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**Economic and Environmental Evaluation of Wood-
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in Port Harcourt, Nigeria**

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ECONOMIC AND ENVIRONMENTAL EVALUATION OF WOOD-BASED ENTERPRISES AT A CLUSTERED-SAWMILL IN PORT HARCOURT, NIGERIA

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ABSTRACT: The Econo-environmental aspects of wood-based enterprises (WBEs) around the wood processing mill are crucial to the sustainability of the enterprises. Using a retrospective design, a total of 108 WBEs units around Illoabuchi sawmill, Port Harcourt were analyzed by economic tools: cost-benefit analysis (CBA), Rate of Return on Investment (RORI), sensitivity analysis (SA), and a SWOT (strengths, weaknesses, opportunities, and threats) modeling approach. The WBEs studied were classified into two output categories: wood output enterprises [including furniture making (71.3%), firewood selling (20.4%), carving (4.6%)], and non-wood output enterprises [fish smoking (3.7%)]. The economic analysis results for five consecutive years (2012-2016) showed that all the enterprises have been profitable at a discounted rate of 14%, however for them to remain viable, the SA on RORI for fish smoking, firewood, furniture, and wood-carving must not exceed 40%, 80%, 80% and 160% increase in the cost of production, respectively. Chi-square statistics showed origin ($\chi^2= 6.936, \alpha_{0.031}$), name ($\chi^2= 8.392, \alpha_{0.039}$), and class ($\chi^2= 7.129, \alpha_{0.008}$) of entrepreneurs as significant factors associated with reduced timber supply. The major weaknesses of the resource area included irregular downpours of yearly rainfall, an unimproved working environment, and an irregular supply of public electric power. The major threats to the development of enterprises from the study were; inadequate lumber supplies, unsafe behaviours, and high rent of land space. Policies and actions to address these weaknesses and threats, and turn them into strengths and opportunities, respectively are advised to ensure the sustainability of the enterprises.

Key words: Wood, Enterprises, Economic tools, SWOT Analysis, Cluster-sawmill

1. INTRODUCTION

Globally, the wood-based enterprises (WBEs) have grown quite wide and they consist not only of those that harvest the forests, cut, size the logs or build homes, but also of those that turn the wood into parts ready for assemblage, into the finished home, business products, and art (Food and Agriculture Organization (FAO), 1982; Arnold *et al.*, 1987; Rosenfeld, 2004; Acharya and

Acharya, 2006; Humphries *et al.*, 2012; Ekhuemelo *et al.*, 2014; Lopes and de Azevedo, 2014; Hurmekoski *et al.*, 2018). Sawmill is a critical contributor to WBEs development worldwide including Nigeria. Aside creating primary jobs, the Nigerian sawmilling industry is an essential actor for WBEs through the provision of input(s) for a diverse of enterprises development (Ogunwusi, 2012). Currently, while the consumption shift exists, solid wood still remains one of the basic

structural materials/products of everyday use. Around the primary conversion sites (sawmills), the increasing uses of sawn wood *in-situ* are evident from an ever-burgeoning list of enterprises related utilities.

The Illoabuchi cluster-sawmill established in 1987 is the only conventional wood processing system in Port Harcourt (Adedeji *et al.*, 2016) and has been providing several benefits for different categories of people (Oladele and Ikedionu, 2021). However, the economic and environmental evaluation of wood-based enterprises (WBEs) stemming from sawmills to assess the sustainability of on-site enterprises' development has not been fully explored in Nigeria. The published literature around sawmills in this part of the world includes studies that focused primarily on negative impacts of sawmilling on human health (Oguntoke *et al.*, 2013; Okedere *et al.*, 2017), socio-economic impacts on residents (Olawuni and Okunola, 2014), and technical efficiency of sawmills (Egbewole *et al.*, 2011; Olufemi *et al.*, 2012; Ohwo *et al.*, 2018).

The economic and environmental data necessary to make a useful decision that can determine the sustainability of WBEs are inadequate, particularly in the Niger Delta, Southern part of Nigeria where nearly 100% of the dependent natural forests are owned and managed by private individuals (landowners). While economic development is often associated with increasing consumptions of environmental resources, WBEs are much of environmental concerns. Economic and environmental evaluations in forestry are based on standard profitability and sustainability assessment tools (Karvonen *et al.*, 2017; Zamula *et al.*, 2020). In such evaluations; cost, revenue, and profit are the three principal determinants of the success of the enterprise development, and the sustainability of the enterprise predominantly depends on the internal and external environmental factors (Karvonen *et al.*, 2017). Several economic and environmental methods are being used to evaluate the sustainability of the economic benefits generated by forest-based enterprises. The most suitable and prominent of these methods which can ensure the sustainability of the economic benefits secured from WBEs development is demonstrated in this article by the use of cost-benefit analysis (CBA), Rate of Return on Investment (RORI), sensitivity analysis (SA), and a SWOT (strengths, weaknesses, opportunities, and threats) modeling approach. Combined financial evaluation and SWOT analysis can provide invaluable and comparable insights into the value of potential enterprises and products as to whether to continue to produce or terminate the enterprises (Schoukroun-Barnes *et al.*, 2019).

