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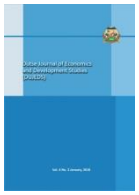

DETERMINANTS OF OPEN DEFECATION (OD) IN NIGERIA (1990-2015)

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Abstract

This study investigates the determinants of open defecation in Nigeria from 1990 to 2015 using annual time series data from World Bank World Development Indicators 2017 database and Central Bank of Nigeria annual reports and statement of accounts for various years. Johansen cointegration test, vector error correction model, impulse response and variance decomposition were used to analyzed the data. The study revealed that there exists a stable long-run equilibrium relationship amongst open defecation, income, and sanitation and literacy rate in Nigeria from 1990 to 2015 at 5 per cent level of significance. It also suggests that literacy rate, income and improved sanitation facilities are important determinants of open defecation that explained about 63 per cent variation in open defecation. Furthermore, impulse response showed that as literacy rate increases, open defection will decline and also as income increases, open defecation reduces. The variance decomposition revealed that literacy rate is the most significant driver of changes in the rate of open defecation, followed by income, then sanitation. The study recommends among other more public enlightenment on Community-Led Total Sanitation (CLTS) approach to sanitation and hygiene behaviour coupled with the significance of open defecation free society. There should be cash transfer to people that are below the poverty line so as to enhanced the income level in the country. More improved sanitation facilities-cum-public toilets/latrines should be provided in schools, markets, motor parks and transit points together with increased provision of mobile toilets/latrines during occasions/festivities so as to ensure "fixed-point defecation".

Keywords: Cointegration, Impulse Response, Income, Literacy Rate, Nigeria, Open Defecation, Sanitation, Variance Decomposition,
JEL Classifications: D62, I18, I31, O44, Q53, Q56, Q58

Introduction

Nigeria with a population of 122,352,009 people and a population density of 134. 34 people per square kilometer of land area in 1990 and a population of 181,181,744 and 198.93 people per square kilometer of land area in 2015 (World Bank, 2018), was the most populous country in Africa, and has an alarming number of over 35 million people defecating openly out of the 1.1 billion people that practice Open Defecation (OD) in the world, making the country the fifth in the ranks of open defecating countries, where India ranks first with about 620 million people (UNICEF, 2013 as cited by Singh, Chavan & Mathur, 2013). It is estimated that out of the 15 percent of the world's population that practice open defecation, about 215 million are in sub-Saharan Africa. Although between 1990 to 2010, there is a decline by 11 percent of the proportion of people defecating in the open spaces in the sub-Saharan African countries, but as a result of the growth in population, there has been an increased in absolute number of people practicing open defecation to 33 million during the same period (Galan, Kim & Graham, 2013). In 2015, the number of people practicing OD declined to 965 million worldwide (Mara, 2017), with rate of open defecation in rural areas of the world reduced by almost half from 38 percent in 1990 to 25 percent in 2015 where one in four people in the rural areas are still defecating in the open fields (United Nations, 2015). There are about 25.54 percent people practicing Open Defecation (OD) in Nigeria (World Bank, 2018) making the country as one of the countries of the world with more than 15 percent

of their population practicing OD in 2018. With the rapidly growing population and surprisingly as one of the fastest growing economies coupled with improved in sanitation and water supply, open defecation is also increasing in the country. Open defecation (OD) according to Galan, Kim and Graham (2013) refers to defecating in the open fields, forest, bushes, and bodies of water or other open spaces. It is simply a condition where human faces are disposed of in fields, forests, open bodies of water, beaches or other open spaces or disposed with solid waste (Federal Ministry of Water Resources, 2016). Ngwu (2017) posited that open defecation in rivers and lakes that are the sources of drinking water are more prevalence in the rural areas in Nigeria with serious health and environmental consequences.

Nigeria is one of the countries in World that have explicitly adopted the total sanitation approaches as part of its national policy. These approaches comprise of community-led total sanitation and community approaches to sanitation that were introduced to the sub-Saharan African countries in 2006 (Galan et al. 2013). However, despite this effort, there has been a decrease in access to sanitation facilities of 8% and 3% in the rural and urban areas respectively, between 1990 and 2015, where over 70 million people have no access to improved sanitation coupled with the more than 46 million people that are defecating openly in Nigeria (Federal Ministry of Water Resources, 2016). As of July, 2014, Community Led Total Sanitation (CLTS) implementation in Nigeria indicates that, out of the 123,240 total number of communities, there were 19,467 total number of triggered communities, with only 3,276 number of open defecation free (ODF) certified communities (UNICEF as cited in Federal Ministry of Water Resources, 2016).

Some of the reasons for open defecation as enumerated by Singh, Chavan and Mathur, (2013) are lack of toilet facilities, customs and traditions, perceptional barrier to construction of toilets. It was established that in the Krishnagiri, Pudukottai and Salem Districts of India, people believed that having toilets close to their houses was unhygienic and culturally inappropriate. Also open defecation was cleaner most especially during water scarcity coupled with inadequate resources to construct toilets (Singh et al, 2013). Other reasons are lack of adequate knowledge of the potential health and socio-economic consequences of open defecation. Coffey, Gupta, Hathi, Khurana, Spears, Srivastav and Vyas (2014 as Mara, 2017) discovered that many people in rural India claimed that open defecation was more pleasurable and desirable than using latrines. Galan, Kim and Graham (2013) asserted that internal conflict is also one of the causes of Open defecation (OD). Open defecation is more pronounced in the rainy season in Sub-Saharan Africa countries, when latrines are overfull, collapsed or washed away by heavy rainfall which also obstructs construction of new latrines, repairing or rebuilding the old latrines. There are also the beliefs by open defecators that human faces acts as fertilizer, hence it enhances the fertility of the land, thereby improving agricultural yields (O'Connell, 2014). It has been established by O'Connell, (2014) that when open defecation is perceived as a common behaviour, when there is no access to latrine, when people are in the farm or far away from their dwellings, or when they have negative feelings on the latrines' safety, durability, quality, hygiene and safety, defecating in the open fields is the last alternative. Acquisition of latrines is influenced by privacy, comfort and improved social status. While usage of latrines are influenced by embarrassment, humiliation and shame. It has also been argued by Spears (2013), that the failure of households to be using latrine instead of open defecation is their failure to take into account the negative effect of their open defecation on other individuals. According to United Nations Human Settlements Programme (UN-HABITAT) (2003) lack of toilets in their homes, unavailability of public toilets, too distant or too expensive has forced over "100 million urban dwellers worldwide are defecating in open spaces or into waste paper or plastic bags ("wrap and throw')" (p.xviii). Consult Abubakar (2018); Coffey, Gupta, Hathi, Khurana, Spears, Srivastav and Vyas (2016). O'Connell (2014) and Spears (2013) for review of some of the factors that influenced open defecation in many countries.

