UTILIZATION OF *Brachystegia nigerica* IN TETRA-PIECE FURNITURE DESIGN AND CONSTRUCTION FOR EFFECTIVE ROOM-SPACE MANAGEMENT IN AKWA IBOM STATE

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ABSTRACT

Brachystegia nigerica is a tropical hardwood readily available in the market and identified as "Achi." This wood was used in the design and construction of tetra-piece furniture which comprises unit A and B linked by means of a pivot ironmongery to enhance convertibility into tripartite positions and kept in place using adjustable stopper. Unit A is a stand with four tapered legs fixed to the minor seat whereas unit B consists of a major seat fixed to a wide board, which is rounded at one end with an elliptical curve at the other end. The design and construction of the tetra-piece furniture entailed working drawing, measurement, marking, setting-out, sawing, chiseling, planing, assembling, filling, sanding and spraying of the wooden furniture to the desired shade. The design makes for efficient utilization of wood and the attendant cost savings. By performing four functions in one, the tetra-piece furniture helps in solving the problem of over-crowding a room facility with many furniture. The tetra-piece furniture is made to function as a self-standing ladder, lamp stand, ironing board and a convertible chair. The tetra-piece furniture is recommended for bachelors, spinsters and as an instructional material for teaching life skills in woodwork, for job creation and for foreign exchange earnings.

Key words: *Brachystegia nigerica*, Tetra-piece furniture, design, furniture construction, room-space management.

INTRODUCTION

Akwa Ibom State is one of the states in the Niger Delta region of Nigeria. The State is in the Atlantic Coastline which stretches 129 kilometers from Oron in the East to Ikot Abasi in the West (Utuk *et al.*, 2019). The rain forest of the State has abundant tropical hardwood of diverse durable species such as *Brachystegia nigerica* (Achi), *Terminalia superba* (Afara), *Mitragyna ciliata* (Owen) *Chlorophora excelsa* (Iroko) and *Entandrophragma cylindricum* (Mahogany), to mention but a few. According to Etukudo (2003), *Brachystegia nigerica* is brown in colour, very dense, moderately strong, fairly durable and used for plywood cores and faces, wood flooring, window and door frames, stairways, tool handles, furniture and cabinet works, roof trusses, carcassing and shuttering. The wood has good figure, with straight grain orientation; it is easy to work with and has a high strength property. According to Rahmon (2017), *Brachystegia nigerica* at an average moisture content of 11.78% has a density of 1,148.25 kg m^{-3} and modulus of elasticity of 11,220.99 N mm^{-2}. In addition, the choice of *Brachystegia nigerica* for the construction of tetra-piece furniture was sequel to the fact that they are readily available in the market in Akwa Ibom State.

The tetra-piece furniture is a free-standing furniture that is designed in cognizance with the science of ergonometrics, to perform four functions. These include: convertible chair, ironing board, self-standing ladder and a lamp stand. The tetra-piece furniture is made up of two units – A and B – pivoted together by means of a piano hinge ironmongery, for ease of convertibility. Utuk and Usoro (2019) adopted a combination of butt joint and a piano hinge ironmongery to aid in the convertibility of furniture to perform multiple functions. Unit A is 'A'-framed stand with four tapered legs fixed to a minor seat. According to Denig *et al.* (2015),

furniture frame gives the structural support and determines the basic shape of the furniture, setting limits upon the final design, establishing stability and functionality of the product. The tetra-piece furniture can also function as a self-standing ladder. According to Walton (2007), the ladder rungs should be fixed securely to the post at the rise of 260mm – 360mm, for ease of climbing. The third ladder rung was designed to also function as a lamp stand.

Furniture making requires the intelligent and imaginative thinking to evolve suitable designs for the intended purpose (James, 2015). Design is the intentional planning, drafting and making of objects for a particular use (Akpan, 2006). According to Utuk and Usoro (2018), furniture design is the intentional creation of moveable and immoveable objects to support human activities such as eating (e.g. dining table and chairs), sitting (e.g. chairs, stools and sofas), sleeping (e.g. bed, and sofas), storage (e.g. chest of drawers, wardrobes and cabinets) as well as for comfort. Well-designed furniture, according to Feirer (2001), is one that adheres to certain style, has beautiful wood and finish, fine construction and attractive cabinet hardware. Furniture construction entails interpreting the design, choice of materials, fabrication and assembling of the component parts to build the desired object (Usoro, 2018). The tetra-piece furniture production was in line with the theory of production, postulated by Koskela (2000), in the Transformation - Flow - Value model.