2. METHODOLOGY

2.1 The Study Site

Illoabuchi cluster-sawmill (4° 47' 17'' - 4° 47' 23''N, 6° 59' 08'' - 6° 59' 19''E) with 12 functional primary wood conversion machines (CD-6 machines) is located on a land area covering over 2.5 hectares in Port Harcourt of Rivers State, Niger Delta, Nigeria. The site was established in 1987 with 3 CD-6 machines but started full operations in 1989. In 1988, the CD-6 machines increased from 5 to 21 in 2006, and have decreased to 12 in 2017 when this study was conducted. The site is an important business hotspot in Rivers State jointly owned by the community and private individuals. Mgbodara River was channeled to the site for transportation of logs and artisanally sawn wood (Adedeji *et al.*, 2016). The site has functioned as an industrial wood-based market since its establishment in 1987 supplying lumbers to scales of users with multiplying effects of several WBEs including their appendages around the area. The mean annual rainfall in the area is above 2500mm (Eludoyin *et al.*, 2015). The vegetation types of the area are moist/swamp tropical forests and mangroves. The soils in the area are a mixture of whitish brown sand and brownish clay. The dominant wood species in the area include; *Alstonia boonei*, *Khaya grandifoliola*, *Mitragyna ciliata*, *Terminalia ivorensis*, *Terminalia superba*, and *Rhizophora racemosa*.

2.2 Study Design and Data Collection

A retrospective design was used to sample the respondents and information is collected regarding the sustainability of the economic benefits obtained from WBEs development for the consecutive past five years (2012-2016). This study targeted all WBEs that utilized paid wood as parts of their inputs, whether the output is wood-based or not. The pretesting of questionnaires and data collection were carried out between February and August, 2017. The WBEs that met the study inclusion requirements were 108 units. In addition to personal on-site observations, data on resource base area regarding the establishment and trend of the logs supplies and processing were obtained from the General Manager of the mill.

2.3 Statistical Analyses

The WBEs were categorized into two classes as 1) wood-output enterprises, and 2) non-wood-output enterprises using the input-output method (Mattila *et al.*, 2011). The profitability of the WBEs for the 5-year period (2012-2016) was estimated using three economic tools: CBA, RORI, and SA and the discount rate used was 14% - being the interest rate for agricultural loans in Nigeria

(Larinde and Santus, 2014) as at when the study was conducted. The equations for estimation of CBA and RORI are presented in Equations 1 and 2, respectively.

$$CBA = \frac{\sum_{t=0}^{t=n} \frac{R_t}{(1+r)^t}}{\sum_{t=0}^{t=n} \frac{C_t}{(1+r)^t}} \quad (1)$$

Where;

B/C	=	benefit-cost ratio
R_t	=	revenue over time t
C_t	=	cost over time t
r	=	discount rate
l	=	constant
t	=	Number of years

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

Where;

TR	=	Total Revenue
TC	=	Total Cost

A sensitivity analysis was conducted to assess the uncertainty of the WBEs towards the increasing and decreasing cost of production by 20% while other variables remained constant according to the procedure of Ji *et al.* (2018). Furthermore, Chi-square statistics were performed to test the strengths of association between entrepreneurs' demographics and awareness about the effects of their enterprises on log supply. A *p*-value of 0.05 was chosen as a significant level and the software IBM SPSS version 23 was used for the analyses. Finally, the environmental indicators for clarifying the sustainability of WBEs were analyzed using the SWOT model.

3. RESULTS

3.1 Classes of WBEs

The classes of the 108 WBEs units studied were outlined in Table 1. The proportion of wood-output enterprise units is greatly higher than non-wood-output enterprise ones in the ratio of 26:1. Furniture making (FM) as a set of the subclass of wood-output enterprise dominated the WBEs followed by wood carving (WC), fire-wood selling (FWS), and fish smoking (FS). *Rhizophora racemosa* (Ngala) was the sole fuel marketing wood species. *Khaya grandifoliola*, *Milicia excelsa*, *Brachystegia eurycoma*, and *Lovoa trichilioides* were reported to be the desirable wood species by the furniture makers and wood-carvers. The scarcity of *Brachystegia eurycoma*, *Lovoa trichilioides*, and *Milicia excelsa* was reported and the introduction of lesser-known wood species locally called "Cross" (or Apumini Ikwerre Language) – the scientific name (yet to be identified) was evident.

