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Economic Analysis of Solid Waste Management in Oyo State, Nigeria

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Abstract: Solid waste management is important in our environment due to expected welfare gains to the entire community. This study examines the economies of solid waste management in Ibadan North local government area of Oyo State. A random sampling technique was used to select 40 solid waste contractors from the list of registered members obtained from Ibadan waste management authority. With the aid of structured questionnaire information on inputs, costs, service fees, numbers of trips, numbers of refuse containers managed and so on were sought. Gross margin and multiple regression analysis were the analytical tools. The study revealed that few household patronize the waste contractors. Average monthly gross margin and net income of waste contractors were N21,455.71 and N17,063.19, respectively. Mere collection and disposal of solid waste constituted the activities of the contractor. None of them engaged in reuse or recycling of the waste. The regression results showed that only number of trips made to dump site, number of containers of refuse managed and service fees charged were statistically significant in determining the quantity of solid waste collected and disposed by the waste contractor. It is therefore recommended that service delivery be improved while advertisement and enlightenment programme in order to educate the household be staged. Recycle plants could also be established by the government or jointly established by the waste contractor so as to increase the monthly income through sales.

Key words: Solid waste management, analytical tools, waste contractors, disposed, recycle plants

INTRODUCTION

Management of municipal solid waste resulting from rapid urbanization has become a concern for government in most cities in developing countries. A high rate of growth of population and increasing per-capita income have resulted in the generation of enormous solid waste posing serious threat to environmental quality and human health (Chakrabrati and Sarkhal, 2003). This is more so in the case of developing countries where large quantities of solid waste are dumped haphazardly, thereby, putting pressure on scarce land and water resources. It also adversely affect the health of human-beings, mostly that of the poor persons who have greater exposure to it. Several studies have shown that solid waste generation rate is average of 0.5 kg per person per day (Okpala, 1984). The generation rates for the African's major cities are estimated to range from 0.3 to1.4 kg per capita per day. This gives an average of 0.78 kg (Achankang, 2003). According to World Bank study, urban per-capita waste management rate for most of the low-income countries will increase by approximately 0.2 kg per day by 2025 because of relatively high annual growth rates of GNP and urban population (Chakrabarti and Ssarkhal, 2003). Urbanization in Nigeria has brought about concentration of population that generate waste. Haskoning and Konsadem Associates (1994) generation rate of 0.6 kg per day, with a density of 300 kg m^{-3} for Ibadan city. Achankang (2003) revealed that the rate had increased to 1.1 kg with only 40% of the total population enjoying garbage collection. Due to limiting resource availability, the increased population in Ibadan has not witnessed the corresponding basic infrastructure or facilities that could facilitate effective disposal. The city is being characterized by heaps of undisposed refuse or open dumps on streets, highways, markets, residential areas and the community at large. Solid waste management is an expensive public service. Studies have shown that it consumes up to half of the operating budget available to municipal government that bears this burden of refuse collection. Despite this, few of the populace is still served; where served, not all the refuse is collected in most cases. Due to the overwhelming volume of solid wastes, the Ibadan city council cannot single-handedly collect and dispose them. Consequently, the government has allowed private collection and disposal of these solid wastes on a commercial basis. It is alarming that problem of inefficient solid waste management still lingers on after the

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incorporation of the private business men tagged 'waste contractors'. This leaves refuse containers filled to the brim and sill over and more importantly allowing the refuse enough time to decompose. These constitute health risk to the household. Improper collection and disposal leads to spread of communicable diseases, obnoxious conditions and spoils biosphere as a whole; for instance, respiratory infections and diarrhea diseases have been identified as the two major causes of death among the poorest 20% of the world countries ranked by national GDP per capita (Gwatkin and Guillot, 1999). The outbreak of these diseases has been attributed to area where solid waste is improperly collected and disposed. The foregoing therefore permits us to conceive critical objective that could help in forming relevant policies towards solid waste-heap-free environment.
The objectives are:

- To appraise the profitability analysis of solid waste collection and disposal
- To examine the factors that affect the quantity of solid wastes collected by the waste contractors in the study area.

