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Prediction of Cost Recovery Time of Commercial Borehole Operation in Owerri Metropolis, Imo State

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Abstract-This study on the prediction of cost recovery time of commercial borehole operation in Owerri metropolis was carried out in 2018 at selected locations in Owerri, namely, Orji, Akwakuma, Irete, World Bank area and Ihiagwa. Ten (10) borehole vendors were selected, two from each location in the study area. The locations cover 60% of the Geographical spread of the metropolis. The parameters considered in the investigation were drilling cost, initial operation cost, maintenance cost, pumping cost and annual sales. Using the data obtained as variables, a multiple regression model was developed to predict the cost recovery time of the boreholes investigated. The cost recovery time for the various water boreholes ranges from 1½ years to 4 years. The results obtained shows that borehole number 1, 2, 3, 4, 7, 8, 9 and 10 have recovered the cost incurred in setting up the borehole, while borehole number 5 and 6 are yet to recover the cost. This was attributed to the factors affecting sales in the location. The research has provided useful insights to cost recovery of commercial borehole operation in the metropolis. It concludes that the business of borehole vendors is profitable, provided the factors influencing sales are favourable.

Keywords- *Borehole, Cost Recovery, Prediction*

I. INTRODUCTION

Water is critical to all forms of life on planet earth. In fact it is impossible to over-emphasize the usefulness of water because it plays an indispensable role in the life of every living thing. Man uses water for domestic, industrial, agricultural, recreational and wildlife purposes. Quality water must be wholesome and potable, however, naturally occurring waters rarely meet these requirements and may be treated for any or a combination of the following impurities, taste, colour, odour, turbidity, hardness, alkalinity and iron. In Nigeria, as at 1990, 20 – 30% of the rural population in Nigeria has access to drinking water (Onuoha, 1990). Over the last ten (10) years, people living in Imo State and Nigerians as a whole have tried to seek alternatives in solving the problem of inadequate water supply.

About 70% of water borehole schemes are commercialized, where people in need of water can come and buy water. This has helped to reduce the water scarcity in Imo State. The design, construction and drilling of water boreholes require huge capital to achieve. The question still remains at what time in the nearest future the commercial borehole operator will recover the cost of his or her investment, through sales of water. This paper tends to address this particular question. It has been argued that the least cost slope method of recovering has failed to yield optimal result (Akpan 2000). Hence, the multiple regression analysis was adopted for this study. It should be understood that project cost recovering differs according to the type of project in question and its subsequent environment as they are bound to operate within different constraints/limitations. Other authors whose publications were reviewed in respect of this study include Ajayi et al (1990), Bolt, (2001), Brook and Locussol, (2002), Fagly and Sylvy, (2002), Katko and Tapio, (1990), MacDonnei, (2002), Nedjoh and Thogersen, (2002). However, indicators for Cost Recovery Survey are geared towards Tariff structure, Billing efficiency, Operation expenses and Operation Revenue generated.

II. METHODS

This study was carried out in 2018 at selected location in Owerri metropolis, namely Orji, Akwakuma, Irete, World Bank area and Ihiagwa. Then (10) borehole vendors were selected two from each location in the study area. The location covers 60% of the geographical spread of metropolis. The parameters considered in the investigations were drilling cost, initial operation cost, maintenance cost, pumping cost and annual sales.

The general purpose of multiple regression is to learn more about the relationship between several independent variables and a dependent variable. The general equation for multiple regressions is given by:

$$Y = a + B_1X_1 + B_2X_2 + \ldots + B_nX_n \quad (1)$$

TABLE I. DATA VALIDATION

	Tolerance	VIF
Drilling Cost	0.269	3.720
Operational Cost	0.393	2.543
Maintenance Cost	0.152	6.572
Pumping Cost	0.525	1.903
Annual Sales	0.211	4.728

A. Test for multicollinearity

Multiple regression assumes that the independent variables are not highly correlated with each other. This assumption is tested using Variance Inflation Factor (VIF) values. The VIF values must be less than 10, indicating no interactions between variables. Table 1 shows a VIF less than 10, hence there is no interaction between the independent variables.

B. Test for autocorrelation

Autocorrelation is a characteristic of data in which the correlation between the values of the same variables is based on related objects. From Table 4 the value for the Durbin-Watson test is 2.615. Hence, since it lies between 0 and 4, there is presence of autocorrelation among the independent variables.

