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ANALYSIS OF TECHNICAL EFFICIENCY OF SAWMILL INDUSTRY IN OGBOMOSO AREA OF OYO STATE, NIGERIA: A STOCHASTIC FRONTIER APPROACH

***KABIR, G.B., IDUMAH, F., AWE, F., ODEDIRAN, F.A. AND UKOHA, P.A.**
Forestry Research Institute of Nigeria, P.M.B. 5054, Jericho Hills, Ibadan.
*Corresponding author: belloganiyah263@gmail.com

Abstract
The study examined the technical efficiency and observed determinant of technical inefficiency of sawmill in Ogbomoso area of Oyo state. Multi-stage sampling procedure was employed to select seventy-six (76) saw millers in the study area. Detailed questionnaire was used to obtain relevant information from the respondents. Stochastic production frontier was used to determine the technical efficiency while ordinary least square was used to determine the factors affecting revenue generated by the saw millers in the study area. About thirty-six percent (36%) of the respondents fell within the age range of 51 - 60 years, eighty three percent (83%) were males and ninety two percent 92% engaged in saw milling as the only source of livelihood. The result of the cobb –douglas function showed that sex (P<0.05) and years of experience (P<0.05) in sawmill business had direct effects on the technical efficiency of the saw millers in the study area and they were towards constant returns to scale. In addition, Labour (P<0.1), price per plank (P<0.1) and power (P<0.1) increased the revenue generated by the respondents in the study area. The study concludes that old /obsolete machineries should be replaced, and respondents' proper training is paramount to an efficient saw milling operation.

Key Words: *Sawmill, Technical efficiency, Ogbomoso, Stochastic frontier*

Introduction

Forest is a major economic resource that is of great importance to the people and the nation in general. The main products derived from the forest are trees (timber). Globally, about 3.4 billion cubic meters of timber equivalent are provided from the forest yearly (Babatunde, 2019). The forest sector is crucial to the supply of forest products to related industries in Nigeria such as sawmills, plywood mills, paper mills etc. All these wood related-industries contribute immensely to the economy in Nigeria (Oguntade *et al*., 2013). Timber extracted from the forest are converted in the sawmill and used in the construction of houses, barns, fences, bridges, furniture items and musical instruments. In contemporary times, wood is still widely used for constructional purposes. According to Larinde and Popoola, (2008), the Nigerian wood-based industry comprises of about ten groups, these are the sawmills, particleboard mills, plywood mills, match industry furniture manufacturing, wood preservation, flush

doors, toothpicks, medical spoons and confectionary sticks and pulp and paper mill while the wooden furniture parts and component industry is the new addition to the wood industry in Nigeria. Some notable tree species used for lumber in Nigeria and particularly in the study area include Gmelina (*Gmelina arborea*), Teak (*Tectona grandis*), Red apa (*Afzelia Africana*), Ekki (*Lophira alata*), Opepe (*Nauclea diderichii*), Afara (*Terminalia superb*) Mansonia (*Mansonia altissima*), Iroko (*Milicia excelsa*), Afromosa (*Pericopsis elata*), Obeche (*Triplochiton sclexylon*) (Eru (*Erythrophloeum spp*). Timber industry has the potential to improve economic performance and increase state and household revenues. One of the major methods of reducing wood logs into useable forms is by saw milling. Sawmilling is defined as the process of converting round wood from the forests into lumbers by using a variety of machines (Aina, 2006).The sawmill industry is among the popular micro-enterprises that have contributed to the advancement and growth of the economy (Ogundari, 2010). Ogunwusi, (2011), noted that one of the major characteristics of the sub-sector is increasing number of operators and decreasing performance. Olorunnisola, (2000), maintained that the annual rate of return of sawmill industry is between 15.2% and 44.3% while over 70% of the workforces are labourers. The industry is dominated by the use of CD4, CD5 and CD6 horizontal band saws usually supported by circular saw machines and only very few (10%) use advanced technology (Babalola *et al*., 2018). Timber or log sawing involves the conversion of logs into square edged pieces of lumber into different dimensions depending on the desired end use. Generally, the method of cutting wood depends on the intended use, appearance, and the stability of the wood. Babalola *et al*., (2018) stated that the conversion of timber to lumber of various grades or sizes is a major process that is needed for the end use of wood products which is a major economic activity of most small scale saw mills. In Nigeria, small scale sawmill industries accounted for a large proportion of 81% while medium and large scale accounts for 13% and 6% of the total population respectively (Ogunwusi, 2014). Sawmills are important and indispensable components of the wood supply chain because they connect the conversion flow of raw materials into finite products (Borz, 2021). Sawmill is a critical industry whose performance has direct implications for both present and future generations. Sawmill industry is characterized by small scale operation which constitutes more than 90% of the entrepreneurs in the sector (Fuwape 2003 as cited by Ogundari 2010). Studies conducted by Akanni and Adetayo (2011) identified some problems affecting the operations of the sawmill industries as low capital utilization, inadequate logging equipment, shortage of spare parts and skilled manpower coupled with poor condition of the machinery and tools. Apart from energy supply, another major factor limiting growth in sawmill industry is scarcity of economic timber resources (Larinde, 2010). Esiere *et al*., (2020) also stressed that over-exploitation of forest resources due to high demand and population increase has resulted to extinction of some valuable timber species. These problems are also, peculiar to the sawmill industries in Ogbomoso area of Oyo state and have in a way