The tetra-piece furniture is a technical innovation in wood technology in the efficient utilization of wood, cost savings and to solve the problem of over-crowding a room facility with many furniture. Hence, its creation is intended to promote effective room-space management. Room-space management according to Gate (2006), is the process of planning, directing, controlling and organizing pieces of furniture in a room so as to create space and achieve maximum comfort for the occupiers of the room.

The amount of wood utilized for the construction of the tetra-piece furniture is far less than that required for the production of four different furniture. Hence, the cost of the tetra-piece furniture is far less than the cost of four different furniture pieces. The use of tetra-piece furniture will enhance the conservation of our forest reserves, in the long run, due to the efficient use of wood. The tetra-piece furniture could be used as an instructional material for teaching saleable skills to teeming youths for employability, job creation and self-reliant. Moreso, the product could be exported to other countries for foreign exchange earnings so as to boast the economy.

Purpose of the study

The main purpose of the study was to utilize *Brachystegia nigerica* in tetra-piece furniture design and construction for effective room-space management in Akwa Ibom State. Specifically, the study sought to:

i. design tetra-piece furniture for effective room-space management.
ii. determine the cutting list for tetra-piece furniture design.
iii. develop tetra-piece furniture design for effective room-space management.
iv. develop appropriate wooden joints for the tetra-piece furniture.

MATERIALS AND METHODS

Materials used in the tetra-piece furniture construction include:

1 No air-dried plank of wood (moisture content - 15%)
1 No piano hinge ironmongery
4 No zig-zag nails
1 kg ordinary wire nails
4 No bolts and nuts
½ kg screw nails
30 mls of ponal glue

Development of the Tetra-piece Furniture

The development of tetra-piece furniture starts with the design of the product. The design of the tetra-piece furniture is shown in Figures 1 – 4.

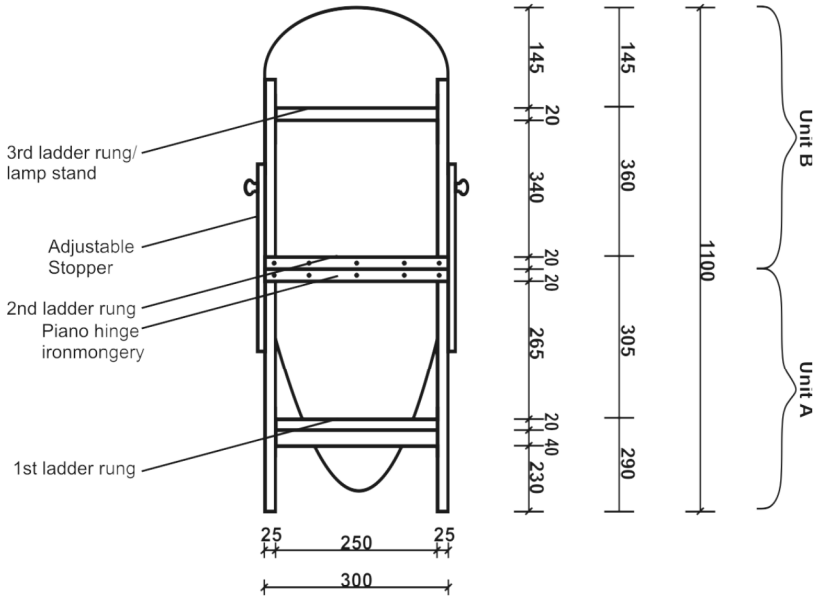


Figure 1: Self-standing ladder/lamp stand position

All dimensions in millimetres (mm)

