QUANTIFICATION OF THE SIGNIFICANT VARIABLES DETERMINING THE METHODS OF LATRINES EMPTYING IN OGUN STATE, NIGERIA.

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Abstract

In a bid to fundamentally address the problems associated with poorly managed onsite sanitation systems, there is need to examine the significant factors influencing the choice of households' latrines emptying methods. Therefore, the objective of this study is to investigate the significant factors influencing the emptying methods of households' latrines in Ogun State, Nigeria. A total of 165 questionnaires were administered to representative households in the study area. This implies that 55, 50, and 60 questionnaires were administered in Surulere, Ilaro I, and Sodeke/Sale Ijeun I, respectively, on the basis of ratio 1.1:1.0:1.23, which reflects the variance in population of 1,250,435(33%), 1,112,761(30%), and 1,387,944(37%) for Ogun East, Ogun West and Ogun Central, respectively. The study, adopting the multinomial logistic regression, found among others, that awareness of faecal waste reuse (DREUSE) was the only significant variable in the first equation. Awareness of faecal waste reuse (DREUSE), Lower-middle-class Income category (INCCAT3) and Simple pit latrines (LATTEC 2) at 0.18, 0.00, and 0.00, respectively, were significant in the second equation ,while only the sub-categories of income class such as floating class (INCCAT2) and upper-middle class(INCCAT4), both at 0.00, were significant in the third equation . Based on the findings, the study,among others, concludes that there is need for the careful application of poverty mitigation strategies to not just result in the elevation of people's purchasing ability but also targeted at improving how their faecal wastes are managed.

Keywords: *Emptying; Faecal Waste;Latrines; Multinomial; Nigeria.*

INTRODUCTION

A billion of global population essentailly depends on onsite sanitation technologies (WHO, 2017b). According to a study conducted by The World Bank on faecal waste management in 12 cities in Africa, Latin America, South Asia and East Asiaon faecal waste management value chain, 64% of the excreta in cities were contained through onsite sanitation technologies but only 22% was safely managed, and 42% of excreta from onsite sanitation technologies is directly discharged into the urban environment (Harada, Strande & Fujii, (2016). Morever,the study reveals that about 38% of the world population, 29% of urban households, and close to half of people living in the countrysides (48%) only reported using basic sanitary facilities such as improved latrines and septic tanks. However,effective managment is important for sanitary installations based on onsite sanitation technologies to function optimally. This management begins from adequate planning and sitting of the onsite faecal waste containment, followed by emptying, transportation, treatment, and final reuse or safe disposal (Balasubramanya, *et al.,* 2017).

The entire faecal waste value chain requires adequate management to ensure capacity, affordable recovery enabling sanitation technology , and the protection of public health (Harada, Strande & Fujii, (2016). But majority of developing countries have still not attained adequacy in faecal waste management. As evidenced in WHO (2017a) globally, three out of five people with safely managed sanitation live in urban areas (1.7billion), while two out of five were in rural areas (1.2 billion). Households can meet the criteria for a safely managed sanitation service when households' faecal waste are adequately out of sight, flushed out ofbuildings via conduits, and treated at a treatment plant. However, for households using onsite sanitary technologies,the criteria for safely managed sanitation service are met when faecal waste are properly stored, emptied, transportedand treated off-site, or remain contained and considred for in situtreatment (Government of Idia, 2017).