Though open defecation is an age-long common practice and as O'Connell (2014) revealed, open defecators has held it to be traditional, habitual and part of individual's daily routine. It is worrisome, due to its adverse consequences on health status of the population. As it causes ascariasis, cholera, dysentery, diarrhea, typhoid fever, trachoma, hookworm infection, under nutrition, stunting. Also it leads to environmental degradation through methane and carbon dioxide emission, coupled with reduction in the aesthetic beauty of an area (see Singh, Chavan & Mathur, 2013 for details). It is one of the leading causes of under-five mortality in sub-Saharan Africa (Galan, Kim & Graham, 2013). There is also physical violence comprising of rape, stabbing, murder and other bodily harm against women and girls as they go out to defecate in the bush, most especially in the night (Gómez, Gómez, Kabajuni, Kaur, King & Ricciardi, 2008 as cited in Mara, 2017). There are also loss of dignity and privacy (Water and sanitation Programme, 2012). Open defecation (OD) has social stigma and has contributed to violence against girls and women

which has been documented in Nigeria (Federal Ministry of Water Resources, 2016). It also causes child stunting (Spears, 2013). Some of the serious concerns regarding open defecation according to WaterAid (2009) are shame and disgust, fear of snake bites particularly in the night, risk of sexual abuse of women and girls. Others are distance to track in search of comfortable place to defecate and difficulty of open defecating whenever it is raining. See United Nations Human Settlements Programme (UN-HABITAT) (2003), Federal Ministry of Water Resources, (2016), Khurana, (2016), Mara, (2017), Ngwu, (2017), United Nations World Water Assessment Programme (WWAP) (2017) and Abubakar (2018) for detail treatment of the adverse health and environmental consequences of open defecation.

In recognition of the adverse effects of the open defecation on health and education, coupled with the country's inability to meet the Millennium Development Goals (MDGs) target, the National Council on Water Resources in agreement with the United Nations worldwide campaign to eliminate open defecation, fashioned out a national roadmap. The roadmap presented different strategies in 2014 to end open defecation (OD), which was later endorsed in 2016 by the Council, to make Nigeria an open defecation free country by 2025 (Federal Ministry of Water Resources, 2016). Where Open defecation Free (ODF) is when no faeces are openly exposed to the environment (Federal Ministry of Water Resources, 2016). This is in line with the Sustainable Development Goals (SDG) 6. The SDGs Goal 6 is "Clean Water and sanitation" and the target 6.2 specifies that "By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying attention to the needs of women and girls and those in vulnerable situations" (United Nations World Water Assessment Programme (WWAP), 2017, p.25).

Since the Sustainable Development Goals (SDG) sanitation target 6.2 is the elimination of open defecation (OD) by 2030 (United Nations General Assembly, 2015 as cited by Mara, 2017) by reducing the prevalence of open defecation to zero in developing countries, tagged as "No OD by 2030" and enhance the practices of "fixed-point defecation", "basic sanitation" or ideally safely-managed sanitation" (Mara, 2017). Also having established by Augsburg, Caeyers and Oteiza (2015 as cited by Mara, 2015) that, cost is the main barrier to the adoption of latrine in India and Nigeria. Furthermore, taking into account that the ability and capability of Nigeria to achieve the open-defecation-free country by 2025 has been questioned if no change in the approaches and strategies adopted in the past (Federal Ministry of Water Resources, 2016). It is important to identify the impact of income and other factors on open defecation in Nigeria which is one of the leading open defecating countries in the world. This is also necessary because it has reported by Water Aid (2009) that the practice of open defecation continues in West Africa due to the inability to adequately analyze or take into considerations the conditions behind it.

Although there are empirical studies on the factors influencing open defecation and related issues to open defecation in Nigeria, such as Aremu (2012), Water and sanitation Programme (2012), Spears (2013), Sample, Evans, Camargo-Valero, Wright and Leton (2016), Abubakar (2018), Abdu, Adewara and Oloni (n.d), Most of these studies used Demographic and Health Survey (DHS) data, some are cross-sectional in nature, while others are based on some few communities/schools, hence questioning the reliability of their results and findings. Taking into account the argument that "open defecation is a policy priority of the first-order importance" (Spears, 2013. p.3) and the negative consequences of the high level of open defecation as captured above coupled with the fact that none of the studies used time series data on Nigeria from 1990 to 2015, this current study attempted to fill the gap by investigating the determinants of open defecation in the country from 1990 to 2015 using annual time series data, so as to minimize or eliminate the practice of open defecation amongst the people and eradicate its negative externalities on the populace.

The remaining parts of the paper are as follows. Section 2 dwelled on literature review. Section 3 centre on the methodology of the study. Section 4 focuses on results and discussions and section 5 featured the conclusion and recommendations.

Literature Review

The conceptual framework for the determinants of open defecation can be situated within the SaniFOAM or simply FOAM framework comprising of *focus, opportunity, ability and motivation* factors (O'Connell, 2014), which influenced sanitation behaviour by impacting on individual's willing and ability to acquire and use latrines or practice open defecation as an acceptable norm or not. See figure 1.

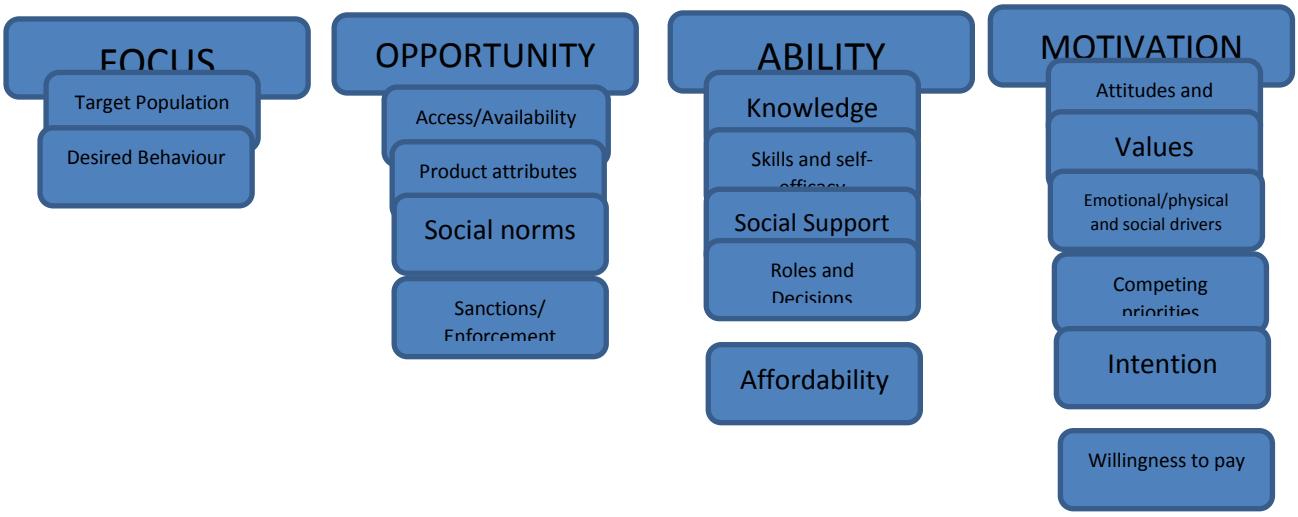

Fig. 1: SaniFOAM Framework

Source: O'Connell (2014)