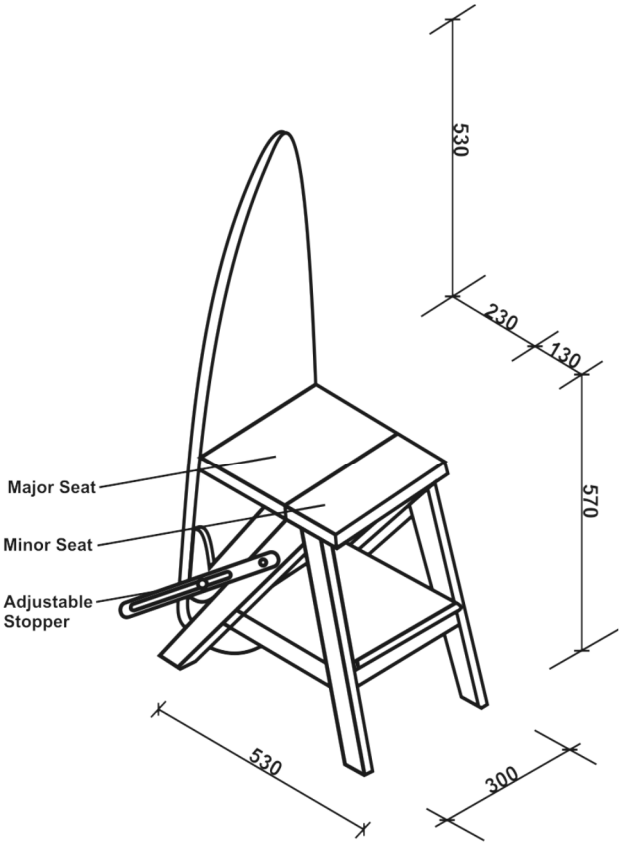


Figure 2: Convertible chair position

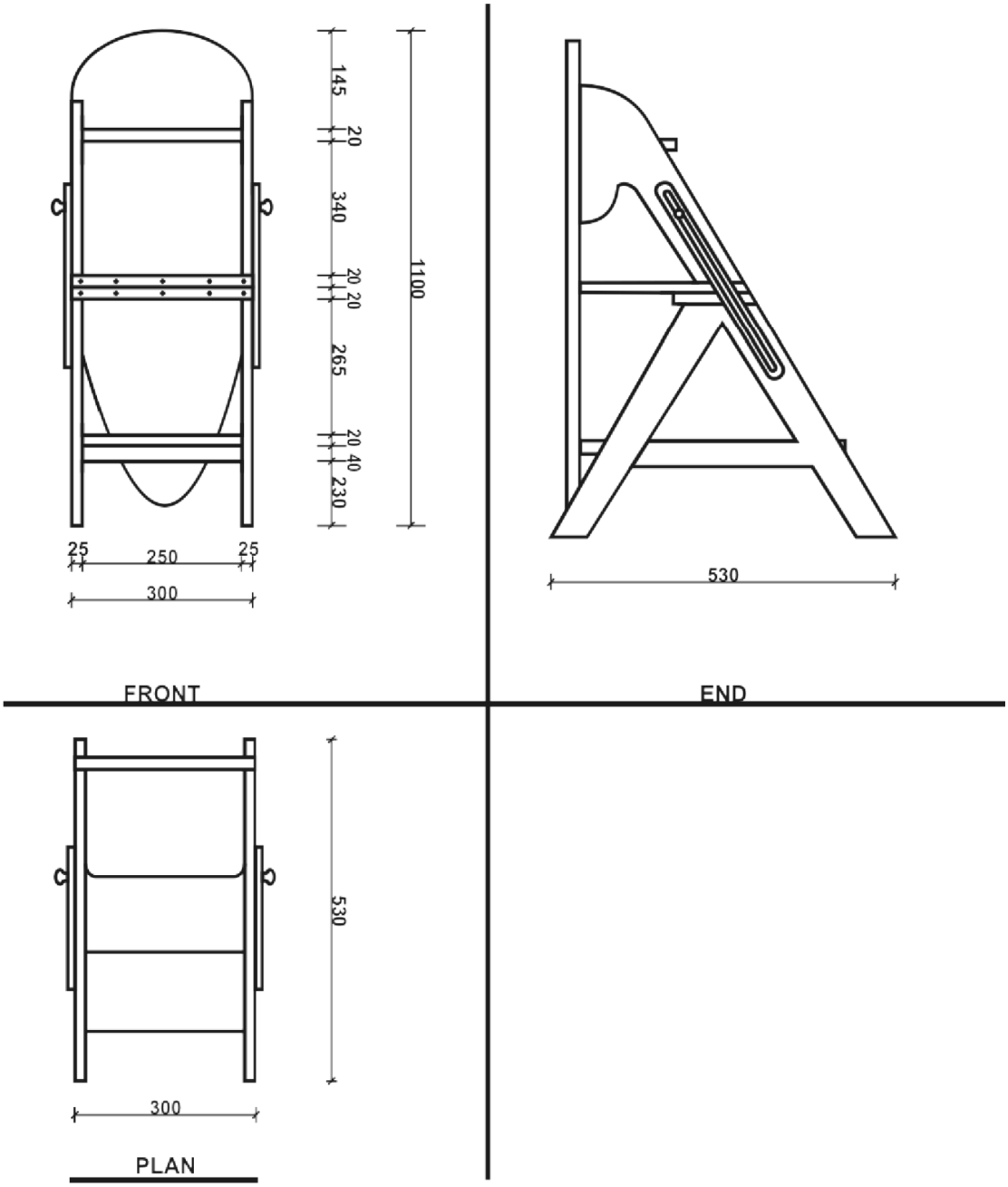
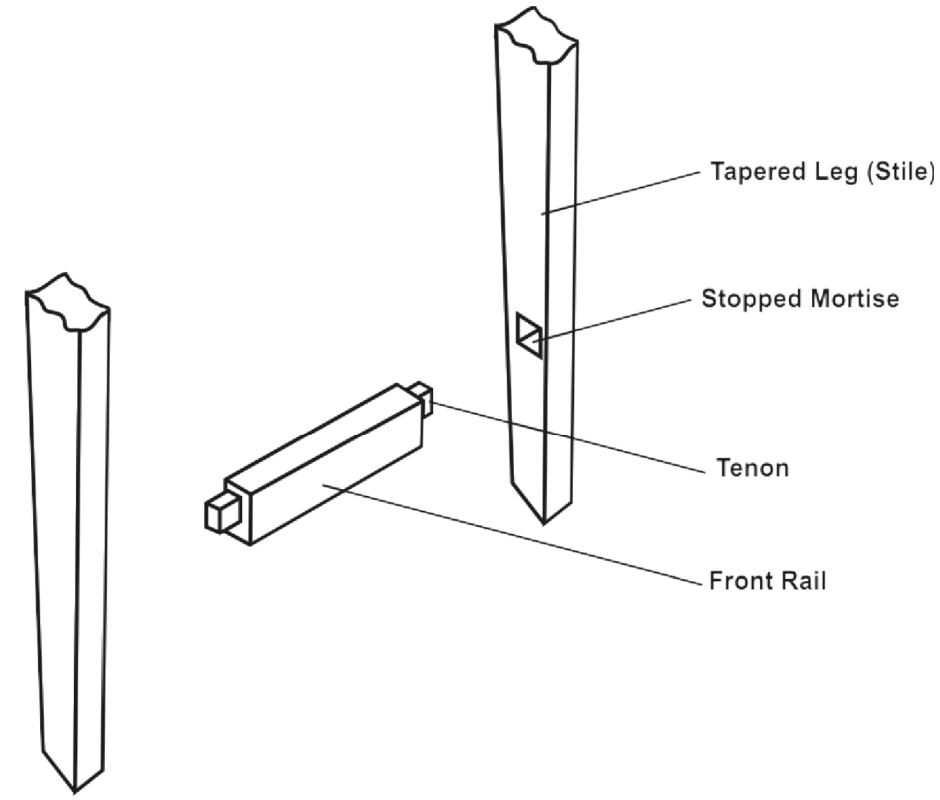
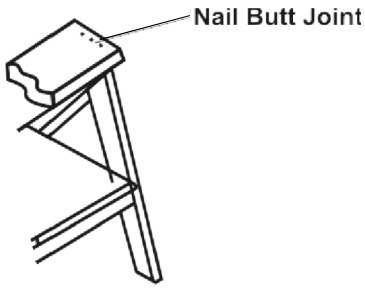


Figure 3: First angle orthographic projection (working drawing) of tetra-piece furniture



(a) Stopped Mortise and Tenon Joint



(b) Nail Butt Joint

Figure 4: Woodwork joints

Theory of production by Koskela, Laurin (2000)

This theory states that:

i. Production is the transformation of inputs to outputs.
ii. Production is the flow of processes.
iii. Production is the means for the fulfillment of the customers' need.

The resulting transformation-flow-value generation model is called the theory of production. This theory relates to this study in that the wood has to be transformed efficiently into the marketable tetra-piece furniture in a well-defined production flow processes to meet the needs of the customers.