impacted on the technical efficiency of the sawmill owners/operators.

Technical efficiency is defined as the ability to produce a given level of output with a minimum quantity of inputs under certain technology. Technical efficiency of an individual firm is the ratio of the observed output to the corresponding frontier output based on the level of inputs used by the firm. The gap between the observed output and the frontier output is termed technical inefficiency (Ogundari, 2010). This is caused by socioeconomic factors which are usually beyond the control of the producer. Technical efficiency comprises of allocative and economic efficiency. Allocative efficiency refers to the ability to choose optimum input levels for given factor prices while economic efficiency is the product of technical and allocative efficiencies. An economically efficient input- output combination would be on both the frontier function and the expansion path (Ogundari and Ojo, 2006). Some studies have been carried out on cost and return analysis and technical efficiency of timber processing in Ondo and Osun States Nigeria (Ogundari, 2011, Akanni and Adetayo, 2011, Esiere, *et al*., 2020). Binuomote (2017), conducted efficiency studies on some selected small and medium scale enterprises in Ogbomoso agricultural zone in which sawmill industry was included and the methodology was quite different from the one employed in this study. No known in-depth study has been carried on the technical efficiency of saw mill operators in the study area. This study therefore, seeks to determine the technical efficiency of the saw millers in the study area, examine the determinants of technical efficiency and determine the factors affecting revenue generation by saw millers in the study area.

Study area

The study was carried out in Ogbomoso, Oyo state, Nigeria. Ogbomoso has five local government areas namely, Ogbomoso north, Ogbomoso south, Oriire, Suurulere and Ogo – Oluwa. It lies on the latitude $8^{\circ}10'$N $40^{\circ}10'$Eof the Greenwich meridian. Ogbomoso is in Southern Guinea savanna zone. The climate is equatorial notably with dry and wet season with relative humidity. Average daily temperature ranges between 25˚C (77.0˚F) and 35˚C (95.0˚F) almost throughout the year. The population was approximately 354,690 in 2006 census. The majority of the people are members of the Yoruba ethnic group. Agriculture is a major occupation of the people in the area. Yam, cassava, cashew, mango, maize, and tobacco are some of the notable agricultural products of the region. Cashew and mango plantations are widely distributed across the land. Ogbomosho is one time the largest planter of cassava across the globe. The residents also engage in trading and rearing of domestic animals like goats and sheep. Also, saw milling business is a viable enterprise in the area.