Nkansah (2009) principally identifies two techniques of evacuating excreta from latrines in the developing countries. These include the manual and mechanical emptying means. The manual methods could be in form of bucket systems where faecal wastes are emptied from the latrines with the aid of buckets. The second variant of the manual method involves the adoption of tools such as diggers, shovels, pans, hand-operated pumps, bare or gloved hands, drums, scoopers, ladders, ropes, and boots for emptying accumulated sludge in the pits. However, the disadvantage of the manual variants is the fact that the scanvengers involved in the emptying endeavour, are inevitably exposed to faeces ,and faecal waste are most times indiscriminately disposed around the neighbourhood, culminating in the proliferation of flies and worms, which have consequences on public health (Peal *et al.,* 2014) Investigations by Ezekwe, Odubo, T., Odubo, E & Akosa., (2011) corroborates this finding with the revelation that about 40% of faecal sludge evacuated via manual emptying and deposited in Nigerian landfills find their way into water bodies on the other hand,the mechanical method involves the use of tankers to siphon out sludge under vacuum and pneumatic forces. The efficacy of this method could actually be threatened in instances where faecal waste had been solidified at the bottom of pits, such that can only be emptied by specialized and expensive tankers with adequate pneumatic pressure, which inmost cases, arebeyond the accessibility or affordability of most people in low-income countries (Chowdhry & Kone, 2012). There is also the threat of road access to the latrines by the mechanically emptying tankers, as most settlements in developing countries are usually not well laid-out to make roads directly abut dwelling units (Nkansah, 2009)

However, there is also the small sized emptying technology that is more like a hybrid of manual and the mechanical variants, which are adapted to address the accessibility challenges peculiar to the operation of mechanical methods in unplanned areas and the unsightly and unhealthy inefficiencies of the manual rudimentary tools (William & Overbo, (2015). Moreover, as expatiated in WHO/ UNICEF JMP, (2017), developing countries like Bangladesh, Niger, and Nigeria still adopt the non-recovery faecal waste management

that involves the burying of filled latrines and digging of another within same premises. Another variant of the non-recovery faecal waste management method is the use of chemicals, particularly dichlorodiphenyltrichloroethane (commonly referred to as DDT) and calcium carbide to their shrink faecal sludge (Appiah-Effah, Nyarko, Gyasi & Awuah, 2014).

This had been earlier documented in Oyesile and Olapeju (2012), in their study on the Assessment of Faecal Waste Management in Ilaro, Nigeria that majority of households use non-recovery management method such as the usage of acids to shrink sludge in the management of their latrines. The non-recovery method of faecal waste management is the greatest threath to the recoverability of faecal waste and application for reuse. High energy char, which can be a domestic substitute for firewood and charcoal both of which negatively impinge on sustainable development Natalya (2010), as it affords cleaner cooking, can be produced when faecal waste is subjected to microwave hydrothermal carbonisation (M-HTC) treatment, which is a microwave assisted thermochemical conversion process between 180 °C and 200°C (Afolabi & Sohail, 2016). Solid biofuels, a renewable resource, which produce less greenhouse gas emissions, and construction materials like bricks and tiles can also be produced from faecal waste (Semiyaga, *et al.,* 2015).

However, like every other sustainability applications, the reuse of faecal waste involves a specific understanding of technological consideration (Laura, *et al.,* 2014). The quality and quantity of faecal waste, the design of sanitary installation, and accessibility are some of the factors that inform the selection of specific emptying method (Balasubramanya, *et al.,* 2017). The inevitable need to empty latrines in developing economies where sanitation technologies are esssentially on-site based creates the potential for a significant risk to public health and threathens faecal waste recoverability and reuse. This is because of the various unsustainable faecal waste emptying methods adopted by households. These emptying techniques lead to careless disposal of faecal waste and do not afford the opportunity of reuse. This is the case with Ogun State, the scope of this study, where households adopt faecal waste methods that lead to careless

disposal of faecal waste and do not afford the opportunity of reuse. The recent cases of cholera and gastroenteritis in the study area, Vanguard (2016),

The Guardian Newspaper 2016, further makes how households latrines are managed a poser that cannot be disregarded in the quest to proactively enhance current environmental health and sanitation. However, in a bid to fundamentally address the problems associated with badly managed latrines, there is need for the significant factors that influence the choice of households latrines' emptying methods to be appreciated. The study is aimed at investigating the significant factors influencing emptying methods of households' latrines' in Ogun State, with the view of providing sustainable solutions to the faecal waste management challenge.