The *focus* which is the first concept/factor of the framework dwells on the target population (open defecators) whose behaviour are main concern that need reforms and their desired behaviour (the practice of open defecation) that need to be eliminated or reduced (O'Connell, 2014).

The second concept of the framework the *opportunity*, centers on access/availability (of the latrines/toilets), product attributes (positive or negative perceptions regarding latrine quality, comfort, safety and hygiene that will determine whether to open defecate or not). It likewise considers social norms (tradition and culture that perceived open defecation as a common or natural behaviour), There are similarly sanctions/enforcement (law enforcements and other regulations that have bearings on the structural and institutional variables that determines people's desire to undertake a behaviour (to acquire a latrine and use it, town/villages rules and penalties on latrines construction, ownership and usage, elimination of open defecate or not) (O'Connell, 2014).

Ability which is the third factor of the framework captures knowledge (of variety of latrines and prices), skills and self-efficacy (to perform sanitation behaviour efficiently). It further centers on social support (for acquiring latrines and usage), roles and decisions (regarding purchases of latrines) and affordability (ability to pay for the toilet facilities or engage in sanitation behaviour by individuals or households) (O'Connell, 2014).

The last concept, *motivation* incorporate attitudes and beliefs, values (regarding the behaviour of concern that is open defecation), emotional/physical/social drivers, competing priorities with either the individuals or households concern), intention and willingness to pay (O'Connell, 2014).

Water Aid (2009) in a study of cultural drivers of open defecation in rural communities of four West African countries (Burkina Faso, Ghana, Mali and Nigeria) revealed that, there is a general perception that toilets/pit latrines have unpleasant heat and smell due to the human excreta. These make their usage unacceptable. Also in Burkina Faso and Mali, many people avoid going to the direction of toilets/latrines to ease themselves as they are ashamed or embarrassed by that action. More to that, some people in Burkina Faso believe that toilets/latrines are for the rich people. But in Bwaba ethnic group in Burkina Faso, it is an obligation on the guest to defecate in the farm of his host, if he gives him food. While in Tamale and WA East District of Ghana people practice open defecation because of the fear of demons or losing magical powers, hence their avoidance of toilets as being inhabited by evil spirits. In Idoma communities in Nigeria, and some parts of Mali open defecation is culturally encouraged as it is perceived to be an ancestral practice from generation to generations, where husbands do not permit their wives or daughters to use their latrines/toilets. It again discovered that due to poverty coupled with high cost of constructing latrines, open defecation is encourage in farm lands as an inexpensive source of fertilizer in most of the communities in the four countries surveyed.

In a study by United Nations World Water Assessment Programme (WWAP) (2017) worldwide there are about 2.1 billion people with access to improved sanitation facilities since 1990, 2.4 billion people without access to improved

sanitation facilities and about 1 billion people that are defecating openly. This tends to suggest that the lack of adequate sanitation facilities may be the reasons for open defecation.

Aremu (2012) investigated the nature of sanitation facilities in primary schools within Ilorin in North Central Nigeria using multistage sampling of 200 schools. Data were collected through physical inspection of the facilities and semi-structured questionnaire. Descriptive analysis was used to analyze the data. The study revealed that there are sufficient quantity of sanitation facilities in 22.5% of the schools, and there are fewer sanitation facilities in 23% of the schools. But, there are inadequate sanitation facilities for pupils in 84 schools (42%) and no functional latrines or urinals in 25 schools (12.5%) making the pupils defecate and urinate openly within the schools compound. It was discovered that, pupils from 26.5% of the schools used the sanitation facilities either because of cultural acceptability, privacy or security to the pupils. Pupils from 22.5% of schools seldom use the sanitation facilities due to lack of privacy or security risks. But pupils from 38.5% of the schools (representing 77 schools) do not use the sanitation facilities at all.

In a study by Water and sanitation Programme (2012) using data from Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS) and the Joint Monitoring Programme for Water and Sanitation (JMP), seventy (70) million people in Nigeria use unsanitary and shared latrines, and the poorest quintile is 10 times more likely to defecate in the open than the richest. Also, open defecation cost the country USS1 billion annually, whereas the cost of eliminating it would demand for less than 6.5 million latrines to be constructed and put to use. More to that, there are economic losses for access time to open defecate, US$ 243 million are lost every year, where an average of 2.5 days are spend by each person that is defecating openly due to securing a private place to defecate. The time lost in accessing open defecation site is valued at 30% and 15% of the Gross Domestic Product per capita for adults and children over 5 years respectively. These tend to signify the adverse effect of open defecation on productivity and income in the country.

Spears (2013) studied the association between sanitation and child height in 65 developing countries. Some of the results revealed that after accounting for Gross Domestic Product (GDP), the differences in open defecation are statistically significant in explaining the observed differences in average height between African countries and India. Where the differences between open defecation rate of 26 percent in Nigeria and 55 percent in India is connected "with an increase in child height approximately equivalent to quadrupling GDP per capita" (p.3).

Galan, Kim and Graham (2013) examined changes in open defecation prevalence in 34 sub-Saharan African countries between 2005 and 2010 based on national surveys data. Wilcoxon Signed-rank and Spearman's rank correlation tests were used to analyze the data. Their study revealed that only three (3) countries, Ethiopia, Angola and Sao Tome and Principe have recorded decreased in open defecation by 10 percent or more between 2005 and 2010. Their results further indicated that, there was no association between the reduction in open defecation prevalence and the existence of national sanitation policy, public sector budget or budget allocations. But, per capita GDP and economic growth are not related to the reduction in the level of open defecation prevalence. It was also discovered that, the reduction in open defecation has no relationship with the aid disbursement to the countries; no association between reduction in open defecation and the existence of total national sanitation approaches.