3.2 Demographics of Entrepreneurs

Among the entrepreneurs, 63.9% were migrants from States sharing boundaries with Rivers State, where the study was carried out followed by 22.2% being natives of Rivers State, and 13.9% migrants whose States are not sharing boundaries with Rivers State. With respect to gender, more than three-fourth (78.7%) of the respondents were male, and about one-fifth (21.3%) of them are female. Regarding the age, 73.1% of the entrepreneurs are within the more active age group followed by 25.9% within the active age group, and 0.9% within the exiting (retiring) age group. As for educational attainment, 63.9% of the entrepreneurs obtained a Secondary school certificate followed by 28.7% obtaining a Primary school certificate, 5.6% obtaining no formal education certificate, and 1.9% obtained a tertiary institution certificate. With reference to marital status, 77.8% of the entrepreneurs are married followed by 20.4% being single, and 1.9% being widows. As for family size, 46.3% of the entrepreneurs have a medium family size followed by 27.8% having the highest and 25.9% having the lowest family size. In respect of entrepreneurship experience, 31.5% of the entrepreneurs have medium entrepreneurship years followed by 27.8% having lower medium entrepreneurship years, 21.3% having upper-medium entrepreneurship years, 13.0% have lowest entrepreneurship years, and 6.5% have highest entrepreneurship years (Table 2).

3.3 Profitability of WBEs

Table 3 shows the costs, benefits, and profits of WBEs for the 5-year period (2012-2016) with no response for 2012 and 2013 from entrepreneurs selling smoked fish. Benefit/cost ratio, WC had the highest ratio followed by FWS, FM, and FS (Table 4). As regards RORI, WC enterprise had the highest percentage followed by FM, FWS, and FS (Table 4). In respect of sensitivity analysis, results indicated that at an increasing cost of 20-40%, all the enterprises were profitable. FM and WC remained profitable until cost increased beyond 80%. The WC enterprise, however, remained profitable up to 160% increased cost of production (Table 5). At 20% and 40% decrease in revenue, all enterprises remained viable except for FS that became very sensitive when the revenue decreased beyond 20% but wood carving remained profitable up to a 60% decrease in revenue (Table 6). Hence, for FS, FWS, FM, and WC enterprises to remain profitable, the increasing cost must not exceed 40%, 80%, 80%, and 160%, respectively (Table 5), and decreasing revenue must not exceed 20%, 40%, 40%, and 60%, respectively (Table 6).

Table 1: Classes of WBEs

Broad Classes of Enterprises	Sub-classes	Frequency	Percentage (%)
Wood-output enterprises	FM	77	71.3
	FWS	22	20.4
	WC	5	4.6
	Sub-total	104	96.3
Non-wood-output enterprise(s)	FS	4	3.7
	Sub-total	4	3.7
Total		108	100

Table 2: Demographics of entrepreneurs

Demographic variables		Frequency	Percentage (%)
Origin	Native	24	22.2
	Near Migrant	69	63.9
	Far Migrant	15	13.9
	Total	108	100
Gender	Male	85	78.7
	Female	23	21.3
	Total	108	100
Age	18-23	0	0
	24-45 years	79	73.1
	46-65 years	28	25.9
	66 and above	1	0.9
	Total	108	100
Educational attainment	Non-formal	6	5.6
	Primary Sch. Cert.	31	28.7
	Secondary Sch. Cert.	69	63.9
	Tertiary Inst. Cert.	2	1.9
	Total	108	100
Marital Status	Married	84	77.8
	Single	22	20.4
	Widowhood	2	1.9
	Total	108	100
Family Size	1-2	28	25.9
	3-5	50	46.3
	6-10	30	27.8
	Total	108	100
Entrepreneurship years	1-5 years	14	13.0
	6-10 years	30	27.8
	11-15 years	34	31.5
	16-20 years	23	21.3
	20 and above	7	6.5
	Total	108	100

Table 3: Cost and Benefit of WBEs for the 5-year period (2012-2016)

Year	FM			WC			FWS			FS		
	Cost (₦)	Benefit (₦)	Profit (₦)	Cost (₦)	Benefit (₦)	Profit (₦)	Cost (₦)	Benefit (₦)	Profit (₦)	Cost (₦)	Benefit (₦)	Profit (₦)
2012	502859.15	951704.23	448845.08	676000	2021800	1345800	231176.47	468882.35	237705.9	0	0	0
2013	497310.81	915398.65	418087.84	673200	1981000	1307800	225222.22	456000	230777.8	0	0	0
2014	496414.47	870210.53	373796.06	667400	1763800	1096400	221850	422600	200750	461000	689000	228000
2015	243138.16	552907.89	309769.73	663200	1650200	987000	217590.91	391318.18	173727.3	445666.67	688666.67	243000
2016	292690.79	621506.58	328815.79	635500	1361600	726100	213727.27	368886.36	155159.1	416763.33	620500	203736.67
Total	2032413.4	3911727.9	1879314.5	3315300	8778400	5463100	1109566.9	2107686.9	998120	1323430	1998166.7	674736.67