Methods and Procedures

A total of 165 questionnaires were administered to representative households in the study area. This implies that 55, 50, and 60 questionnaires were administered in Surulere, Ilaro I, and Sodeke/Sale Ijeun I, respectively, on the basis of ratio 1.1:1.0:1.23, which reflects the variance in population of 1,250,435(33%), 1,112,761(30%), and 1,387,944(37%) for Ogun East, Ogun West and Ogun Central, respectively. The multi-stage method adopted, which several random processes enabled eventual selection of suitable samples within homogenous clusters, immensely reduced the chance of sampling error that could be associated with the sample percentage. However, significant factors influencing the choice of faecal waste emptying method adopted by households was determined through the multinomial logistic regression technique. Households' Faecal Waste Emptying Methods, the dependent variable for this analysis, at 0.00 significant levels, for both Kolmogorov-Smirnov and Shapiro=Wilk tests, failed the normality test. This, together with the fact that it is a polychotomous categorical outcome informed the choice of multinomial logistic regression for the analysis. Variables with a p-value of <0.05 after backward elimination were retained in the final equations.

RESULTS AND DISCUSSION

Socio-economic characteristics of survey respondents

The male gender accounts for the majority of respondents (64.2%)in the study area, of a preponderantlyYoruba population. The absolute ages of respondents varied from 27 to 78 years, with a median age of 52 years and a standard deviation of 12.8. Moreover, 79.5 % of respondents had secondary education as their highest educational qualification. A great percentage of the respondents were actively engaged in the economy (97.4%) as artisans, civil servants and private sector employees. However, the greatest chunk of respondents (45.9%) was ranked as belonging to the Lower-Middle Class. This is followed by others who were ranked in the Upper-Medium Class (26.1%), Floating Class (12.1) and the Rich (4.8%). This grouping, however, was guided by the World Bank classifications of economic classes on the basis of per capita consumption levels in Africa , which are < $61 dollars per month, < $124 per month,< $310 per month , <$ 620 per month , and > $ 620 per month for the Poor, Lower-Middle Class, Upper Middle Class, and the Rich, respectively (Corral, Molini & Oseni, 2017).

Significant Factors Influencing Emptying Methods of Households' Latrines.

The study reveals that the major types of faecal waste containment facilities in the study area are pit latrines (54.5%) and septic tanks (40.5%). In addition, the prevailing techniques for faecal waste emptying in the study area were classified into three groups. Emptying with the aid of manual emptiers (20.1%); emptying with mechanical emptiers (31.5%); and the non-recovery management (NRM) method (48.4%). The NRM is the dominant variant which involves burying of filled latrines with sand or digging new pits within the same compound, and the use of chemicals to shrink sludge.This multinomial logistic regression analysis revealed a lot of key information. First,the likelihood ratio chi-square of 15 with a p-value < 0.0001 suggests that the model, as a whole, fits significantly better than an empty model (i.e., a model with no predictors), which is the null hypothesis. Second, Cox & Snell R Square and Nagel

kerke R Square values of 0.640 and 0.684, respectively, which are the pseudo R square statistics, suggest that between 64% and 68.4% percent of the variability is explained by the model's predictors. Third, as shown in the first column of Table 1 labeled 'How Latrines Are Managed Whenever They Get Filled', the output above has three parts, and a reference category not reflected in the outcome. The first category (Empty the Pit with the Aid of Manual Emptiers), at P value 0.35, only the variable awareness of faecal waste reuse (DREUSE) was significant. Other variables and their categories had insignificant values. For the second category, awareness of faecal waste reuse (DREUSE), Lower-middle-class Income category (INCCAT 3) and Simple Pit latrines (LATTEC 2) at 0.18, 0.00, and 0.00, respectively were significant. Other sub-categories of income class such as poor class (INCCAT 1), floating class (INCCAT 2), upper-middle class (INCCAT 3), and the rich (INCCAT 4) were not significant. Similarly, other sub-categories of latrine technology such as Bucket latrine (LATTEC 1), Double pit latrine (LATTEC 3), VIP latrine (LATTEC 4), Aqua Privy latrine (LATTEC 5), WC to septic tank (LATTEC 6) and WC to sewers (LATTEC 7) were not significant. For the third category, only the sub-categories of income class such as floating class (INCCAT 2) and upper-middle class (INCCAT 4), both at 0.00, were significant. Other variables were not significant.