C. Normality Residuals

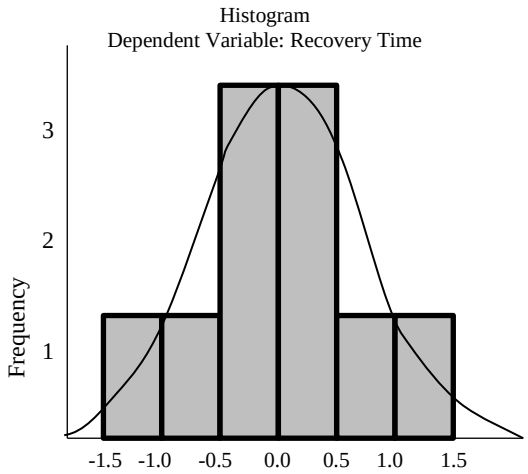

Figure 1. Regression Standardized Residual

We assume that the errors around the idealized regression model at any specified values of the x-variables follow a Normal model. We need this assumption so that we can use a Student's t-model for inference.

It can be seen from figure 1.0 that the residuals are normally distributed. Hence, the data is suitable for the model.

TABLE II. MODEL COEFFICIENTS

Model	Coefficients		T	Sig.
	B	Std. Error		
(Constant)	2.903	0.888	3.271	0.031
Drilling Cost	2.968E-006	0.000	1.123	0.324
Operational Cost	1.734E-008	0.000	0.009	0.993
Maintenance Cost	6.312E-006	0.000	1.177	0.304
Pumping Cost	5.210E-006	0.000	5.880	0.004
Annual Sales	-8.785E-006	0.000	-7.692	0.002

Dependent variable: Recovery Time

From the Table 2, the recovery model is given by:

Recovery Time (Years) = $2.903 + 2.968 \times 10^{-6}DC + 1.734 \times 10^{-8}OC + 6.312 \times 10^{-6}MC + 5.210 \times 10^{-6}PC - 8.785 \times 10^{-6}AS$

Where DC = Drilling cost

OC = Operational cost

MC = Maintenance cost

PC = Pumping cost

AS = Annual sales

D. Test of Model Coefficients

H_0 = the coefficients of the model are equal to zero

H_1 = At least one of the coefficients of the model is not equal to zero

TABLE III. ANALYSIS OF VARIANCE (ANOVA)

Model	Sum of squares	Degree of freedom	Mean square	F	Significant value
Regression	5.548	5	1.110	23.859	0.004[b]
1 Residual	0.186	4	0.047		
Total	5.734	9			

a. Dependent Variable: Recovery Time

b. Predictors: (Constant), Drilling Cost, Initial Operation Cost, Maintenance Cost, Pumping Cost and Annual Sales.

Table 3 is the ANOVA table i.e. analysis of variance. It consists of calculations that provided information about levels of variability with a regression model and form a basis for tests of significance. From the table 3, $P < 0.05$, hence, we reject the null hypothesis (H_0).

Thus, at 0.05 level of significance, we can conclude that the coefficient of the model is not equal to zero.

TABLE IV. MODEL SUMMARY

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.984[a]	0.968	0.927	0.21566	2.615

a. Predictors: (Constant), Drilling Cost, Operational Cost, Maintenance Cost, Pumping Cost and Annual Sales.

b. Dependent Variable: Recovery Time

From the table 4, coefficient of determination (R^2) is given by 96.8%. Hence, the model accounts for 96.8% of the changes in the dependent variable which suggests a good fit for the model. Therefore, using the model to predict the recovery time, the recovery time is calculated for same specific locations as shown in table 6. Having the cost recovery time predicted the recovery status of the boreholes were established as shown in Table 7.

III. RESULTS

Table 5 shows the borehole information of various locations, it was observed that vendors in rural areas within the Owerri metropolis tend to have higher sales than vendors in area a little further from the city centre as in the case of Irete and World Bank. The reason behind this is not farfetched, construction of borehole facilities in rural areas is rare, and owing a borehole is quite expensive as shown in the Table 5. The rural areas are majorly occupied by citizens on the lower end of the socio-economic strata of the society. These people will depend on commercial borehole as their major source of water supply, hence, increased sales for vendors in rural areas. Vendors in densely populated regions definitely enjoy higher patronage from consumers than vendors in sparsely populated regions as seen in Akwakuma and Irete areas.