Preparation of cutting list

The cutting list is a table showing the quantity of items required for the construction and their specifications. It is usually prepared according to the blueprint or working drawing of the product. Table 1 shows the cutting list of the tetra-piece furniture.

Table 1: Cutting List of the Tetra-piece Furniture

Qty	Description	Remarks
1No	25 mm x 300 mm x 1000 mm wooden board	Used for ironing board
1No	25 mm x 230 mm x 300 mm wooden board	Used for major seat
1No	25 mm x 130 mm x 300 mm wooden board	Used for minor seat
4No	25 mm x 65 mm x 600 mm wooden pieces	Used for tapered legs
2No	25 mm x 50 mm x 260 mm wooden pieces	Used for side rails
1No	25 mm x 250 mm x 360 mm wooden piece	Used for 1st ladder rung
1No	25 mm x 220 mm x 300 mm wooden piece	Used for 2nd ladder rung
1No	25 mm x 110 mm x 250 mm wooden pieces	Used for 3rd ladder rung/lamp stand
2No	25 mm x 65 mm x 450 mm wooden pieces	Curved according to template used for board support
2No	20 mm x 40 mm x 450 mm wooden pieces	Used as adjustable stopper
2No	25 mm x 50 mm x 275 mm wooden pieces	Used for front and rear rails

Preparation of timber

Every piece of wood to be used in the construction of tetra-piece furniture has to be prepared. According to Walton (2007), these operations are in six consecutive steps which could be represented by the acronym F.E.W.T.E.L where, F = **F**ace side, E= Face **E**dge, W = **W**idth, T = **T**hickness, E = **E**nd, L = **L**ength of the board.

i. Select the face side and plane it perfectly flat. Use straight edge to test its flatness. Mark the face side appropriately.
ii. Plane the face edge. Use straight edge and try square to test for straightness and squareness respectively. Mark the face edge as well.
iii. Gauge both sides to the required width using marking gauge. Plane off wastes. Test for straightness and squareness.
iv. Gauge the piece to the required thickness from the face side. Plane off the wastes and test for flatness.
v. Square, cut and shoot one end. Test for squareness.
vi. Measure the required length from the prepared end. Square, cut and shoot off waste.

Setting-out

Set out the various dimensions on the different pieces of the prepared timber. This involves measuring, squaring and marking according to specifications in the cutting list.

Sawing

The timber pieces were sawn with the panel saw as required. The two sawing operations carried out were ripping and cross-cutting. Ripping is sawing along the grain of wood whereas, cross-cutting is sawing across the grain of wood.

Preparation of joints

Two types of joints were used in the construction of the tetra-piece furniture. These are: tenon and mortise joint shown in Figure 4a and butt joint shown in Figure 4b.

Tenon and mortise joint

Steps in the preparation of the joint were:

i. Prepare the wooden pieces according to the required width, thickness and length.
ii. Set-out component parts according to the blueprint and cutting list. Mark positions of mortise on the stile (leg). Square lines across the face side and edges. Set-out length of tenon on end of rails. Set mortise gauge to the width of the chisel blade.
iii. Chisel out mortise half-way through.
iv. Cut tenon on rails. Saw on waste sides of the line. Pare slopping grooves and saw off shoulders to obtain tenon.

Butt joint

Ensure that mating end and side are perfectly straight and squared. Apply ponal glue evenly on the mating surfaces (if required). Drive nails to fasten the joint. Punch nail heads below wooden surface. Fill nail holes with fillers.

Assembling

i. Clean up mortise and tenon.
ii. Try to fit the mortise and tenon without applying glue (trial assembling).
iii. Apply glue on the mortise and tenon and fix them together.
iv. Hold the glued tenon and mortise in a sash cramp and nail in that position.
v. Ensure that side and end pieces for butt joint had been prepared and tested for straightness and squareness.
vi. Apply glue on side and end pieces.
vii. Nail glued side and end pieces in position.

Unit A, comprising the 'A'-shaped stand, minor seat and 1st ladder rung was assembled first. Followed by assembling unit B, comprising the ironing board, major seat/2nd ladder rung, and lamp stand/3rd ladder rung. Units A and B were joined together using a piano hinge ironmongery and screws.