O'Connell (2014) reviewed of Water and Sanitation Programme (WSP) formative quantitative and qualitative research studies that were undertaken from 2006 to 2012 to identify the commonalities and differences coupled with the factors that determine sanitation behaviour in from of open defecation, acquisition of toilets and improvement of latrines in eight countries Cambodia, India, Indonesia, Kenya, Malawi, Peru, Tanzania and Uganda. Using descriptive analysis, it was found out that Open defecation is a common behavior among people which has been sustained by local cultural norms, that has emerged to be a social norm that is rooted in traditional belief and has been in practice since childhood, which in some communities in India and East Java, open defecation have locations established for it. More to that, wealthier individuals are more likely to own and use improved latrines, instead of open defecation. This implies that the poor people are more likely to practiced open defecation.

Coffey, Gupta, Hathi, Khurana, Spears, Srivastav and Vyas (2016) examined the social and cultural determinants high open defecation rate in India using nationally representative statistics on sanitation and human development from different countries, semi-structured qualitative interviews, quantitative survey data from 23,000 individuals in 3,200 households and long term fieldwork in some villages. Descriptive analysis was used to analyze the data. They find out that the exceptionally high rate of open defecation in rural India has no relationship with differences in poverty, literacy

rates or access to improved water. But rather open defecation has become more acceptable socially due to cultural values, beliefs and norms about purity, pollution, caste together with unique history and continuing practice of untouchability. Where many individuals perceived open defecation as upholding health, purity. Strength and masculine vigor, while the ownership and usage of affordable pit latrines as dirty, impure and ritually polluting. Furthermore, in India. Muslims are more likely to construct pit latrine and less likely to practice open defecation than Hindus

Sample, Evans, Camargo-Valero, Wright and Leton (2016) evaluated sanitation behaviour in two riverine communities of Odi and Kaiama in Bayelsa State, Nigeria. Data were collected using observations, interviews, and focus group discussions. The data were analyzed using NVivo and qualitative content analysis. They found out that where open defecations are widespread into water bodies, behind buildings, bushes and places close to dwellings, flood waters and dumpsites; the progress of the national policy of community-Led Total Sanitation (CLTS) are slower or non-existent where there are persistence of open defecations. It was also found out that about 32 percent and 39 percent of the people in Bayelsa State are practicing open defecation and hanging toilets constructed over the water bodies respectively. Furthermore, there are separate areas designated purposely for male open defecators and female open defecators close to the river banks which are considered the best side for open defecation in Odi and the water from the river are the perceived to be the best source of drinking water for the people. Some of the causes of open defecation in the two communities are physical factors in form of flooding, flood waters, river sites. Added to that, are cultural factors comprising of perceiving it as a tradition that has been passed from generation to generation, cultural and social norms, lack of shame and disgust. Other cause is economic factors comprising of the perception that there is no direct financial cost of open defecation and high cost of constructing toilets/latrines. There is the issue of inadequate space for toilet construction, expectation of free or subsidized toilets/latrine construction by the government and/or oil producing companies operating in the area.

Abubakar (2018) investigated the socioeconomic, demographic and geographic factors that influence and determine the open defecation among households in Nigeria with data from 2013 Demographic and Health Survey (DHS). Descriptive and inferential statistics were used to analyze the data. The study revealed that 32% of people in the country practice open defecation and there is a statistically significant difference between rural and urban households' practices of open defecation with a proportion of 23.8% and 7.5% in the rural and urban households respectively. In addition rural households are 2.5 times more likely to practice open defecation than urban households. Furthermore, educational level of the head of households is significantly associated with the level of open defecation, where OD is more pronounced with 13.9% in households where heads are uneducated, followed those with secondary having 7.8%, then primary education 7.6% and households with heads educated beyond secondary school with 2.1%. Ninety three percent (9.3%) of the people that practice open defecation are not educated beyond secondary school.

Abdu, Adewara and Oloni (n.d) examined the socioeconomic determinants of safe toilet facilities among households and factors responsible for the rural-urban disparity in accessing safe toilets in Nigeria using 2013 Demographic and Health Survey (DHS) data. Descriptive statistics, ordinary least squares (OLS), binary, probit regression models and Blinder-Oaxaca decomposition together with were used to analyze the data. They find out that people without access to safe toilets facilities has risen from 64 percent in 1990 to 69 percent in 2010 and 71.5 percent in 2013, with people practicing open defecation decreasing from 24 percent in 1990 to 23 percent in 2012. Their results similarly indicated that age in years, size of households, and level of education, locality, wealth index and ethnicity are statistically significant determinants of access to safe toilets. It equally revealed that as household size increases the probability to safe toilets access decreases. But as the educational level of household increases, the probability of access to safe toilet facilities increases. Furthermore, if the households' ethnic affiliation is either Hausa, Igbo or others, the probability of them using safe toilet facilities is higher than if it is Yoruba ethnic group. Households from North-West region are more likely to adopt and use safe toilet facilities than their counterparts from the other five Geopolitical zones of North-Central, North-East, South-East, South-South and South-West.

These empirical studies reviewed used either utilized Demographic or Health Survey (DHS) such as Abdu, Adewara and Oloni (n.d), Abubakar (2018), and Water and sanitation Programme (2012). While some of them are cross-sectional in nature, for example Spears, (2013), Galan, Kim and Graham, (2013), and WaterAid, (2009). Others focused on national surveys data, like that of Galan, Kim and Graham, (2013). There are some studies that used nationally representative statistics on sanitation and human development from different countries, semi-structured qualitative interviews, quantitative survey data and long term fieldwork, such as Coffey, Gupta, Hathi, Khurana, Spears,

Srivastav and Vyas, 2016). Similarly, others are based on some few communities such as Sample, Evans, Camargo-Valero, Wright and Leton, (2016) and some are schools-based studies like Aremu (2012). What are left to be understood these studies and others are times series econometric studies on the most important determinants of open defecation in form of income, sanitation facilities and literacy rate which influenced individual's behaviour, willing and ability to practice open defecation as an acceptable standard, norm or not as conceptualized by SaniFOAM/FOAM (O'Connell, 2014), most importantly in Nigeria. Also none of these studies capture dynamic long run relationship amongst the open defecation income, sanitation facilities and literacy rate variables in the country, using Johansen cointegration test, error correction, impulse response functions and variance decomposition analyses. Therefore, this present study endeavoured to bridge the missing link by investigating the determinants of open defecation in Nigeria using annual time series data, with the aforementioned techniques of analyses.