As evident in the second column of Table 2, for the first category, A one-unit increase in the scale of faecal waste reuse knowledge is associated with an even more increase of 1.494 (B value) in the relative log odds of households emptying their latrines with the aid of manual emptiers versus Shrinking Sludge with Strong Acids. For the second category, a one-unit increase in the scale of faecal waste reuse knowledge is associated with a 1.728 (B value) increase in the relative log odds of households emptying their latrines with the aid of mechanical emptiers versus Shrinking Sludge with Strong Acids. Further, the relative log odds of the propensity of households to using mechanical waste emptiers to empty latrines will increase by 22.979 (B value) if moving from the highest income class (INCCAT 4) level to the lower-middle level(INCCAT 3) . Also, the relative log odds of households tendency to use mechanical waste emptiers to

latrines will decrease by 3.926 (B value) if moving from the most advanced latrine technology of WC-to Sewer (LATTEC 7) to simple pit latrine (LATTEC 2). For the third category, the relative log odds of the propensity of households to burying filled pits with sand and digging another pit within the same compound will increase by 20.642 (B value) if moving from the highest income class (INCCAT 4) level to the lower-middle level (INCCAT 3). The relative log odds of the propensity of households to burying filled pit with sand and digging another pit within the same compound will increase by 19.405 (B value) if moving from the highest income class (INCCAT 4) level to the floating (INCCAT 2). These are the significant equations:

$$\text{Log } P\left[\frac{\text{Empty the Pit with the Aid of Manual Emptiers}}{\text{P[Shrink Sludge with Strong Acids}}\right] = -5.976+4.454\ (\text{DREUSE}) \quad (1)$$

$$\text{Log } P\left[\frac{\text{Empty the Pit with the Aid of Mechanical Emptiers}}{\text{P[prog Shrink Sludge with Strong Acids}}\right] = -26.064 +22.979\ (\text{INCCAT3}) -3.926\ (\text{LATTEC2}) +1.728\ (\text{DREUSE}) \quad (2)$$

$$\left(\text{Log } P\left[\frac{\text{Bury Pit with Sand and Dig Another Pit}}{\text{P[Shrink Sludge with Strong Acids}}\right]\right. = -15.057 +19.405\ (\text{INCCAT2}) + \left. 20.642\ (\text{INCCAT3})\right. \quad (3)$$

Fourth, the ratio of the probability of selecting one outcome group over the probability of choosing the reference category, in the instance of this study, 'shrink sludge with strong acids' is often referred to as relative risk. These relative risk ratios were, however, captured under the seventh column labeled "Exp (B)" in Table 1. For the first category, the relative risk ratio for a one-unit increase in the scale of the awareness of faecal waste reuse (DREUSE) is 4.454 for households who make use of manual emptiers for emptying their faecal waste versus Shrinking Sludge with Strong Acids. For the second category, the relative risk ratio for a one-unit increase in the scale of the awareness of faecal waste reuse(DREUSE) is 5.631 for households who make use of mechanical emptiers for emptying their faecal waste versus shrinking sludge with strong acids.

Moreover, the relative risk ratio of switching from the highest income class (INCCAT 4) level to the lower-middle level (INCCAT 3) is 9.547E9. This means that the propensity of households to use mechanical emptying option versus shrinking sludge with strong acids

increases by 9.547E9 from the highest income class(INCCAT 4) level to the lower-middle level (INCCAT 3). Also, the relative risk ratio of switching from the most advanced latrine technology of WC-to Sewer (LATTEC 7) to simple pit latrine (LATTEC 2) is 0.2. This means that the propensity of households to use mechanical emptying option versus shrinking sludge with strong acids decreases by 0.2 from WC-to Sewer (LATTEC 7) to simple pit latrine(LATTEC 2). However, for the third category, the relative risk ratio of switching from the highest income class (INCCAT 4) level to the lower-middle level (INCCAT 3) is 9. 219E8. This implies that that the propensity of households to bury filled pit with sand and dig another pit within the same compound versus shrinking sludge with strong acids increase by 9.219E8 from the highest income class(INCCAT 4) level to the lower-middle level(INCCAT 3). The relative risk ratio of switching from the highest income class (INCCAT 4) level to the floating class (INCCAT 2) is 2.677E8. This implies that that the propensity of households to bury filled pit with sand and dig another Pit within the Same Compound versus shrinking sludge with strong acids increase by 2.677 from the highest income class (INCCAT 4) level to the lower-middle level (INCCAT 3).

