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Production of Specialty Wood Products from Wood Waste of Selected Timber Species Generated In Furniture Workshops.

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Abstract
Processing of wood waste for specialty wood products (souvenirs) are one of the few value-addition techniques in vertically integrated processing mills. Some wood conversion centres in Nigeria have not embraced further processing of wood waste because of affordability of the technology, cost and returns of processed wood waste. The economic returns on wooden souvenirs recovered from further processing of wood waste from furniture workshop were evaluated. Wood waste of four hardwood species namely Gmelina arborea (Gmelina), Mansonia altissima (Mansonia), Afzelia africana (Apa) and Tectona grandis (Teak) were processed to turned wooden souvenir products namely fruit bowls, ash trays, flower vase. Off-cut of wood strips in quartersawn orientation was glued side-by-side to form a laminated plank to prepare these faces for millwork turning using a Wadkin-Bursgreen lathe model machine. Data on production cost were collated for the various items produced. Parameters evaluated included Average Total Costs (ATC) per unit of turned wood laminate produced as main determinant of production cost, cash flow and Rate of Returns on Investment (RORI). The main determinants of production costs in the industry were glue and labour with values of 72.7 % and 15.8% of the production cost respectively. The RORI was between ranges of 38.9% to 133.3%, while the benefit-cost ratio was 1.90: 1. Laminate is environment-friendly as it uses wood waste in construction and makes more efficient use of the left over wood in wood processing centers.
Key words*: Wood waste, wooden souvenirs, lamination and Saw Mills*

Introduction

The efficiency with which sawnwood are converted into finished products can significantly affect the area of forest needed to satisfy demand. Several studies on log conversion efficiencies in the saw mills processing centre showed that the total volume of solid wood in a typical saw log is less than 35 percent when converted into sawn timber (Badejo and Giwa, 1983, Larinde 2006, Akande et al 2007). The use of inadequate or outdated equipments as well as non-integration of mills also reduces the conversion efficiency of logs to timber (Larinde, 2008).

Substantial gains in the conversion efficiency of sawnwood to finished products could come with the implementation of some relatively simple techniques and technologies primary among these is laminated wood products. The development of new product lines to make use of small pieces of wood could improve efficiency by another 5 percent (ITTO, 2002). The generally poor timber management practices could probably be attributed to low levels of education, limited exposure to suitable technologies and limited technical training of workshop personnel in carpentry and joining practices

(Olorunnisola, 2005). Seremba (2005) noted that only 16% of the carpenters had training in carpentry and processing practices. (Auren and Krassowska, 2004), also observed low levels of education amongst small scale entrepreneurs which include small furniture workshops.

Increased problems of timber availability have caused many wood processing industries, analysts and planners to recognize the importance of wood workshop conversion efficiency. Conversion efficiency not only affects mill profits but is also important on a much broader level. Timber supply issues have caused resource planners and policy makers to consider the effects of conversion efficiency on the utilization and depletion of the timber resource. Improvements in wood workshop conversion efficiency would favorably impact industry profits, and would be equivalent in effects to extending existing supplies of standing timber.

In most workshops shavings, off-cuts and sawdust were either sold or burnt. There is limited utilization of wastes as noted by (Atuhe 2005); improved general recovery of these workshops depends on waste management. Abdullahi (1999) reported that the furniture industry is the most widely distributed of all the wood-based industries in Nigeria and that they represent about 80% of the wood based industries. The implication of this is that a lot of wood off-cut are generated on daily basis which are not converted into utilizable or value added products. Many marketable items can be fashioned from off-cuts of sawnwood or from laminated wood of different species that have unique colour. Laminated wood is in very high demand within decorative wood markets. Lamination occurs when some sawn hardwoods, notably mahogany, mansonia, Red Apa, Gmelina and other with distinct colours glued together, and these laminates create a very decorative appearance. Wood that would not even have made good firewood can become a valuable piece to when laminated. The possibilities for decorative wood products are limited only by imagination and ingenuity. Nish (1980) noted that some of the largest markets are for musical instruments, decorative boxes such as jewelry boxes, and wood turning materials for artists, sculptors, and crafts persons. Tabletops, table and floor lamps, table legs, candleholders, ashtrays, bowls, platters, vases, plaques, centerpieces, planter, carved animals and birds, matchbox holders, key holders, note pad or napkin holders, Christmas ornaments, and religious figures are all made from decorative woods. The main objective of this study, therefore, was to determine the economic return of converting this so called waste into laminated wood turned souvenirs.