Table 4: Benefit Cost Ratio and Rate of Return on Investment of WBEs

Enterprises	Total Discounted Cost (₦)	Total Discounted Benefit (₦)	Benefit/Cost Ratio	RORI (%)
FM	1454363.566	2775861.666	1.91	92.47
WC	2283476.7	6170661.4	2.70	164.78
FWS	765424.6732	1470241.205	1.92	89.96
FS	1172340.67	1770125.17	1.51	50.98

Table 5: Sensitivity Analysis on RORI at Increasing Cost of WBEs

Enterprises	RORI	Sensitivity Analysis of RORI (Increasing Cost)							
		20%	40%	60%	80%	100%	120%	140%	160%
FM	92.47	60.39	37.48	20.30	6.93				
WC	164.78	120.65	89.13	65.49	47.10	32.39	20.36	10.33	1.84
FWS	89.96	58.30	35.68	18.72	5.53				
FS	50.98	25.82	7.85						

Table 6: Sensitivity Analysis on RORI at Decreasing Revenue of WBEs

Enterprises	RORI	Sensitivity Analysis of RORI (Decreasing Revenue)		
		20%	40%	60%
FM	92.47	53.97	15.50	
WC	164.78	111.83	58.87	5.91
FWS	89.96	51.96	13.97	
FS	50.98	20.79	-9.41	

3.4 Socioeconomic Impacts of WBEs

As contained in Table 7, 77.8% of the entrepreneurs have people that depend on them while 22.2% of the entrepreneurs have no dependents. Around four-fifths (84.3%) of the entrepreneurs claimed to have savings and less than one-fifth (15.7%) of the entrepreneurs have no savings. About three-fifths (57.4%) of the entrepreneurs belonged to an association in the strength of 55 members, 2 Public Relation Officer (PRO), 1 President, 1 Treasurer, and 1 Secretary. The membership requirement is fifty thousand naira (₦50,000). All the members indicated that they enjoyed social benefits such as financial contribution support for naming and burial ceremonies and sometimes external market opportunities. Almost all (96.3%) the entrepreneurs are sole proprietors with 1.9% being in a partnership and 1.9% of the entrepreneurs declared not their enterprises'

ownership. Slightly above four-fifths (83.3%) of the entrepreneurs run their enterprises through the personal savings from the sales of their products followed by 8.3% of them obtaining loans with no interests from friends/relatives, and 7.4% obtaining running costs from other sources with interests. About four-fifths (80.6%) of the entrepreneurs sustain themselves only through earnings from their enterprises while 15.7% of the entrepreneurs have an additional source of income, and 3.7% of the entrepreneurs did not declare whether they have other sources of income or not. Of the 108 entrepreneurs, 57.4% are working alone without apprentices or paid workers while the rest (42.6%) have 158 people working with them of which 50 persons are paid workers (Table 7).

Table 7: Socio-economic impacts of WBEs

Socio-economic Background		Frequency	Percentage
Other dependents	Yes	84	77.8
	No	24	22.2
	Total	108	100
Do you have savings?	Yes	91	84.3
	No	17	15.7
	Total	108	100
Do you belong to any association?	Yes	62	57.4
	No	46	42.6
	Total	108	100
Capacity in association	Member	57	91.9
	President	1	1.6
	P.R.O.	2	3.2
	Treasurer	1	1.6
	Secretary	1	1.6
	Total	62	100
Benefits derived from association	Social benefits	62	100
	Market opportunities	62	100
	Total	62	100

Figures in parenthesis ‘()’ signifies total number of workers including the entrepreneurs while figures in brackets ‘[]’ signifies number of paid workers excluding the entrepreneurs.

Table 7: Cont'd.

Socio-economic Background		Frequency	Percentage
Enterprise ownership	Sole proprietorship	104	96.3
	Partnership	2	1.9
	No response	2	1.9
	Total	108	100
Source of investment capital	Gift	1	0.9
	Personal savings	90	83.3
	Loan from friends/relatives	9	8.3
	Others	8	7.4
	Total	108	100
Do you have other source of income?	Yes	17	15.7
	No	87	80.6
	No response	4	3.7
	Total	108	100
Number of workers	1	10 (20)	9.3
	2	18 (54)	16.7
	3	9 (36)	8.3
	4	6 (30)	5.6
	5	3 (18)	2.8
	Entrepreneurs alone	62 (62)	57.4
	Total	108 (220)	100
	Number of paid workers	1	10 [10]
2		12 [24]	44.4
3		4 [12]	14.8
4		1 [4]	3.7
Total		27 [50]	100

Figures in parenthesis ‘()’ signifies total number of workers including the entrepreneurs while figures in brackets ‘[]’ signifies number of paid workers excluding the entrepreneurs.