Conceptual and theoretical framework: Conceptually, solid waste or refuse is any solid material, which is discarded by its owner. It consist therefore of discarded solid materials resulting from domestic and community activities, industries, commercial and agricultural operations (Okpala, 1984). It is a material that requires no compensation upon abandonment (Cointreau, 1982). Chakrabarti and Sarkhel (2003) stated that household waste is a by-product of household production process and therefore could be analyzed within the framework of household production function. Chakrabarti and Sarkhel (2003) stated that estimation of quantity of waste generated is carried out at two scales, i.e., National/ international scale and Municipal/regional scale. Karavezyris (2000) discussed the various forms of model associated with the estimation procedure. The explanatory variables may be overall consumption, inputs or output of production. The generic model ideally applied can be described as follows:

$$\text{Log } W_{it} = \alpha + \beta \log Y_{it} + \gamma_t$$

Where W_{it} is the amount of given waste of category 'i' at time 't'. Y_{it} is the period amount of a specific economic activity expressed in monetary or physical terms; β is the constant ratio of generated waste to the output of the relevant economic activity and γ is the dynamic ratio of generated waste. In terms of municipal/regional planning, estimation of future quantities and composition of households waste are derived in the first place as a function of population figure.

The model is represented thus:

$$W_{it} = \lambda P_{it}$$

Where λ is a constant term and P is the population. Frequently, municipal waste which is generated from industry may be estimated as a function of employees in the various industrial branches. Beede and Bloom (1995) have used time series data of 36 countries on per capita municipal solid waste generated to estimate income and population elasticities of Municipal Solid Waste (MSW) generation following the relation below:

$$\text{Log (Annual MSW generated by weight)} = \alpha + \beta_0 \log (\text{per capital GDP}) + \beta_1 \log (\text{population}) + \varepsilon$$

Where
β_0 = Income elasticity of municipal solid waste generation and
β_1 = Population elasticity of municipal solid waste generation.

Several other studies have been carried out on waste management-waste reduction, reuse and recycling (Bowers, 1997; Turner, 1995; Ackerman, 1997).

MATERIALS AND METHODS

The study area was Ibadan North local government area. The area was selected as it is the most populated among the 11 LGA in Ibadan city. The report of Nigeria population commission NPC (1992) puts the population figure at 300,934. The area is characterized by several higher institutions, establishments, hospitals, largest food markets, banks, tourist centers among others. These characteristics have severely reduced agricultural activities in the area. Except for few livestocks, crop farming is rarely found due to rapid urbanization.

A simple random sampling of 40 residential waste contractors was carried out with the aid name list of registered contractors obtained from the Ibadan Waste Management Authority. Information on equipment/ material used, cost and returns, number of trips made to dump site, service fees paid by the households and so on were sought from the waste contractors through the of questionnaires. Five of the questionnaires were rejected due to inconsistencies in the supplied information. Descriptive statistics, gross margin analysis and multiple regression models were the analytical techniques used in the study.

Gross Margin (GM) analysis: This was used to examine the profitability of solid waste management business in the study area.

$$GM = \text{Total Revenue} - \text{Total Variable Cost}$$
$$\text{Net Income (NI)} = GM - \text{Total Fixed Cost (TFC)}$$

In this study, the variable costs were those of variable inputs like labour, fuel and rent on vehicle hired for the disposal. Common fixed inputs among the contractors are shovel and hand gloves. Most of the waste contractors did not own personal truck/vehicle for the business hence only rent and fuel costs were incurred. A straight line depreciation technique was also used in the analysis. Monthly equivalent value of each of the items was computed for the analysis.

Multiple regression analysis: This was used to examine the factors influencing quantities of refuse collected and disposal by waste contractors. The implicit form of the regression model is specified below:

$$Y = f(W_1, W_2, W_3, W_4, U_i)$$

Where

Y = Quantities of refuse collected and disposed in a month (tones)
W_1 = Number of years spent in the business (years)
W_2 = Number of trips taken to dump site for disposal
W_3 = Number of containers of refuse managed by waste contractors
W_4 = Service charge/fees (Naira)
U_i = Random error.

The four functional forms-linear, semi-log, double-log and exponential models were fitted. The lead equation was selected based on number of significant variables, the signs of the coefficients, the value of coefficient of determination (R2) and the size or magnitude of the sum of square error. The coefficients of the four variables considered are expected to be significant and have positive signs as a-priori.

RESULTS AND DISCUSSION

Characteristics of the solid waste contractors: The characteristics of the waste contractors are as shown in Table 1. Average quantity of refuse collected was 22.46 tonnes while the modal quantity was 16 tonnes. This shows that majority of the contractors were rather patronized by few households. The result also shows that most contractors had at least five years of the business experience. This level of experience is relatively high enough since the activity is almost carried out every week. The mean and mode of number of trips made to dumpsite, monthly fee charged and number of solid waste container are as shown.