Materials and Methods

Strips of off-cuts of the four selected wood species namely *Gmelina arborea* (Gmelina), *Mansonia altissima* (Mansonia), *Afzelia africana (*Apa*) and Tectona grandis* (Teak) of predetermined length and width depending on object to be produced were glued together with powdered phenol-formaldehyde resin at two laminate dimension levels and four species combination levels. The laminates were further held in firm position with the aid of Iron clamp for 48hours. The samples were later transfer to the lathe machine (Wadkin-Bursgreen model) where they were rotated against hand held chisel and cut into desired forms and shapes. On getting the desired form, the products were also rotated against sharp and smooth sanding to achieve a smooth finish surface prior to spraying.

Data Analysis

The techniques used in analyzing the data were economic valuation analytical tools such as profitability analysis and cost benefit analysis.

The profit was determined using the formula;

$$Profit = TR - TC \quad \text{---------- (1)}$$

The profitability of the enterprise was determined through the rate of returns on investment (RORI). The formula is represented by;

$$RORI = \frac{TR - TC}{TC} \times \frac{100}{1} \quad \text{---------- (2)}$$

Where: TR= Total Revenue

TC= Total cost

$$B/C = \frac{\sum_{t=0}^{i-n} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{i-n} \frac{C_t}{(1+r)^t}} \quad \text{---------- (3)}$$

Where B = Benefit, C = Cost, t = time, r= interest rate, n=number of years = 1year, i= discount rate= 14%.

Results and Discussion

Lamination is the joining of two or more short sticks or boards' side-to-side to form a block or wider one resulting in less waste and better material utilization. The pieces are joined and glued side-by-side by adhesives (Plate 1b). Any piece five inches or longer can be used. To quickly cure glued sides iron clam are used to increase the speed of the curing and improve the quality of the laminate. Curing is the solidification of the glue and must start after assemblage and be complete before the assembly is removed from the press and the rectangular wood is subjected to lathe turning stress. Machining, or

sometimes called turning shapes the rectangular strips produced by the rough side laminating into the finished dimensions specified for the end products (Plate 1c). Sanding which follows is basically rubbing the wood with an abrasive to smooth or prepare the surface for subsequent finishing or coating steps. Sanding can be done by hand or with sanding machinery. Sanding can take place on the lathe machine before removal, or take place during finishing in between coating steps. Colour matching is an important factor in laminated wood products where clear coating as the final finish is required (Plate 1d) but if the finished product will take dark stain or painted then color matching will not be a problem.

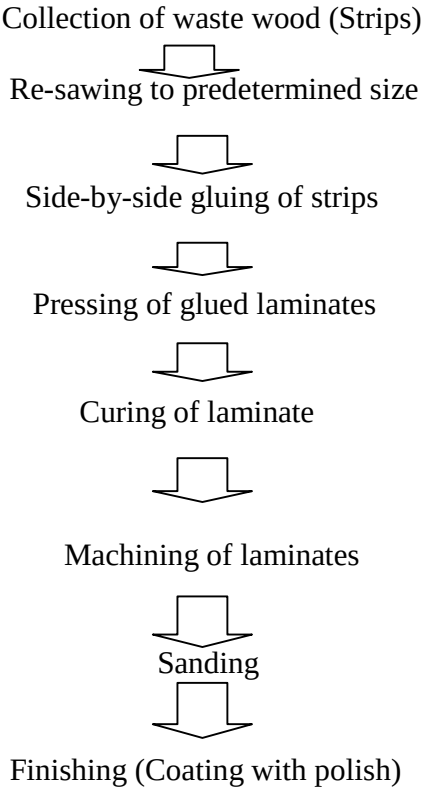

Figure 1: Production Flow Chart

The profitability of the enterprise determined through the rate of returns on investment as shown in Table 1 showed that the profitability of the laminated wood products ranges from 38.9% to 133.3% while the benefit-cost ratio is 1.90: 1 (Table 2), indicating that it is worthwhile. Ogunsanwo *et. al* (2007) while studying production of wood souvenirs

from purchased wood raw material observed a benefit-cost ratio of 1.87:1. The higher benefit-cost ratio from this study could be as a result of wood waste raw materials that were utilized at zero wood raw material and transportation cost.