3.5 Environmental Indicators of WBEs Sustainability

Out of the 108 entrepreneurs, 103 representing 95.4% perceived the effect of their enterprises in the reduction of logs supply. Although, 78.6% of them indicated “yes”, however, only origin, names and classes of the enterprises showed significant association with the perceived effect of the enterprises in the reduction of logs

supply to the cluster sawmill (Table 8). The five major weaknesses of the timber base area which can hinder the adequate availability of wood for on-site WBEs sustainability are outlined against their strengths (Table 9). Similarly, the threats that could pose risks to the sustainability of on-site WBEs were listed against the opportunities that have opened to entrepreneurs (Table 9).

Table 8: Test of associations between entrepreneurs’ demographics and perceive effect of enterprises in the reduction logs supply

Respondent Background		Do you perceive the effect of your enterprise in the reduction of log supply?		Total	Chi Square Statistics
		Yes (%)	No (%)		
Origin	Native	22 (21.4)	1 (1.0)	23 (22.3)	$\chi^2 = 6.936$ df = 2 $\alpha_{0.031^*}$
	Near Migrant	46 (44.7)	19 (18.4)	65 (63.2)	
	Far Migrant	13 (12.6)	2 (1.9)	15 (14.6)	
	Total	81 (78.6)	22 (21.4)	103 (100)	
Gender	Male	66 (64.1)	14 (13.6)	80 (77.7)	$\chi^2 = 3.177$ df = 1 $\alpha_{0.075}$
	Female	15 (14.6)	8 (7.8)	23 (22.3)	
	Total	81 (78.6)	22 (21.4)	103 (100)	
Age	24-45	59 (57.3)	15 (14.6)	74 (71.8)	$\chi^2 = 0.545$ df = 2 $\alpha_{0.762}$
	46-65	21 (20.4)	7 (6.8)	28 (27.2)	
	66 and above	1 (1.0)	0 (0.0)	1 (1.0)	
	Total	81 (78.6)	22 (21.4)	103 (100)	

Table 8: Cont'd

Respondent Background		Do you perceive the effect of your enterprise in the reduction of log supply?		Total	Chi Square Statistics
		Yes (%)	No (%)		
Educational Qualification	Non-Formal	4 (3.9)	2 (1.9)	6 (5.8)	$\chi^2 = 6.766$ df = 3 $\alpha_{0.080}$
	Primary	20 (19.4)	11 (10.7)	31 (30.1)	
	Secondary	55 (53.4)	9 (8.7)	64 (62.1)	
	Tertiary	2 (1.9)	0 (0.0)	2 (1.9)	
	Total	81 (78.6)	22 (21.4)	103 (100)	
Marital Status	Married	61 (59.2)	19 (18.4)	80 (77.7)	$\chi^2 = 3.000$ df = 2 $\alpha_{0.223}$
	Single	19 (18.4)	2 (1.9)	21 (20.4)	
	Widowhood	1 (1.0)	1 (1.0)	2 (1.9)	
	Total	81 (78.6)	22 (21.4)	103 (100)	
Family Size	1-2	23 (22.3)	3 (2.9)	26 (25.2)	$\chi^2 = 2.005$ df = 2 $\alpha_{0.367}$
	3-5	36 (35.0)	12 (11.7)	48 (46.6)	
	6-10	22 (21.4)	7 (6.8)	29 (28.2)	
	Total	81 (78.6)	22 (21.4)	103 (100)	
Name of Enterprise	FM	58 (56.3)	14 (13.6)	72 (69.9)	$\chi^2 = 8.392$ df = 3 $\alpha_{0.039^*}$
	WC	5 (4.9)	0 (0.0)	5 (4.9)	
	FWS	17 (16.5)	5 (4.9)	22 (21.4)	
	FS	1 (1.0)	3 (2.9)	4 (3.9)	
	Total	81 (78.6)	22 (21.4)	103 (100)	
Class of Enterprise	Wood-output enterprises	80 (77.7)	19 (18.4)	99 (96.1)	$\chi^2 = 7.129$ df = 1 $\alpha_{0.008^*}$
	Non-wood-output enterprise	1 (1.0)	3 (2.9)	4 (3.9)	
	Total	81 (78.6)	22 (21.4)	103 (100)	

Table 9: SWOT analyses on WBEs development

Strengths	Weaknesses
1. Availability of floatable river.	1. Non regular down pour of rainfall throughout the year and longer period of logs arrival.
2. Availability of cheap human labour.	2. Unimproved working environment, scarcity of mill spare parts.
3. Sited in Capital city.	3. Irregular supply of electric power.
4. Availability of good roads leading to the resource base.	4. The roads are few and narrow.
5. A good centre of attraction for businesses, education and research.	5. Unwelcoming behaviour of the community, and reduction and depreciation of facilities.
Opportunities	Threats
1. Availability of desirable wood species.	1. Inconsistence of wood supplies.
2. Availability and affordability of tools.	2. Unsafe behaviour.
3. Access to adequate space.	3. Land developmental issues and high rent.
4. Locally available markets.	4. Management challenges.
5. Social benefits.	5. High membership acceptance fee.