Table 1: Multinomial Logistic Regression Parameters.

How Latrines Are Managed Whenever They Get Filled[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Empty the Pit with the Aid of Manual Emptiers	Intercept	-5.976	2.916	4.200	1	.040			
	DREUSE	1.494	.707	4.463	1	.035	4.454	1.114	17.812
	[INCCAT=2]	-18.684	7627.190	.000	1	.998	7.682E-9	.000	.[b]
	[INCCAT=3]	1.599	1.121	2.032	1	.154	4.946	.549	44.549
	[INCCAT=4]	-.924	1.138	.659	1	.417	.397	.043	3.692
	[INCCAT=5]	0[c]	.	.	0	.	.	.	.
	[LATTEC=2]	.055	.856	.004	1	.949	1.056	.197	5.651
	[LATTEC=6]	0[c]	.	.	0	.	.	.	.

Empty the Pit with Mechanical Emptier	Intercept	-26.064	2.807	86.208	1	.000			
	DREUSE	1.728	.730	5.603	1	.018	5.631	1.346	23.554
	[INCCAT=2]	4.887	6347.075	.000	1	.999	132.510	.000	.[b]
	[INCCAT=3]	22.979	.752	933.986	1	.000	9.547E9	2.187E9	4.168E10
	[INCCAT=4]	21.060	.000	.	1	.	1.400E9	1.400E9	1.400E9
	[INCCAT=5]	0[c]	.	.	0	.	.	.	.
	[LATTEC=2]	-3.926	.834	22.154	1	.000	.020	.004	.101
	[LATTEC=6]	0[c]	.	.	0	.	.	.	.
Bury Filled Pit with Sand and Dig Another Pit within the Same Compound	Intercept	-15.057	2.326	41.922	1	.000			
	DREUSE	-1.077	.647	2.767	1	.096	.341	.096	1.212
	[INCCAT=2]	19.405	.943	423.156	1	.000	2.677E8	4.214E7	1.701E9
	[INCCAT=3]	20.642	.701	868.238	1	.000	9.219E8	2.336E8	3.639E9
	[INCCAT=4]	17.727	.000	.	1	.	4.999E7	4.999E7	4.999E7
	[INCCAT=5]	0[c]	.	.	0	.	.	.	.
	[LATTEC=2]	-.795	.791	1.010	1	.315	.451	.096	2.129
	[LATTEC=6]	0[c]	.	.	0	.	.	.	.

a. The reference category is: Shrink Sludge with Strong Acids.

b. Floating point overflow occurred while computing this statistic. Its value is therefore set to system missing.

c. This parameter is set to zero because it is redundant.

CONCLUDING REMARKS

The paper is an attempt to analyze the significant factors that inform the propensity of households to adopt a particular latrine emptying method. It is envisaged that the findings will be of help in environmental policy formulation and the application of both planning and technology in the quest for sustainable faecal waste management. As evident in the multinomial regression equations, awareness of income category, reuse and latrine technology featured prominently as the most significant factors. These call for a more systematic approach to faecal waste management.Foremost, the study, suggeststhere is need for the careful application of poverty mitigation strategies to not just result in the elevation of people's purchasing

ability but also targeted at improving how their faecal wastes are managed,towards improving it.There is the need for institutional authotities to engage households in the form of enlightenment campaigns aimed at sensitizing households on the nexus between the reusability of faecal waste management and the methods they adopt in emptying their latrines.Further, there is need for municipal authorities to encourage the adoption of simple onsite low-cost technologies, which can allow for sustainable latrine emptying and also afford recoverability and eventual reuse.

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