Methodology

This encompasses the nature and sources of data, model specification and methods of data analysis used.

Nature and Sources of Data

The study used annual time series data from 1990 to 2015 on open defecation (percentage of the population), sanitation, income (per capita gross domestic product (PGDP) were sourced from the World Bank's World Development Indicators 2017 dataset. While literacy rate was sourced from Central Bank of Nigeria annual reports and statement of accounts for various years.

Model Specification

In sub-Saharan African countries some of the dominant factors that could influence the prevalence of open defecation (OD) are; (a).Government policy and practices in form of implementation of the national sanitation policy, public sector budget line for sanitation, and government budget allocation to sanitation; b) Economic factors in form of per capita GDP, economic growth, the level of external development assistance for water and sanitation; c) Sanitation approach in form of adoption of total sanitation approaches at the national level (Galan, at al., 2013). However in the model specification for the determinants of open defecation comprises of Per Capita Gross Domestic Product (PGDP), improved sanitation, and literacy rate as depicted below:-

$$OPD_t = \alpha_{1t} + \beta_{1j} Log(PGDP)_{t-j} + \varphi_1 SAN_{t-j} + \psi_1 LIT_{t-1} + \varepsilon_t \ldots\ldots\ldots \quad (1)$$

Where: OPD= Open defecation is proxied by people practicing open defecation refers to the "percentage of the population defecating in the open, such as in fields, forest, bushes, open bodies of water, on beaches, in other open spaces or disposed of with solid waste" (World Bank, 2017).

PGDP= Income is proxied by GDP per capita refers "gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current local currency" (World Bank, 2017).

SAN= Sanitation facilities is proxied by access to improved sanitation facilities refers "to the percentage of the population using improved sanitation facilities. Improved sanitation facilities are likely to ensure hygienic separation of human excreta from human contact. They include flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet" (World Bank, 2017).

LTR= Literacy rate proxied by Adult literacy rate which is "Percentage of the population age 15 and above who can, with understanding, read and write a short, simple statement on their everyday life. Generally, 'literacy' also encompasses 'numeracy', the ability to make simple arithmetic calculations. This indicator is calculated by dividing the number of literates aged 15 years and over by the corresponding age group population and multiplying the result by 100 (World Bank, 2017)..

Unit Root Test

In order to determine the stationarity properties of the variables, to know whether they are stationary or non-stationary (that is, whether they have no unit root problems) and the order of integration, unit root test was carried out at intercept and trend within the Augmented Dickey-Fuller (ADF) test framework. The model for the unit root test of each of the individual variable in the study is as follows:

$$\Delta OPD_t = \beta_1 + \beta_2 + \delta OPD_{t-1} + ai\sum_{i=1}^{m}\Delta OPD_{t-i} + \varepsilon_t \ldots\ldots\ldots \quad (2)$$

$$\Delta Log(PGDP)_t = \varphi_1 + \varphi_2 + \varpi Log(PGDP)_{t-1} + \varpi i\sum_{i=1}^{m}\Delta Log(PGDP)_{t-i} + \varepsilon_{t2} \ldots\ldots \quad (3)$$

$$\Delta SAN_t = \varphi_1 + \varphi_2 + \lambda SAN_{t-1} + \delta i\sum_{i=1}^{m}\Delta SAN_{t-i} + \varepsilon_{t2} \ldots\ldots \quad (4)$$

$$\Delta LIT_t = \phi_1 + \phi_2 + \psi LIT_{t-1} + \delta i\sum_{i=1}^{m}\Delta LIT_{t-i} + \varepsilon_{t2} \ldots\ldots\ldots \quad (5)$$

Where all the variables are as earlier explained above.

Δ = is the different factor

ε_t = is pure white noise error term

The null hypothesis is that each of the variables, open defecation (OPD), Income (Log (PGDP), Sanitation (SAN) and Literacy rate (LIT) is not stationary (i.e., has unit root problem) against the alternative hypothesis that the variable is stationary. The null hypothesis of non-stationary is rejected if the ADF t-statistics in absolute term is more than the critical t-value at 5% level of significance.

Results and Discussions

Descriptive Analysis

The descriptive analysis of the variables are presented in table 1, where the average literacy rate which is 60.36 percent, with the maximum of 66.9 percent recorded from 2007 to 2015, and the minimum of 54.00 percent witnessed from 1990 to 1992. On the other hand, the average open defecation rate is 24.6 percent for the period from 1990 to 2015 with maximum percentage of open defecators of 25.1 percent in 2015 and the minimum of 24.00 percent in 1990.

Table 1: Descriptive Statistics

	LIT	OPD	PGDP	SAN
Mean	60.36538	24.60000	259423.6	33.26154
Median	57.70000	24.70000	209650.2	33.10000
Maximum	66.90000	25.10000	383023.4	38.10000
Minimum	54.00000	24.00000	186069.0	29.00000
Std. Dev.	5.254860	0.297993	75219.85	2.790280
Skewness	0.286725	-0.406969	0.446832	0.138269
Kurtosis	1.351811	2.294862	1.515223	1.809924
Jarque-Bera	3.299152	1.256356	3.253464	1.617151
Probability	0.192131	0.533563	0.196571	0.445492
Sum	1569.500	639.6000	6745013.	864.8000
Sum Sq. Dev.	690.3388	2.220000	1.41E+11	194.6415
Observations	26	26	26	26

Source: Author's computation using E-Views 10

Correlation Analysis

Table 2 presents the results of the correlation matrix, where there is a positive correlation between literacy rate (LIT) and open defecation (OPD) and income (PGDP). While there is positive correlation between open defecation and income. However, improved sanitation facilities (SAN) and literacy rate, open defecation and income.

Table 2: Correlation Matrix

VARIABLES	LIT	OPD	PGDP	SAN
LIT	1.000000			
OPD	0.863650	1.000000		
PGDP	0.930759	0.815673	1.000000	
SAN	-0.925501	-0.979453	-0.901897	1.000000

Source: Author's computation using E-Views 10

Unit Root Test

Augmented Dickey-Fuller (ADF) unit root test in table 3 indicates that we accept the null hypothesis that open defecation (OPD), income (Log (PGDP)) and sanitation (SAN) are non-stationary at levels because their absolute t-values are not greater than the 5% critical values. But they all become stationary at first difference, since the absolute t-values are greater than the 5% critical values. On the other hand that we reject the null hypothesis of non-stationarity of literacy rate (LIT) at level, because it absolute t-value is greater than the 5% critical values. Hence, the results suggest that, open defecation (OPD), income (Log(PGDP)) and sanitation (SAN) are integrated at order one [I (1)], whereas literacy rate (LIT) is integrated of order zero [I (0)].