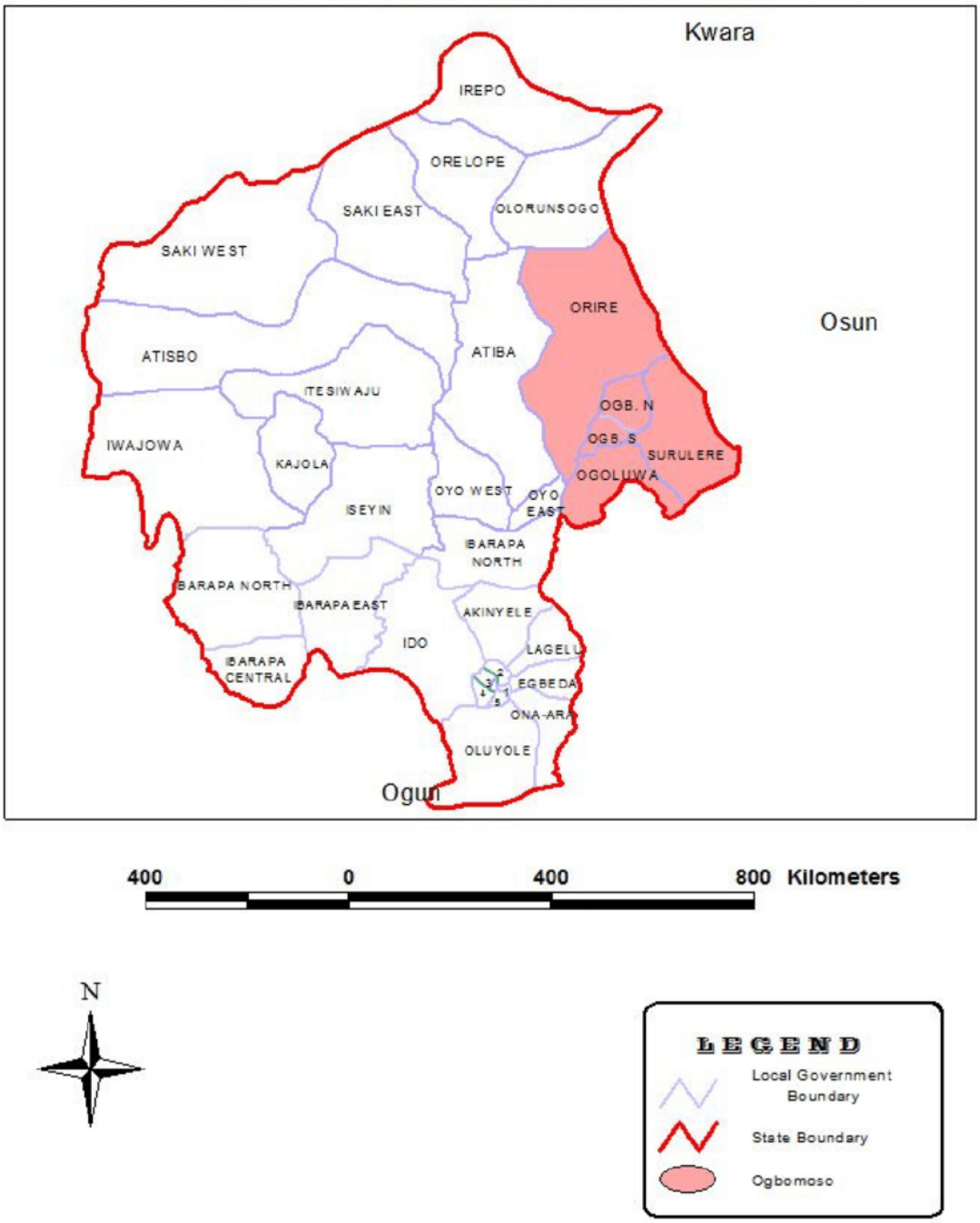

Fig. 1: Map of Oyo state showing the five local governments areas of Ogbomoso

Methodology

Sampling Procedure

Multi-stage sampling technique was used to select the respondents for this study. The first stage involves a purposive selection of two Local Government Areas: Ogbomoso north and south. This selection was borne out of the fact that the two local government areas selected are the largest and most populated areas out of the five local government areas in Ogbomoso. The second stage involves purposive selection