Table 1: Rate of Return on production and Sales of Turned Laminated wood souvenirs

PRODUCT	UNIT	COST (₦)	REVENUE (₦)	MARGIN (₦)	RORI (%)
Flower vase	1	300	750	450	133.3
Fruit bowl	1	700	1200	500	71.4
Ash tray	1	180	250	70	38.9
Pen case	1	200	500	300	75
Serving Plate	1	250	400	150	60
Total		1,630	3,100	1,470	

Table 2: Benefit-cost Analysis

Total Revenue	Discounted revenue	Total Cost	Discounted cost	Benefit-cost ratio
₦ 3,100	₦ 2,719.32	₦ 1,630	₦ 1,429.83	1.90:1

Conclusion

In estimating production cost for forest products the main variable to be taken into account, as in the case of all other forest based industry, is wood raw material. However, in the case of laminated wood products from furniture industries off-cuts, wood is relatively free whereas wood raw material accounts for a very large part of inputs. The laminated wooden products waste utilization opportunities provides an economic avenue that can reduce costs in wood workshops and also prevent the pollution of our environment. It reduce costs by conserving raw materials, minimizing waste volume, meeting the public's growing desire for environmentally-responsible products made by environmentally-responsible processes. Laminated wood products also provide the opportunity to extend production line in furniture workshops with available equipments such as lathe turning machines, clamp and sanders. The

lamination process can provide significant increases in material utilization, and thus less wood waste in a typical wood workshop.

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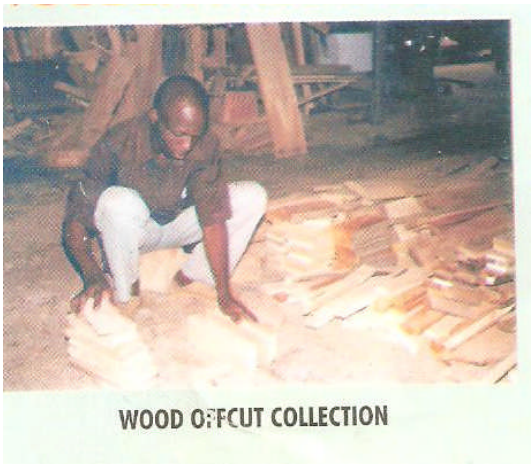

Plate 1a

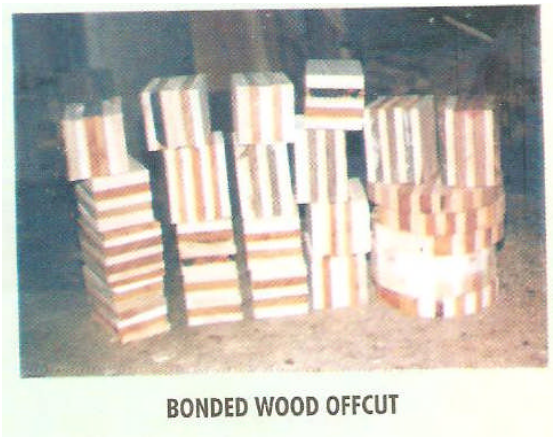

Plate 1b

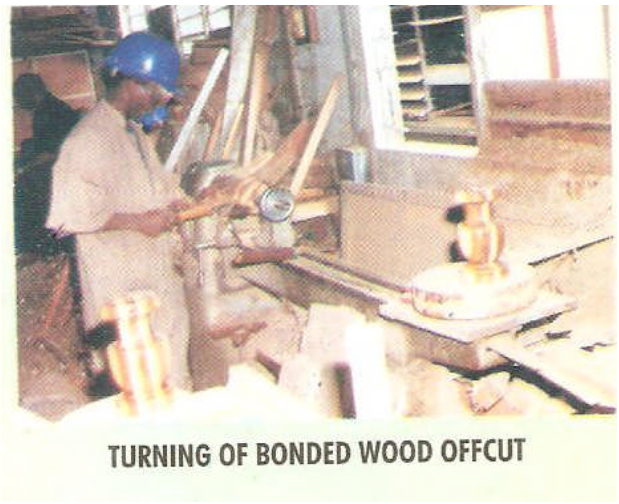

Plate 1c

Plate 1d