Weather is a major determining factor in borehole facilities, from the information obtained, it is obvious that dry seasons and rainy season have different sales record and also that sales multiply in dry seasons as compared to rainy seasons. The reason is due to the fact that in rainy season water supply from natural sources like rainfall is abundant, therefore reducing the need for water from water vendors. Most homes make use of rain water for domestic activities, thus, vendors don't enjoy so much patronage from consumers during rainy seasons as compared to dry seasons when there is so much natural water scarcity.

From table 6, the cost recovery time for each borehole is evaluated. This was determined by looking at the total cost invested in the boreholes that are the Drilling cost, Initial operational cost, maintenance cost, Average pumping cost per year and compared with the average total sales per year. This gives an idea when the cost recovery time might be.

From table 7 all water vendors, excluding B5 and B6 have recovered the initial incurred expenses on the boreholes. As for B5 and B6 the cost recovery time of these selected boreholes were influenced by several factors among which sales were the major determining factor. It is obvious and unarguable that sale is an important factor in determining cost recovery time in commercial boreholes, therefore the need for evaluating factors affecting sales.

Commercial boreholes will hardly thrive in developed areas as the need for it is not pressing, as in the case of World Bank area in Owerri where every home has a source of portable water.

TABLE V. FIELD ASSESSMENT OF BOREHOLE VENDORS OPERATIONS IN OWERRI METROPOLIS

Borehole No	Location	Year of drill	Duration (years)	Drill cost	Initial opp. Cost	Maintenance cost/year	Water treatment cost/year	No of tanks	Pumping cost per/day	Sales raining season per day	Sales dry season per day	Remarks
B1	Orji	2015	3	210,000	280,000	80,000	40,000	2	800	650	1750	
B2	Orji	2009	9	280,000	300,000	100,000	50,000	3	1450	1250	2500	
B3	Akwakuma	2014	4	180,000	200,000	62,000	None	2	800	750	1650	
B4	Akwakuma	2012	6	15000	200,000	80,000	40,000	3	1450	1150	2250	
B5	World Bank	2016	2	140,000	220,000	10,000	30,000	2	800	550	1150	
B6	World Bank	2015	3	120,000	180,000	10,000	20,000	3	1150	550	1100	
B7	Irete	2012	6	110,000	220,000	10,000	None	2	800	600	1200	
B8	Irete	2015	3	180,000	200,000	20,000	20,000	2	750	650	1600	
B9	Ihiagwa	2014	4	120,000	230,000	30,000	10,000	2	800	850	1550	
B10	Ihiagwa	2015	3	130,000	180,000	25,000	20,0000	3	1150	750	1650	

TABLE VI. COST RECOVERY EVALUATION

Water Vendors	Drilling Cost	Operational Cost	Maintenance Cost	Average Pumping Cost/year	Average daily Sales/year	Recovery Time (Years)
B1	210,000	280,000	120,000	292,000	403,350	2.26
B2	280,000	300,000	150,000	529,250	645,000	1.77
B3	180,000	200,000	62,000	292,000	409,650	1.75
B4	150,000	80,000	120,000	529,250	585,850	1.72
B5	140,000	220,000	30,000	292,000	291,350	2.47
B6	120,000	180,000	30,000	419,750	177,870	4.08
B7	110,000	220,000	40,000	292,000	291,350	2.45
B8	180,000	100,000	40,000	200,750	373,150	1.46
B9	120,000	220,000	40,000	292,000	415,950	1.38
B10	130,000	180,000	45,000	419,750	402,100	2.23

TABLE VII. COST RECOVERY STATUS OF THE SELECTED BOREHOLES

Water Vendors	Recovery Time (Years)	Borehole Duration (Years)	Cost Recovery Status
B1	2.26	3	Recovered
B2	1.77	9	Recovered
B3	1.75	4	Recovered
B4	1.72	6	Recovered
B5	2.47	2	Yet to be Recovered
B6	4.08	3	Yet to be Recovered
B7	2.45	6	Recovered
B8	1.46	3	Recovered
B9	1.38	4	Recovered
B10	2.23	3	Recovered

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