) of 40cm, width (b) of 56cm and volume (v) of 95,247cm³, a length (l) of **42.5cm** approximated to 43cm was derived from the mathematical formula of a cuboid:

$$l = v/bh.$$

With length of approximately 43cm, it was possible to load nine (9) HADUs in a column with a permissible broken stowage space of 7cm distributable amongst HADUs from the front to the back of the JAC truck's bucket. The broken stowage space provided enough ease for handling and stowage of HADUs in the column.

Vehicle carrying capacities of kenten and HADUs

Having established the dimensions of the HADU, an assessment was made of the carrying capacities of various trucks and tricycles used for transporting processed fish from the research areas to markets.

- This was done taking into account the different dimensions of the carrier buckets of the various vehicles.
- Numbers of kenten that may be ideally stacked up to three high on the various trucks were calculated to compare their carry capacities to that of the HADUs.
- This was necessary for estimating of the broken stowage space that could be gained by replacing the use of kenten with the HADUs.

Table 1.0 below shows the number of HADUs that can be accommodated on different vehicles popularly used for transporting fish products from the hinterlands to the market centers when they are stacked from one through to a maximum height of three.

Table 1. 0 HADU carrying capacities of trucks and tricycles used in the Ghanaian market

Vehicle type	Dimensions of cargo bucket (cm)			Number of HADUs per		Total HADU base area (cm ²)	Broken Stowage area (cm ²)	Total number of HADUs *projected stack heights (X)		
	L	W	H	Row	Column			1X	2X	3X
JAC truck (1077)	394	174	46	3	9	65016	3540	27	54	81
Motor King (MK200ZH – Box Cabin)	200	130	125	3	3	21672	4328	9	18	27
Motor Kin tricycle (MK200Z -SDT)	200	130	NA	3	3	21672	4328	9	18	27
WAW truck (FD1090P8K –2)	630	220	50	5	11	132440	6160	55	110	165

Table 2.0 shows the number of kenten that can be accommodated on different vehicles popularly used for transporting fish products from the hinterlands to the market centers when they are stacked from one through to a maximum height of three.

Table 2. 0 Kenten carrying capacities of trucks and tricycles used in the Ghanaian market

Vehicle type	Dimensions of cargo bucket (cm)			Number of Kenten per		Total Kenten area (cm ²)	Broken stowage area (cm ²)	Total Kenten * projected stack heights *(X)		
	L	W	H	Row	Column			1X	2X	3X
JAC truck(1077)	394	174	46	2	6	28896	39660	12	24	36
Motor King (MK200ZH – Box Cabin)	200	130	125	2	3	14448	11552	6	12	18
Motor King tricycle (MK200ZH -SDT)	200	130	NA	2	3	21672	4328	6	12	18
WAW truck(FD1090P8K-2)	600	220	50	10	3	72240	66360	30	60	90

Comparing carrying capacities of the trucks and tricycle loaded with HADUs and same loaded with kenten, it was noted that the use of HADUs provided a much higher carry capacity for the vehicles than the use of kenten when those units were stacked 1 or 2 or 3 units high. The assertion is elaborated on in table 3 and a pictorial impression in fig 2 below.

Table 3: Comparison of volumes of cargo space available on trucks with the use of HADUs and kenten

Vehicle type	Total HADU space for fish (cm ³)			Total Kenten space for fish (cm ³)			Extra fish loading space gained with HADU (cm ³)		
	1X	2X	3X	1X	2X	3X	1X	2X	3X
JAC truck (1077)	25704	51408	77112	11424	22848	34272	14280	28560	42840
Motor King (MK200ZH – Box Cabin)	8568	17136	NA	5712	11424	NA	2856	5712	NA
Motor King tricycle (MK200ZH -SDT)	8568	17136	25704	5712	11424	17136	2856	5712	8568
WAW truck FD1090P8K – 2	48552	104720	157080	28560	57120	85680	19992	47600	71400