4. DISCUSSION

4.1 Classes of WBEs

The Illoabuchi Cluster-mills provide inputs (wood) that benefit several on-site enterprises' development. While wood is integral to the development of numerous enterprises worldwide, the systematic classifications of WBEs in the scientific literature (FAO, 1982; Arnold *et*

al., 1987; Rosenfeld, 2004; Acharya and Acharya, 2006; Humphries *et al.*, 2012; Ekhuemelo *et al.*, 2014; Lopes and de Azevedo, 2014; Hurmekoski *et al.*, 2018; Armir *et al.*, 2020) have neglected some WBEs (such as fish smoking, meat marketing) whose development and sustainability have been dependent on wood as major input but their outputs are not wood-based. In general, the method of classifying WBEs revealed FM dominance. The results were not unexpected as the furniture makers

were found spending each day making chairs, tables, beds, cabinets, upholsteries, doors and frames, windows and frames probably for ever-increasing housing, schooling, and other industrial markets. These results are supported by Fisseha (1987) who converged to similar findings in Honduras and Sierra Leone. Wooden furniture has been reported as the largest and widely distributed enterprise in Nigeria (Alao and Kuje, 2012), which was reaffirmed in this study. The *Rhizophora racemosa*, wood locally known as “Ngala” (meaning strength) was the popular species of trade for fuel. This species was highly valued and sought after by fish smokers in the midst of abundant sizable wood wastes of other species utilized as fuel at no cost by other users. The high demand in spite of the availability of other species at free cost ensures the regular supply of *R. racemosa* for marketing. The display of *R. racemosa* wood (in the round and split forms) as only commercial fuel indicated its outstanding superior quality thus corroborating the report of Ihinmikaye *et al.* (2019) that *R. racemosa* was among the highly preferred fuel botanicals at neighbouring State, Bayelsa, Niger Delta, Nigeria. Long ago, wood carving has advanced from cultural activity to highly rewarding economic practices in western and eastern parts of Nigeria (Oloidi, 2014; Oyinloye, 2017) but however, in this study the proportion is small. This could be explained by the specialty nature of carving and/or the low demand for the products locally. For non-wood-output enterprise(s), fish smoking was the only qualified enterprise in this study. While other fire-wood consuming activities utilised free wood wastes as energy, fish smokers majorly preferred payment for *R. racemosa* wood. The fish smokers expressed slow quality burn, quality embers that can be quenched and reused, adding appealing value to the products (smoked fishes), and little influence of weathering on its utilisation as the outstanding attributes for the choice of *R. racemosa* wood. This result is in tandem with the findings of George *et al.*, (2014) who reported that fish smoke-dried with hardwood have desirable eaten value, flavour, and appealing features that attract buyers in Lagos State, Nigeria.

4.2 Demographics of Entrepreneurs

Nigeria being situated on diverse forest zones among other natural resources, indigenous education of Nigerian groups has inculcated in people, the skills and knowledge about the utilisation of the local natural resources including forests and its derivatives for their livelihoods. Over time, different ethnic groups tend to be adapted to the resources available in their environments, which differ substantially across communities (Aldrich and Waldinger, 1990). Native people are born and live close to natural water bodies, and thus practicing crafts, boats, canoes, gears, etc. for fishing are evident. Two of the

major factors contributing to the migration of people globally are employment and career development (Castelli, 2018). The results clearly indicated that the migrants from neighbouring States are the group of entrepreneurs largely engaging in WBEs in Port Harcourt. The results imply that these migrants’ livelihood is intimately linked with the forests. Migrants are predominantly from timber areas and their influx to practice activities related to wood utilisation can be explained by the availability of timber resources and markets for WBEs products in Port Harcourt. Age is closely associated with productivity (Boring and Groggaard, 2021), adaptation, and innovation potential, and the peak productivity for working humans occurs in the age group 34-44 years (Skirbekk 2008). The results on age groups found in this study indicated that a greater percentage of entrepreneurs (73.1% in Table 1) are around their peak productivity. Many WBEs are gender-specific in Nigeria especially furniture making (Adedokun *et al.*, 2012; Ekhuemelo *et al.*, 2017) and the high proportion of males in WBEs reflects the huge units of furniture makers. The small fraction of females is mostly made up of fish smokers and firewood dealers. Though formal education has not been one of the criteria for successful entrepreneurial training of WBEs in Nigeria, the high number of entrepreneurs having secondary education may be an added advantage in this era of e-transaction. All of the entrepreneurs could speak Pidgin English and expressed high numeracy potentials including those that did not receive formal schooling education. While marriage life comes with more responsibilities than singlehood, the economic ventures that could sustain family responsibility are assumed to be dominated by married people. The high proportion of the married men found in this study is an indication that their engagements in WBEs are gainful and deemed to improve social-economic standards. Similar findings have been reported by Aroso *et al.* (2016) that a high proportion of married men engage in furniture enterprises in Ibadan, Nigeria. The family size of the entrepreneurs may not only have an implication on the number of household members supported by the income from WBEs but the study has revealed the availability of family members (n, 21) for the WBEs entrepreneurship. According to Skirbekk (2008), aging is positively associated with manual dexterity (up to 44 years), experience and managerial ability (till retirement age, 65 years). Hence, the results on the years of entrepreneurship revealed the high mixed potentials of entrepreneurs’ manual dexterity, experience and managerial ability.