of four prominent sawmills in the study area. These are Aaje- Ikose, Pakiotan, Ile-ewe and Ahoyaya sawmills. The third stage was the random selection of thirty (30) sawmill operators from Aaje – ikose being the largest saw mill in the area, followed by eighteen (18) respondents from Pakiotan, seventeen (17) respondents from Ile – ewe sawmills and fifteen (15) respondents from Ahoyaya saw mills to make a sample size of eighty (80) saw millers. This selection is proportionate to sample size of the respondents in the study area.

Data Collection

Copies of well-structured questionnaire and interview guide were used to elicit relevant information from the respondents. Information such age, sex, household size, years of saw milling experience, source of capital, quantity of saw wood produced, prices per plank etc were sourced.

Method of Data Analysis

Descriptive statistics and stochastic production frontier were used to analyse the data for this study. Descriptive statistics was used to analyze the socio-economic characteristics of the respondents and constraints faced by saw millers while stochastic production frontier was used to analyse the technical efficiency of sawmill industry and determinant of technical inefficiency in the study area.

Analytical Framework

The stochastic frontier production function in efficiency studies as used by Binuomote *et al*., (2017) will be employed for this study. The stochastic frontier production function model was first proposed by Aigner *et al*. (1977) is designed to account for the presence of measurement of errors and other errors in the data, which are beyond the control of the firm. Stochastic frontier error is composed of two parts *Vi* and *Ui*. For the purpose of this study, it is assumed that *Vi* is normally distributed while *Ui* is assumed to have a truncated normal distribution. The log production function is given by

$$Y = f(X, B) + V - U - - - - - -\text{i}$$

Where Y is the revenue generated from the sawmill business

X = is the vector of explanatory variables which can take the values of 1, 2, 3-----n

B = is the vector of unknown parameters to be estimated.

V= is a symmetric error which accounts for random variations in output

U= is a non – negative random variable technical inefficiency in production relation to the stochastic frontier. The concept of technical efficiency relates to the question of whether a firm uses the best available technology in its production process. It is assumed that 0 < technical efficiency < 1, where technical efficiency 1 implies that the firm is producing on its production frontier and is said to be technically efficient. 1 – technical efficiency is therefore the largest proportional reduction in input X that can be achieved in the production of output Q.

The specification of the production relationship is defined as follows:

$$Ln\,Y = \beta 0 + \beta 1 lnX\,1 + \beta 2 lnX2 + \beta 3 lnX3 \ldots \beta nlnXn + ViUi - -ii$$

Y = Revenue generated (₦)

X_1 = price per plank

X_2 =labour

X_3 = electricity bill / cost of diesel

X_4= transportation cost

X_5 =Machineries

X_6 = Rent on Land

U and V are as defined earlier.

The log production function for the computation of the determinant of technical efficiency is described as

$$TE = a0Z0 + a1Z1 + a2Z2 + a3Z3 + a4Z4 + anZn ----iii$$

Where TE = technical efficiency, Z = are the socio-economic characteristics causing technical inefficiency such as age of the mill operators, sex, years of experience in saw milling business, level of education, type of sawing machine, working capital etc.