Table 3: Augmented Dickey-Fuller (ADF) Unit Root test Results

Variables	**Augmented Dickey Fuller (ADF) test**		**5 % Critical values**		**Order of Integration**
	Levels	1st Difference	Levels	1st Difference	
Constant and Trend			*Constant and Trend*		
OPD	-2.5132269	-6.882856	-3.603202	-3.612199	I(1)
Log(PGDP)	-2.210939	-4.178510	-3.603202	-3.612199	I(1)
SAN	-0.631290	-9.668548	-3.612199	-3.612199	I(1)
LIT	-3.894152	-5.967251	-3,603202	-3.622033	I(0)

Source: Author's computation using E-Views 10

Optimal Lag Length Selection

In the estimation the relationship amongst open defecation (OPD), income (Log (PGDP)), sanitation (SAN) and literacy rate (LIT) in Johansen cointegration test and error correction mechanism, together with the subsequent impulse response functions and variance decomposition, it is important to determine the optimal lag length to be used. First of all VAR model was estimated using the variables at their levels in order to decide on the optimal lag length decided by lag length selection criteria in form of Likelihood Ratio test statistic (LR), Final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQ). The lag length from zero (0) to 5 was examined to determining the optimal lag length of the system. Table 4 presents the results of the optimal lag length of the Vector autoregressive (VAR) model, where the selection criteria suggested three conflicting results, as there is no agreement on the optimal lag length. Sequential modified LR test statistic suggested a lag length of three, Final prediction error (FPE) selected lag length of four, whereas Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQ) choose lag five. Therefore because of the conflict in the choice of the optimal lag length by the five lag selection criteria, stability test was conducted through Autoregressive (AR) Roots graph tests which reports the inverse roots of the characteristics AR polynomial to determine the most efficient and optimal lag length order to be utilize in the study (see appendix A for the AR roots). The stability of the estimated VAR/VECM model is confirmed if all the roots/dots have modulus less than one and lie inside the unit circle. Stability test is essential because if the VAR model is not stable, some of the results, findings or inferences from the study in form VAR, Johansen cointegration, error correction, variance decomposition, impulse response will not be reliable (see Quantitative Micro Software, LLC, 2004-2009). The results from the Autoregressive (AR) Roots graph revealed that all the roots or dots of the lag three chosen by sequential modified LR test statistic falls within/lie inside the unit circle and also all the roots or dots of the lag four as suggested by Final prediction error (FPE) falls within the unit circle. But Autoregressive (AR) Roots graph of the lag five suggested by Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQ) cannot be generated, because of insufficient number of observations to estimate 21 coefficients per equation in the VAR. Hence, lag three was the optimal lag length used for the Johansen cointegration, error correction mechanism, and impulse response and variance decomposition.

Table 4: Lag length selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: LIT OPD PGDP SAN
Exogenous variables: C
Date: 12/05/18 Time: 11:49
Sample: 1990 2015
Included observations: 21

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-285.1592	NA	10721397	27.53897	27.73793	27.58215
1	-181.3277	158.2194	2591.080	19.17407	20.16885	19.38996
2	-163.4993	20.37536	2657.164	18.99993	20.79054	19.38854
3	-127.6194	27.33706*	728.0681	17.10661	19.69304	17.66793
4	-59.54267	25.93399	27.78203*	12.14692	15.52918	12.88096
5	1419.827	0.000000	NA	-127.2216*	-123.0436*	-126.3149*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
Source: Author's computation using E-Views 10

Johansen Co-integration Test

Since the variables open defecation (OPD), income (Log(PGDP)) and sanitation (SAN) are integrated at order one [I (1)], and only literacy rate (LIT) that is integrated of order zero [I (0)], Johansen cointegration test was carried out. Though it is desired that all the variables should be integrated of the same order in conducting Johansen cointegration test, nevertheless, it has been documented by Asteroid and Hall (2007) that that is "not always the case, and that even in cases where a mix of I (0), I(1) and I(2) variables are present in the model, cointegrating relationships might well exist" (p.322). Johansen cointegration test was undertaking to investigate the long run equilibrium relationship among the variables, where literacy rate (LIT) that is integrated of order zero (I(0) was treated as exogenous variable in the model as suggested by Asteriou and Hall (2007), that variables that are either integrated of order zero (I(0) or dummy variables that are likely to "affect the behaviour of the model" (p.327) can be placed in the exogenous variable box in conducting Johansen cointegration test. The test was based on the following model.

$$\Delta OPD_t = \alpha_{1t} + \beta_{1j} Log(PGDP)_{t-j} + \phi_1 SAN_{t-j} + \psi_1 LIT_{t-1} + \sigma_{ij}\,\Delta \mathrm{OPD}_{\mathrm{t\text{-}j}} + \beta_{1j}\Delta Log(PGDP)_{t-j} + \phi_{1j}\Delta SAN_{t-j} + \psi_{1j}\Delta LIT_{t-j} + \varepsilon_t \ldots\ldots 6$$

The results of the Johansen cointegration test as presented in table 4 suggests that the null hypothesis of no cointegration is rejected, because trace and maximum eigenvalue statistics indicates one cointegrating equations at 5% level of significance, denoting that there is a stable long run equilibrium relationship amongst open defecation (OPD), income (Log(PGDP)), sanitation (SAN) and literacy rate (LIT) in Nigeria from 1990 to 2015. This implies that income and sanitation facilities are important drivers of open defecation in Nigeria. This is contrary to Coffey, Gupta, Hathi, Khurana, Spears, Srivastav and Vyas (2016) where they find out that the exceptionally high rate of open defecation in rural India has no relationship with differences in poverty, literacy rates or access to improved water. It is also in contrast to Galan, Kim and Graham (2013) when they examined changes in open defecation prevalence in 34 sub-Saharan African countries and showed that there were no association between the reduction in open defecation prevalence and the existence of national sanitation policy, per capita GDP and economic growth. However this current study is in agreement with O'Connell (2014) in a study of the factors that determine sanitation behaviour in from of open defecation, acquisition of toilets and improvement of latrines in eight countries Cambodia, India, Indonesia, Kenya, Malawi, Peru, Tanzania and Uganda which established that wealthier individuals are more likely to own and use improved latrines, instead of open defecation.