4.3 Profitability of WBEs

The CBA ratios of the WBEs are all greater than 1.5 with RORI ranging from 50.98% to 164.78%, implying that

all the WBEs have highly passed the test of economic performance (viability). The high economic viabilities found in this study have a direct effect on the on-site productivity since it is a proxy for wood production, which removes the cost of transportation from production costs. SA results revealed WC as a very responsive and most viable enterprise followed by FM, FWS, and FS. Therefore, for FS, FWS, FM, and WC enterprises to remain profitable, the increasing cost must not exceed 40%, 80%, 80%, and 160%, respectively and decreasing revenue must not exceed 20%, 40%, 40%, and 60%, respectively. These results agree with those previously reported by Ogunsanwo *et al.* (2007), who analyzed the economic performance of wood carving, but superior to market rates of returns reported by Larinde and Popoola (2014), and Adedokun (2018) who analyzed the economic performance of furniture making and wood carving, respectively in the Western part of Nigeria.

4.4 Socioeconomic Impacts of WBEs

The high proportion of the entrepreneurs who have people depending on them was revealed in Table 2 through their marital status including some singles catering for relatives. The important explanation for this is that WBEs have constituted primary regular cash income and account for a significant proportion of cash income for entrepreneurs in the Illoabuchi cluster-mill Port Harcourt. The sole reliance on WBEs for cash income they earned through their enterprises by over eighty percent of entrepreneurs, several of them having savings to sustain the enterprises, and some of them paying salaries to workers are a further confirmation that WBEs in Port Harcourt are highly profitable. As small/medium scale enterprises, the financial requirements for development and running costs being sourced mostly by personal savings justified the sole proprietorship of nearly all the WBEs. The voluntary association has benefited (social benefits and marketing opportunities) more than half of the entrepreneurs who willingly registered with a fee. To sum up, the socioeconomic analyses have shown that WBEs are significant for creation of employment and sustaining the livelihood of many city people. This could be related to the development of WBEs on the market with availability of inputs followed by a growing increase in economic indicators. This confirms the report of Arnold (1994), who reported that small-scale enterprises employ a minimum of 5 workers and a maximum of 50.

4.5 Environmental Indicators of WBEs Sustainability

The growing of WBEs solely on the natural forest is facing some weaknesses and threats, thus requiring the initiation of new strategies to sustain the development of the enterprises and commercial forestry interests. As

WBEs have heterogeneous wood preferences for development, results have shown that some socio-economic factors are associated with the perceived effect of the enterprises in the reduction of logs supplied to the cluster sawmill, consequently resulting in inadequate production of desirable wood. Classes of the enterprises exhibited significantly strongest associations followed by origin, and names of the enterprises. While woodcarvers are the worst hit (Table 8), the implication of these results is that most entrepreneurs are highly aware of the environmental factor that can hinder the sustainable development of their enterprises. They expressed the scarcity of some wood species such as *Brachystegia eurycoma*, *Lovoa trichilioides*, and *Milicia excelsa* and the introduction of lesser-known wood species locally called “Cross” (or Apumini Ikwerre Language) – the scientific name (yet to be identified) as an indication of short supply of desirable logs.

The availability of floatable rivers was considered the most significant strength of the resource-based area. Transportation of forest products to mill represents 75% or more of the cost of lumber production, exclusive of stumpage value (Seddell *et al.*, 1991). Water transportation is the cheapest where a desirable river is available (Seddell *et al.*, 1991). The resource-based area is blessed with desirable Mgbodara River channeled to the cluster-mill and it has been the sole source of transportation (rafting) of logs since when the mill started full operations in 1989. However, the weakness of this strength is the non-regular downpour of rainfall to satisfactorily provide enough rises for ensuring unhindered logs transportation throughout the year. In consequence, the delay of logs delivery taking up to 3 to 6 months in some periods encourages massive attack of logs by biodeterioration agents such as marine borers and fungi.