Table 1: Characteristics of the solid waste contractors

Description	Mean	Mode
Quantity of refuse collected and disposed	22.46 tonnes	16 tonnes
Number of years spent in the business	7.91 years	5 years
Number of trips made to dump site per month	5.32 trips	4 trips
Monthly fee charged for service provision	₦594.29	N600.00
Number of Solid waste container managed	109.57	50-100

Table 2: Types of operation performed by the waste contractors

Type of operation performed	Frequency	Percentage
Collection and Disposal	35	100
Collection, Disposal and Sorting	0	0
Collection, Disposal and recycling	0	0
Collection, Disposal, sorting and recycling	0	0
Total	35	100

Table 3: Gross margin analysis

Item	Amount (N) per month	Percentage of total revenue
Revenue		
Waste collection and disposal service charge/fee	64671.43	
Sales of sorted re-usable waste	-	
Sales of products of recycled wastes	-	
Total revenue	64671.43	
Variable costs		
Fuel	8632.86	13.35
Labour	20440.00	31.61
Truck (Vehicle)hiring	14142.86	21.87
Total variable cost	43215.72	
Gross margin	21455.71	
Fixed costs		
Dump site charges	2000.00	3.09
Hand gloves	244.28	0.38
Levies	500.00	0.77
Rent	1191.43	1.84
Shovel	115.83	0.18
Tax	333.33	0.52
Total fixed costs	4392.52	
Net Income	17063.19	

The mode of operations of the waste contractors revealed that none of them sort the waste for reuse or recycling. All they did was collection and disposal (Table 2). This would mitigate environmental cost of land fill or where the waste would have been reprocessed into same or another product.

Gross margin analysis: Table 3 shows that average monthly variable and fixed cost of the business are ₦43, 215.72 and ₦4, 392.52, respectively. This shows that 90.77% of the monthly total cost of operating the business is incurred on the variable inputs. Additionally, the result reveals that the gross margin and net income from the business are ₦21, 455.71 and ₦17, 063.19 per month, respectively. The considerable low gross margin and net income of the business can be attributed to the fact that waste contractors spent huge amount of money to hire vehicle for their disposals and the service fees that waste contractors collect was the sole revenue accruing

Table 4: Multiple regression results

Variable	Coefficient	Standard error	t-value
Constant	-5.59155	1.12855	-4.95462***
W_1	-0.01368	0.04682	-0.29223
W_2	0.44775	0.11888	3.76636***
W_3	0.91329	0.17147	5.32626***
W_4	0.57402	0.13189	4.35216***

*** Statistically significant at 1percent, R-Squared (R^2) 0.9402, Adjusted R-Squared 0.9323, Sum of squared residual 0.4006, F-statistics 118.0014

to them as they have not been exploring the profit potentials in waste sorting and recycling.

Factors affecting quantity of solid waste collected and disposed among waste contractors: The double log form was chosen as the lead equation (Table 4). The coefficient of determination R^2 is 0.9402 which shows that 94.02% of the variation in the quantity of solid waste collected and disposed among waste contractors was explained by the independent variables. The results shows that three variables W_2 (number of trips), W_3 (number of containers) and W_4 (service fees) were all significant at 1% level while W_1 (number of years spent in business) was not significant. The result reveals that for every one unit increase in W_2, W_3 and W_4, the quantity of refuse collected and disposed by the waste contractors increases by 0.44, 0.91 and 0.57, respectively. This shows that the elasticities of the quantity of refuse collected and disposed with respect W_2, W_3 and W_4 were less than 1. This implies an inelastic relationship.

CONCLUSION

The study showed that collection and disposal as a business enterprise is profitable, however; the level of the profitability could still be improve if the waste contractors could engage in sorting for recycling and reuse of the collected refuse. It is also revealed from the study that 94.02percent of the variation in the quantity of refuse collected and disposed among the waste contractors was explained by number of trips made to the dump site, number of containers managed and the service fees/charges while number of years spent in the business was not significant. Based on the findings, the following are recommended:

Given the fact that all the waste contractors earn their income from waste collection and disposal activities only, there is need to utilize the bulk of recyclable items in the solid waste collected for disposal. These contractors should therefore jointly establish recycle plants where they can recycle waste and make more income from the recycled products. High number of refuse containers being managed by the contractors increases the quantity of solid waste collected and disposed. Majority of them were found to manage between 50 and 100 refuse containers which indicate low patronage by the households. The waste contractors should therefore be prompt in their service delivery and stage enlightenment jingles on mass media to advertise their services in order to educate and sensitize households and the entire society on the importance and the need for better refuse management.

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