Table. 5: Johansen Cointegration test

Series: OPD LOG(PGDP) SAN
Exogenous series: LIT
Warning: Critical values assume no exogenous series
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.780353	55.04519	42.91525	0.0020
At most 1	0.508649	21.69900	25.87211	0.1517
At most 2	0.240976	6.065881	12.51798	0.4520

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.780353	33.34619	25.82321	0.0042
At most 1	0.508649	15.63312	19.38704	0.1617
At most 2	0.240976	6.065881	12.51798	0.4520

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source: Author's computation using E-Views 10

Reduced Form Vector Error Correction Model (VECM)

Having established the existence of long run relationship among the variables as demonstrated by Johansen cointegration test, the error correction modeling was carried out in order to investigate the movements of the variables or short run disequilibrium amongst the variables in the model over time as represented in equation (4.2) below and the reduced form of the output in table 5.

$$\Delta OPD_t = \alpha_{1t} + \beta_{1j}\Delta Log(PGDP)_{t-j} + \phi_{1j}\Delta SAN_{t-j} + \psi_{1j}\Delta LIT_{t-j} + \lambda ECT_{t-j} + \varepsilon_t .....7$$

Evidence from vector error correction results shows that the coefficients of the error correction mechanism (ECM) of open defecation (OPD) of 0.097 and sanitation facilities (SAN) of 0.27 are not statistically significant in correcting for the short run disequilibrium at 5% level of significance, because their coefficients are wrongly signed as they turned out to be positive and the t-statistic of 0.47 and 1.81 respectively are not statistically significant. Hence, they failed to adjust for the deviations from the long term equilibrium relationship. But the coefficients of income per capita log (PGDP) though correctly signed as it turned out to be negative -0.34, but are not statistically significant at 5% level of significance in correcting for the short run disequilibrium, since the t-statistic is -1.48. This advocate that, there is absence of convergence to equilibrium path, signifying that the adjustment process takes longer period of time regarding the relationship amongst open defecation (OPD), income (Log(PGDP)), sanitation (SAN) and literacy rate (LIT) in Nigeria from 1990 to 2015 at 5 percent level of significance.

The R-squared showed that the endogenous variables in form of income per capita and sanitation facilities together with the literacy rate which served as the exogenous variable in the model have explained about 63 percent variation in open defecation in Nigeria. The standard errors are acceptably low in all the equations and the goodness of fit statistics suggested that the model significantly explains substantial variations of the series in the system.

Table 6: Reduced form Equation of Vector Error Correction model (VECM)

Error Correction:	D(OPD)	D(LOG(PGDP))	D(SAN)
CointEq1	0.097110	-0.337990	0.268474
	(0.20456)	(0.22763)	(0.14861)
	[0.47471]	[-1.48481]	[1.80657]
C	0.349606	-0.269662	-0.377451
	(0.62270)	(0.69292)	(0.45238)
	[0.56143]	[-0.38917]	[-0.83438]
LIT	-0.004035	0.012291	-0.003971
	(0.01070)	(0.01191)	(0.00777)
	[-0.37705]	[1.03222]	[-0.51079]
R-squared	0.628282	0.650119	0.808727
Adj. R-squared	0.219392	0.265250	0.598326
Sum sq. resids	0.019769	0.024478	0.010433
S.E. equation	0.044462	0.049476	0.032300
F-statistic	1.536556	1.689194	3.843747

Source: Author's computation using E-Views 10

Vector Autoregressive (VAR) Model

All the variables are taken to be endogenous, where each is treated as both a dependent variable that is explained by other variables in the model and also an explanatory variable in explaining other variables in the model (see Asteriou & Hall, 2007 for detail). The Vector autoregressive (VAR) model was used as a platform to estimate impulse response functions (IRFs) and Variance Decomposition (VD) as follows:-

Impulse Response Functions (IRFs) Results

Impulse Response functions (IRFs) indicates how each of the variables in the study responds to shocks from other variables of interest in the model. Increasing graph represents positive responses to shocks; whereas decreasing graph symbolizes negative responses to the variable(s) shocks in the system (see Holly & Turner, 2010). However in the analyzing of the impulse response functions, attention is centered on the response of open defecation to the unexpected shocks in income, sanitation and literacy rate as captured by the graphs in the second row in figure 2 using a ten quarters horizon.

Response of Open Defecation (OPD) to Endogenous Variables

The response of open defecation to unexpected shocks in literacy rate has been negative, which implies that as literacy rate increases, open defection will decline. This is in line with the findings of with Abdu, Adewara and Oloni (n.d) that as the educational level of household increases, the probability of access to safe toilet facilities increases in Nigeria. The results is not unexpected because when people are more educated, they will have requisite knowledge and take cognizance of the potential health and socio-economic consequences and negative effects of open defecation on themselves and other individuals; they will acquire latrines so as to ensure their privacy, comfort and enriched their social status; and they will avoid embarrassment, humiliation and shame that accompanied open defecation.

Also income proxies by per capita GDP have negative impact on open defecation, most especially in the short and medium term. This implies that as income of people improved, they will have more access l to toilets/latrines facilities as they will afford/be able to pay for the latrines/toilets or engage in sanitation behaviour that can reduce open defecation as captured by the FOAM framework. This is also in agreement with the findings by O'Connell (2014) that wealthier individuals are more likely to own and use improved latrines, instead of open defecating in the open fields.

The response of open defecation to the improvement in sanitation facilities though positive in the short run has turned out negative in the long run, hence depicting that as people moved up in the sanitation ladder, they tend to realize the importance of improved sanitation by ensuring hygienic utilization of flush/pour flush toilets, ventilated improved pit (VIP) latrine, pit latrine with slab, or composting toilet in their households in particular and the community in general.

Open defecation is self-generating as it has responded positively to its own innovations

throughout the ten quarters. This is not surprising as its reinforces the findings that since people are used to open defecation it becomes a common behavior among them which has been sustained by local cultural norms, that has appeared to be a social norm rooted in traditional belief and has been in practice since childhood in some communities in India and East Java (O'Connell, 2014). More to that, according to Coffey, Gupta, Hathi, Khurana, Spears, Srivastav and Vyas (2016) open defecation in India has become more acceptable socially due to cultural values, beliefs and norms about purity, pollution, caste together with unique history and continuing practice of untouchability, many individuals perceived open defecation as upholding health, purity. Furthermore because of acceptability of open defecation as a social norm in Odi, Bayelsa State of Nigeria, there are isolated areas purposely earmarked for male open defecators and female open defecators (Sample, Evans, Camargo-Valero, Wright & Leton, 2016).