The availability of cheap human labour is another important strength of the resource-based area. The unskilled labour is always in excess and their daily average income is about ₦380 (US\$0.92) per worker. This cannot be compared to the job description, which involves detachments of rafted logs, manual debarking, rolling of logs from the river to the machine for primary conversion, separation, and grading of lumbers, etc. However, the working conditions under which these workers carry out their work are unsuitable and do not conform to ergonomic principles that can ensure their safety against the attendant hazards. Additionally, as witnessed, the primary conversion machines were inadequate, obsolete, and manually operated. The sawmillers report the scarcity of mill spare parts. There has been no regular maintenance of machines, resulting in the frequent breakdown, consequently causing low production of lumber.

Another environmental strength is the location of the mill in the heart of the capital city with city facilities however; the inadequacy in public electricity supply for regular production of lumber has been reported by saw-millers. The on and off of the electricity in the area could not be predicted, when off, the restoration in most cases is at odd periods (night hours). With the high cost of diesel power engines, some workers have resulted in working at nights with poor visibility of the environment.

The fourth most important strength of the resource-based area is the availability of good roads leading to the mill. As observed, the roads are good but however, the roads are few and narrow, sometimes causing difficulties in the flux of inputs and outputs.

The fifth most important strength of the resource-based area is that it is a centre of attraction for wood-based and non-wood-based associated businesses, education, and research. The area has expanded for the inclusion of accessories markets associated with wood-based enterprises. Being the only conventional saw-mill in Port Harcourt coupled with its interesting water transportation system, the mill has been a veritable practical centre for learning and conducting research on a yearly basis by the University of Port Harcourt, Forestry and Wildlife Management students.

There are a number of opportunities open for WBEs development at Illoabuchi cluster-sawmill, however, these opportunities have their associated threats. As inquired, the availability of desirable wood species was considered the first opportunity. As expressed, the wood-based entrepreneurs have enjoyed the utilisation of desirable species, for instance, *Rhizophora racemosa* (Ngala) by wood sellers, and *Khaya grandifoliola*, *Milicia excelsa* by for the furniture makers and wood-carvers. Currently, though, the supply of *R. racemosa* seems adequate but other wood users especially furniture makers have shifted to the utilisation of available wood species when those previously considered desirable are not available.

Availability and affordability of tools were seen as the next important opportunity. As observed from entrepreneurs, the tools required for their enterprises' development are simple, affordable, available at the local market, and maintenance requires no special technical skills. Nonetheless, there are a number of hazards associated with the use of these tools, but many entrepreneurs are not taking precautions seriously when working. The occupational hazard outcomes frequently suffered when asked included cuts, bruises, nasal infections, back pain, eyes infection. These results are similar with those reported by Top *et al.* (2016), who

analyzed the occupational and safety in micro-scale wood-product enterprises in Turkey.

Access to adequate space was ranked the third most important opportunity. WBEs products are expanded and require space. In making furniture and carving wood into beautiful antique products, space is required. Also, more space is required for the storage of finished goods pending their collection by buyers. Space is also needed for storage (stacking) of split firewood. All these are provided for at the mill area. The entrepreneurs have adequate space to carry out their work. Nonetheless, considering the condition of the workshops, the rent is high. The workshops are in poor condition, with leaking roofs, making storage difficult. The rent ranges from ₦24,000 (US\$58.54) to ₦72,000 (US\$175.61) yearly, depending on the size of the workshop. The workshops are small in size and an entrepreneur may need more than one workshops. The land is owned by the community and they give out workshops to individuals but are unconcerned about the state of the workshops for which the entrepreneurs pay. During the rainy season, entrepreneurs have difficulty with storage owing to the poor condition of their workshops.

Demand for WBEs products locally has been encouraging thus availability of market was ranked as the fourth most important opportunity. As observed, the Illoabuchi cluster-sawmill has become a city market primarily for WBEs products consumption. However, in a few cases, membership of the association was reported to influence the quicker market of a product for members than non-members.

The last opportunity is the membership of the association. Members claimed to enjoy social invitation, financial contribution, and gathering during child dedication, marriage, burial rights. Also, they said it accords them respect and a sense of belonging. However, ₦50,000.00 (US\$121.95) membership fee and ₦10,000.00 (US\$24.39) annual due were major reasons while about two-fifth of the entrepreneurs are not members.

Since the economic feasibility of sustainable WBEs development and the cluster-mill depend essentially on the wood-producing function of the diminishing natural forests. Priority should first be given restoration of forests. A powerful dam can be constructed to give strength to river volume during the shortage. Labour inspectors should wake to their responsibility. Modalities on a regular supply of electricity should be reached among stakeholders without breach. A genuine commitment of co-investments between private individuals, community, and government can help to

address all the identified environmental weaknesses and threats.

5. CONCLUSIONS

1. This study affirmed that on-site WBEs offered superior market rates of returns and at the same time provided means of livelihood to a sizable local population.
2. However, measures (Policies and actions) to address the identified weaknesses and threats, and turn them into strengths and opportunities, respectively are advised to ensure the longer-term sustainability of the enterprises.

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