Results and Discussion

Socio-economic characteristics of the respondents in the study area

Table 1 presents the socio- economic characteristics of the respondents in the study area. Age of the respondents showed that (36%) of the respondents were found to be within the age range of 51 and 60 years of age, only very few (7%) fell within the age range of 31 and 40 years. This implies that most of respondents were aged people, and this aligns the findings of Agbonlahor (2010) who reported that most of his respondents were between the age of 51 and 60 years and this directly affects their productivity and ability to take risk. Sex of the respondents showed that majority (83%) of the respondents were males while few (17%) of them were females. This is an implication that the drudgery nature of the work makes it suitable for men to engage in the business as compared to women. About 92% of the respondents engaged in saw milling operation as the only source of income while the remaining 8% were traders. This implies that saw milling business is a very profitable and reliable source of livelihood in the study area. As regards respondents' level of education, majority (90%) of the respondents were literate while only 9% had no formal education. This is an indication that there is a good literacy level in the study area. This result aligns with the study of Akanni and Adetayo (2011) were 75% of the respondents had formal education. Most (64%) of the respondents had more than ten years of working experience and this is an indication that they have been in the business for long. This result is in consonance with the findings of Agbonlahor (2010) where he affirmed that most of his respondents had more than ten (10) years of working experience and that saw-milling experience is very important for an improved productivity. Furthermore, the monthly income of the respondents showed that a good percentage (47%) of the respondents earned between ₦51 000 – ₦100000 a month showing that sawmill business is very lucrative, and majority (83%) had just one sawing machine. The respondents in the study area affirmed that the benefit derived from the saw millers' association were social interaction (58%) and credit/loan facilities (21%).

Most (57%) of the respondents affirmed that they usually encountered some challenges in the saw mill business which include high transportation cost, scarcity of logs in the forest, power failure and unfavourable government policies.

Table 1: Socio-economic characteristics of the sampled saw millers (N=76)

Socio-economic characteristics	Frequency	Percentages
Age		
31 – 40	7	9.2
41 -50	18	23.7
51 -60	37	48.7
61 -70	14	18.4
Sex		
Male	63	82.9
Female	13	17.1
Marital Status		
Single	4	5.3
Married	56	73.7
Divorce	2	2.6
Widow/widower	14	18.4
Level of education		
No formal educ	7	9.2
Primary	12	15.8
Secondary	35	46.1
Tertiary	22	28.9
Years of experience		
1 – 4	10	13.1
5 -9	17	22.4
>10	49	64.5
Type of conversion machine		
Circular saw	27	35.5
Band saw	13	17.1
Both	36	47.4
Sources of logs		
Govt forest reserve	12	15.8
Farms	41	53.9
Natural forest	23	30.3
Challenges encountered		
High transport cost	10	13.2
Capital intensive	43	56.6
Power failure	10	13.2
Government policy	13	17.1

Factors Affecting Revenue Generation in Sawmill industry in the study area

Table 2 shows the result for cobb Douglas production function. The maximum likelihood estimates of the cob-douglas production frontier is presented in table 2. The result showed that labour, price per plank and electricity were positively related to the revenue generated by sawmill industries and were significant at 5% level. The coefficient for labour used in sawmill business in the study area was positive, consistent with a priori expectation and significant at 5% level. That is, a one percent increase in labour supply would cause about 0.31% increase in revenue. This implies that more revenue would be generated as more labour forces

are engaged into the business. This result aligns with study carried out by Kehinde *et al.* (2010). The coefficient of power / electricity used for plank production / processing was positive and significant at 5% level. This shows that a percentage increase in the usage of electricity will lead to about 0.033% rise in revenue. This result emphasized the significance of electricity as an important source of energy in sawmill business and that electricity is very paramount to plank processing in operating machineries. In other words, the availability of electricity for plank processing increases the revenue generated in the study area. This corroborates the findings of Kehinde *et al*., (2010) where electricity was reported to have a positive influence on sawn wood output. Another factor having direct influence on revenue generated was price per plank. That as a percentage increase in the price of a plank can increase the revenue the revenue accruable to the operation by as much as 108%. This result depicts that some economic trees such as Iroko, Obeche and others traded in the study area have higher market prices than others and as a result they increase the amount of revenue generated in the study area. Furthermore, the results showed a negative relationship between hours of use of machinery and revenue generated. In other words, a percentage increase in the length of time of use of machinery for production will lead to about 0.088% decline in revenue. This is an indication that the machines/ equipment used for operation in the sawmill business in the study area were old / obsolete and hence reduced the amount of revenue generated in the study area. In addition, High cost of transportation also had a negative influence on the revenue generated from the enterprise in the study area. As the transportation cost rises by 1%, the revenue accruable to the operators also declines by about 0.093%.