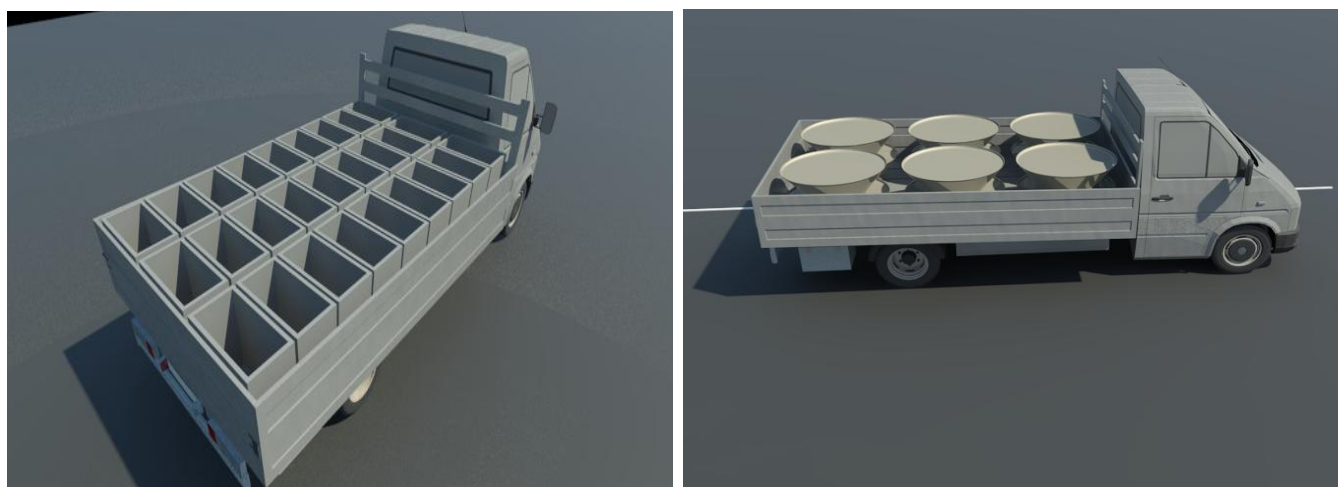


Fig 2: 3D cross sectional view of HADUs vrs. kenten stacked two high in the JAC cargo trucks

Features, design and construction of HADU

Having discussed the concept of the HADU with the sampled basket weavers, it was agreed that the HADU be constructed with a framework comparable to the primary structural parts of a typical 20 ft. ISO shipping container. The essential parts adopted included: -

- The top and bottom rails as well as the corner posts (see Fig 1 above). This framework was to solve the challenge of crushing/breaking of the fish products as occurred with the use of the kenten when one (or more) of such, loaded with fish products were stacked another. In this case, the weight of the HADUs higher in a stack were directly supported by the corner posts of the HADUs which were lower down the stack. Both corner posts and side rails were constructed using cane rods of approximately 25mm in diameter.
- A second frame was attached to the bottom rails of the HADU. This was to act as a stand which would play a dual role. Firstly, to prevent the base plate of the HADU from sitting directly on the ground and so doing, the challenge of contamination of fish products with sand and other contaminants on the bare ground was eliminated. Secondly, to provide corner spaces were an extended corner post of each HADU would sit when another HADU was stacked on it.
- The fitting arrangement provided by the corner space at the bottom of the HADU and the corner extensions at the top of the HADUs were comparable to the fitting mechanism

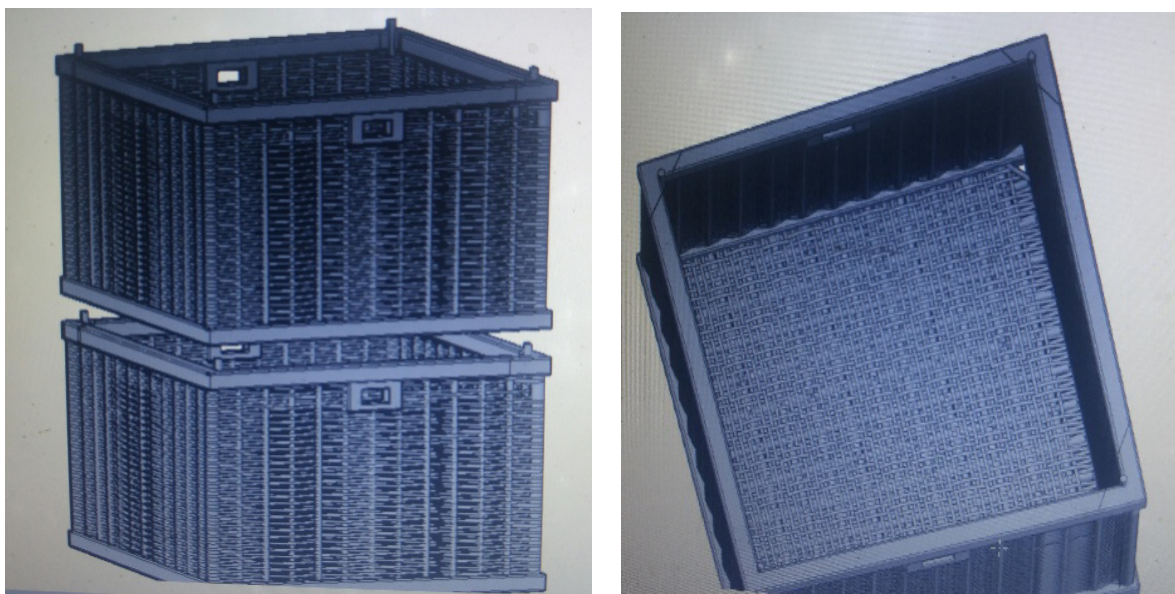
provided by the corner casts or fittings on the ISO containers for securing containers in stacks and on transport vehicles.

- d. The walls and base plate of the HADU were constructed by weaving canes around the bottom and top rails and on the base frame of the HADU respectively. Handles were incorporated on the two shorter adjacent sides of the HADU.