Filling and sanding

Punch nail heads below wooden surface. Apply wood fillers to provide homogenous levelled background for spraying. Use 1½ glass paper on a wooden block and sand along the grain. Use wet cloth on the pieces to raise the grain. Allow the product to dry and sand again using O and OO glass papers successively.

Spraying

Mix a solution of stain, nitro-cellulose lacquer and thinner to the required consistency. Spray the assembled tetra-piece furniture to the desired shade.

RESULTS AND DISCUSSION

The design of the tetra-piece furniture is shown in figures 1 – 4. The cutting list for the tetra-piece furniture (Table 1) had been prepared according to the dimensions in the working drawing (shown in Figure 3). The tetra-piece furniture is shown in Figure 1 in the self-standing ladder/lamp stand position. The overall height of the self-standing ladder was 1100 mm from the ground level. The figure shows unit A being pivoted to unit B by means of a piano hinge ironmongery, for ease of convertibility to other positions. Unit A is "A"-framed stand, made of four tapered wooden legs being fixed to the minor seat by means of glue and nails in a butt joint (Figure 4b). The wooden stiles (legs) were fixed to the rails using stopped mortise and tenon joints (Figure 4a). The legs were joined in pairs using zig-zag wire nails in a butt joint. Tenon and mortise joint and butt joint used for assembling component parts were in line with the findings of Walton (2007), who stated appropriate joints for different wooden products. Unit B is made up of a wide board measuring 25 mm x 300 mm x 1000 mm with an elliptical shape at one end and a round shape at the other end. The design of 'A'-framed stand was in congruence

with Denig *et al*. (2015) who found out that the furniture frame gives the structural support and determines the basic shape of the furniture, setting limits upon the final design, establishing stability, and functionality of the product. The identified constructional steps were similar to Utuk and Usoro (2019) who adopted a combination of butt joint and piano hinge ironmongery to aid in the convertibility of furniture to perform multiple functions.

The ladder rungs were innovatively designed to rise progressively from 290 mm, 305 mm to 360 mm for the first, second and third ladder rungs respectively (as shown in Figure 1). This design was in line with Walton (2007) who specified that the ladder rungs should be fixed securely to the posts at the rise of 260 mm to 360 mm, for ease of climbing. Figure 2 shows the tetra-piece furniture in a convertible chair position with a sitting height of 570 mm from the ground level. It has two seats – major seat and minor seat – joined together by means of the piano hinge ironmongery. The major seat measured 25 mm x 230 mm x 300 mm while the minor seat measured 25 mm x 130 mm x 300 mm.

Figure 3 shows the 1st angle orthographic projection (blueprint) of the tetra-piece furniture. The figure shows the front, plan and end elevations of the tetra-piece furniture. The furniture was uniquely designed and constructed in cognizance with the science of ergonometrics, for the comfort of users. The choice of *Brachystegia nigerica,* an indigenous tropical hardwood, had ensured the stability and strength of the product in line with the findings of Etukudo (2003) and Rahmon (2017). The tetra-piece furniture could be placed in three different positions: It could function as a convertible chair in one position; as an ironing board in another position; and as a self-standing ladder and lamp stand in a third position. The adjustable stopper (shown in Figure 1) is a wooden lever used in keeping the tetra-piece furniture in different positions. The use of tetra-piece furniture in a room will make for economy of space, suitable for single room occupiers.

CONCLUSION

Brachystegia nigerica had been used in the design and construction of tetra-piece furniture for effective room-space management in Akwa Ibom State. The science of ergonometrics had been incorporated in the design to ensure safety and comfort in the use of the product. The furniture performs four functions namely; convertible chair, ironing board, self-standing ladder and lamp stand at different positions. The ingenuity in woodwork craftsmanship had ensured efficient utilization of wood and the attendant cost savings. The use of tetra-piece furniture is recommended for effective room-space management in Akwa Ibom State.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations are made:

i. The tetra-piece furniture is particularly recommended for single room occupiers such as spinsters, bachelors and low income earners as it is capable of solving the problem of over-crowding a room facility with many furniture.
ii. The tetra-piece furniture is particularly recommended as an instructional material for teaching life skills in woodwork and basic technology.
iii. The tetra-piece furniture production will make for efficient utilization of wood in the state and the nation at large. Hence, its adoption as a matter of policy will help in the conservation of our forest resources, at the long run.
iv. The tetra-piece furniture could be exported by industrialists/government to other countries for foreign exchange earnings.

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