Table 2: Showing factors affecting revenue generation in sawmill business

Variable	Coefficient	Z-value	P-value
Labour	0.313553	5236.60*	0.0000
Price/plank	1.080191	3.40000*	0.0000
Rent on land	-0.413999	-1.10000*	0.0000
Power	0.032504	661.810*	0.0000
Machinery	-0.087791	-8343.82*	0.0000
Transportation	-0.092537	2203.85*	0.0000
Log Likelihood	-32.150587		
Sigma(δ)	9.55e-09	2.05e-06	
Sigma(δ^2)	0.5457935	0.0885394	
Lambda(λ)	7.73e+07	.0599228	

*Significant at 5% level

Factors influencing technical efficiency of sawmill in Ogbomoso

Table 3 showed the factors affecting technical efficiency of sawmill industry in the study area. Only sex, and years of experience of the respondents were positively related in determining technical efficiency of the respondents in the study area. The gender of the respondent is significant in determining the technical efficiency in sawmill operations. This implies that, owing to the tedious nature of

sawmill, male operators have more capability to operate the machines efficiently than their female counterparts. This result contradicts the findings of Shumet (2011) were farmers' gender was reported to have a negative effects on technical efficiency. In addition, the number of years a sawmill operator has been in the business also determines the efficiency of operation. This is because overtime, the operators of the machines in sawmills would have acquainted themselves with the workings of the machines and known how best to operate the machines to get optimum plank outputs. This result aligns the findings of Salau *et al*., (2012) where farmers' years of experience had a positive and significant effects on technical efficiency.

Table 3: Factors Affecting Technical Efficiency of Respondents

Variable	**Coeff**	**P-value**	**t- values**
Age	0.0011033	0.6640	0.44
Sex	0.15506 *	0.0050	2.88
Marital status	-0.0463341	0.2130	-1.26
Household size	0.0069456	0.5390	0.62
Level of educ	-0.0132856	0.4540	-0.75
Yrs of experience	0.0660533*	0.0250	2.30
Constant	-0.0129993	0.1977607	-0.07

**Significant at 0.05 level*

Distribution of Technical efficiency

The frequency distribution of technical efficiency of saw mill is presented in table 4. Individual technical efficiency indices ranged between 20 % and 60% with a mean of 44%. Results showed that 6.6%, and 15.7% of the saw millers had technical efficiency indices ranging between 51- 60 and 61- 100 percent respectively. Given an average technical efficiency of 44%, it can be deduced that saw millers in the study area are not operating in an efficient manner, since they are operating below 50% efficiency level. However, about 22% of the operators were operating above 50% efficiency level. Furthermore, a return to scale value of 0.831921, indicates that the sawmill business owners were operating a decreasing return to scale.

Table 4: Frequency distribution of Technical efficiency of saw mill operators

Technical efficiency range	**Observations**	**Percent**
0.21- 0.30	14	18.4
0.31-0.40	22	28.9
0.41-0.50	23	30.3
0.51-0.60	5	6.6
0.61-0.70	6	7.9
0.71-0.80	2	2.6
0.81-0.90	2	2.6
0.91-100	2	2.6
Total	**76**	**100**
Mean	0.44	

Conclusion and Recommendation

This paper examined the technical efficiency of saw millers in Ogbomoso area of Oyo state, Nigeria. The mean technical efficiency of 44%, hence, the need to increase the present level of technical efficiency is quite imperative. This implies the existence of wide variation of output below their production and indicate the existence of potentials for improving productivity with proper allocation of their existing resources. The low levels of education of the respondents depicts that there is need to acquire formal education as this will make them acquire some training related to their business that can help to build their capacity to produce efficiently. This will also help them to replace old / obsolete machines with new ones and work towards how they can generate a stable source of electricity for their business / enterprise for optimum revenue generation.

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