The cumulative effect of the design was a HADU with features ensuring efficient stacking; loading stability and minimum broken stowage; translating in high cargo carrying capacity of vehicles, minimum breakage/crushing of fish product in transit and insignificant contamination of fish product. It was concluded that once the concept of the HADU was accepted and used, other logistics advantages to be derived were easy handling of unit in addition to a professional and attractive packaging of goods whilst in transit. Fig. 3 are drawings demonstrating the above construction and properties.

Figs 3 shows a drawing of HADUs with their essential features. It further demonstrates how one is stacked on the other to provide the stability to a vehicle when loaded and in transit. The suspended base plate of one HADU (*see fig 3b*) forms a lid for the other on which it is stacked and also prevents direct contact of fish products with possible contaminants when the HADU sits on the ground.

Fig 3 Drawings of HADUS with their essential feature



ACCEPTANCE AND USABILITY OF DERIVED HADUS AMONGST STAKEHOLDERS

Views of fishmongers and market women

Summarizing their views, majority of those stakeholders admitted the challenges posed by the use of the kenten and agreed that most can be solved by the use of the HADU. See appendix 2a and 2b, which demonstrate traditional stowage of loads on vehicle and storage of products in kenten at the producing areas of Keta and Anyanui. The fishmongers and market women appeared excited about the decency and professional appearance that was brought to bear with the design to of HADUs for the storage and distribution their products (*see appendix 2c*). They were convinced about measurements of fish products in the volume of the HADU, as it accurately contained the contents

of a full loaded kenten (*see appendix 2d*). They attested to the fact that handling of the HADU was far easier than handling the kenten (*appendix 2e*). They noted that the HADU appeared stronger due to the frameworks incorporated in the design and therefore believed that they would last longer than the kenten. Using the HADU, the women agreed that the level of contamination of their products would be minimal due to the stand which caused the base of the unit to be suspended.

However, the women were of the view that covers for the top layers of HADUs had to be constructed to increase the protection of the products from contaminants in the environment (*see appendix 2f*). They also noted that the HADU was weightier than the kenten, which in their view could increase their transportation cost, as the drivers used both volume and weight as the basis of charge per unit to be transported.

Transporters' views about operationalizing the HAD

Seventy- five percent of the transport operators in the business of distributing fish products in kenten for at least 20 years acknowledged that handling and stowing the traditional kenten on the vehicles was not such an easy process and therefore it required tact as there were tendencies of getting hurt through piercing of the basket material into parts of the body during the process. The transport operators admitted other challenges in their operations such as the fishmongers heaping the kenten with fish in ways that led to uneven distribution of loads inability to stack kenten and low cargo carrying capacity, though the vehicles appeared overloaded. They were forced to squeeze as many kenten into their vehicles causing damages of various degrees to the vehicles depending on where the loads were. Cargoes had the tendency to list, causing instability of vehicles whilst in transit.

The transporters, stated that those practices by the fishmongers resulted in crushing or breaking of the fish products. Transporters, including canoe operators agreed that the HADU was a good innovation that would solve the logistics problems associated with the supply chain of fish products (*see appendix 2g*). However, they stated that they may not be able to carry large numbers of empty kenten on the return hauls, which optimized their cost of operations and increased their profit margins (*see appendix 2h*). In their view, that operational advantage may not be achieved when they are restricted in terms of the number of HADUs they can carry on any voyage for the safety of the vehicle.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

There could be simple ways of increasing the value of products from indigenous industries in developing countries if a little more attention is paid to management of their associated logistics within their supply chains. This was corroborated by stakeholders in the supply chain of fish products from the small scale fishing industry in the Keta and Anyanui Districts in Ghana when they assessed the 'value' to be derived from the use of the HADU. The HADU, which was a newly designed handling and distribution unit was cuboidal in shape with a stand, corner castings, fitted with handles and constructed from the same local raw materials used to weave kenten. This design was proposed to replace the design of kenten with had the shape of a conical frustum. The kenten was the main logistics unit in the supply chain of the industry used for the storage, and distribution of the fish products.

Value here, were the culmination of benefits to be derived from using HADUs, which included enhanced product packaging and handling; professionally acceptable stowing and stacking of packaged products on transport vehicles enroute to market places; high quality of fish... not contaminated or broken at the end of the supply chain; optimum delivery time for products in markets and larger quantities of products delivered per vehicle.

Considering the strength of the HADU, it may be possible to be used for the packaging and distribution of all other products that are transported in kenten.

Recommendations

The new HADU be adopted nationwide for the storage and distribution of processed fish and other products traditionally stored distributed using kenten. Furthermore, the construction of the HADU may be tested with other raw materials such as raffia and palm fronds so as to reduce the unit prices. It was also recommended that other weavers are introduced to some basic logistics concepts, which would motivate them to be innovators. Furthermore, research may be carried out to improve the design of the HADU.

Young Ghanaian and African logisticians may take up research which enable them to apply their highly acquired knowledge to experiment with simple indigenous resources in found abundantly in their communities to solve logistics problems. In so doing, they would be raising the value of indigenous traded commodities, creating many local jobs and ultimately enlarging the GDPs of those developing economies.

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APPENDICES



Appendices a.



Appendices b.



Appendices c



Appendices d



Appendix e.



Appendices f.



Appendices g.



Appendices h.