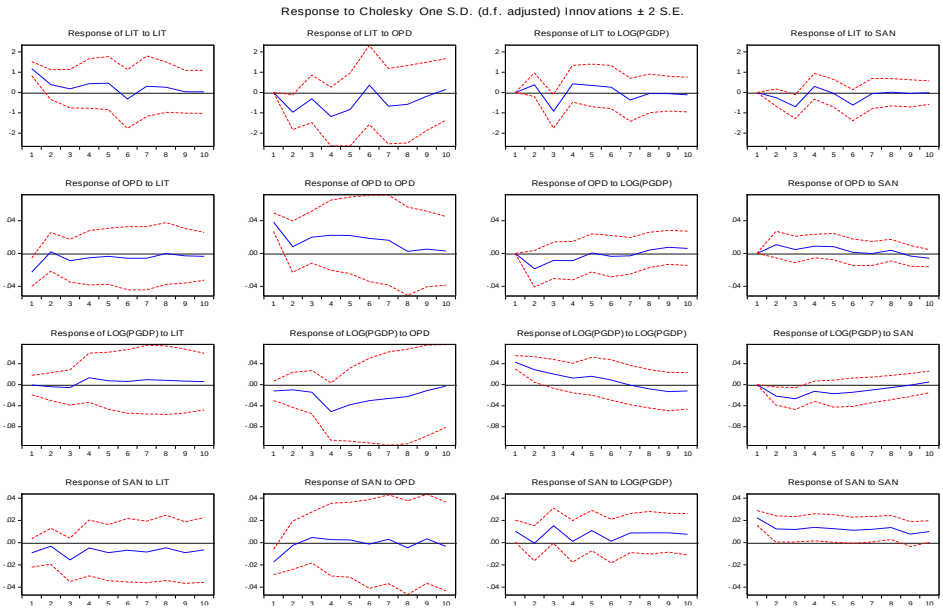

Fig. 2: Impulse Response Functions (IRFs) graphs.

Source: Author's computation using E-Views 10

Variance Decomposition Results

Variance Decomposition was conducted to examine the share of the variations in the endogenous variables emerging from the endogenous variables and the transmission to all other variables of interest in the VAR system (Le & Chang, 2011). Hence, it is a mechanism for determining the relative importance of changes in income, sanitation and literacy rate in influencing open defecation in Nigeria. Based on that only the variance decomposition of open defecation is presented, but variance decomposition of the remaining variables are in appendix B.

The Variance of Open Defecation (OPD)

Variance error decomposition of Open Defecation (OPD) in table 6 revealed that it had explained 74 percent and 68 percent variations of itself in the 1st and 10th periods respectively. Literacy rate has explained 26 percent of the changes in open defecation, whereas income (Log(PGDP) and sanitation (SAN) recorded zero (0.00%) of the forecast error variance of open defecation in the 1st period.

Literacy rate (LIT) has accounted for 26.10 percent variation of the forecast error variance of open defecation in the 1st quarter, 14.68 percent in the 5th quarter and 13.75 percent in the 10th quarter. This implies that literacy rate is the most significant driver of changes in the rate of open defecation apart from the "own shocks", though its importance has declined other the periods. Also it suggests that low level of literacy in the country may have been one of the most important reasons behind the high rate of open defecation as the open defecators have inadequate knowledge of the negative consequences of the open defecation on the health and socioeconomic status of the society in general. This also in line with the findings of Abubakar (2018) educational level of the head of households is significantly associated with the level of open defecation. Therefore educating the populace on the significance of open defecation free society and the dangers associated with open defecation practices can go a long way in reducing this menace.

Table 7: Variance Decomposition of open defecation in Nigeria

	Variance Decomposition of OPD:				
Period	S.E.	LIT	OPD	LOG(PGDP)	SAN
1	0.044376	26.09538	73.90462	0.000000	0.000000
2	0.050035	20.68212	60.89117	13.81409	4.612623
3	0.055431	19.34851	62.63587	13.49098	4.524633
4	0.061274	16.57670	64.50387	13.09328	5.826154
5	0.065724	14.68441	67.24431	11.38932	6.681961
6	0.068574	14.20241	68.90575	10.71398	6.177860
7	0.070781	14.01603	69.96069	10.22460	5.798686
8	0.071070	13.90218	69.52411	10.50723	6.066481
9	0.071788	13.77411	68.72406	11.38293	6.118898
10	0.072432	13.75209	67.69033	11.90357	6.654003

Source: Author's computation using EViews 10

Innovations in income proxies by per capita GDP (Log(PGDP)) has explained less than zero percent in the 1st quarter, increase to 14 percent in the 2nd quarter then dropped to 11.39 percent in 5th quarter and 12 percent in the 10th quarter of the forecast error variance of the open defecation (OPD). This signifies that income is significant in influencing the level of open defecation in Nigeria, most especially in short term. This inclines to the prominence of enhancing the income level of the people in the drive to eliminating the rate of open defecation in the country by 2025 as stipulated in the national roadmap and the Sustainable Development Goals (SDG) 6, target 6.2 of ending open defecation in the World by 2030.

Improved sanitation facilities (SAN) have explained about 4.61 percent, 6.18 percent and 6.65 percent of the variation in open defecation in the 2nd, 5th and 10th horizons respectively. It suggests the importance of inadequate sanitation facilities as one of the factors behind the growth of open defecation practices in the society.

Conclusion and Recommendations

This study investigates the determinants of open defecation in Nigeria from 1990 to 2015 using annual time series data sourced from World Bank World Development Indicators 2017 database and Central Bank of Nigeria annual reports and statement of accounts for various years. Johansen cointegration test, vector error correction model, impulse response and variance decomposition were used to analyze the data. The study revealed that there exists a long run equilibrium relationship amongst open defecation, income, and sanitation and literacy rate in Nigeria from 1990 to 2015 at 5 percent level of significance. It also suggests that literacy rate, income and sanitation facilities are important determinants of open defecation having explained about 63 percent variation in open defecation in the country. Furthermore, impulse response indicates that literacy rate increases, open defection declines and also as increases income per capita GDP open defecation declines, most especially in the short and medium term. The variance decomposition revealed that literacy rate is most significant driver of changes in the rate of open defecation, followed by income, then sanitation.

There should be more public enlightenment on Community-Led Total Sanitation (CLTS) approach to sanitation and hygiene behaviour plus the significance of open defecation free society and the inherent dangers associated with open defecation practices in order to create a sustainable solution in eliminating the practice of open defecation in the country by the communities themselves. Since increase in income has been found to be associated with a reduction in open defecation, efforts should be geared towards enhancing the income level in the country through cash transfer to people that is below the poverty line. Furthermore, there should be provision of more improved sanitation facilities-cum-public toilets/latrines in schools, markets motor parks and transit points coupled with increased provision of mobile toilets/latrines during occasions/festivities to ensure "fixed-point defecation" by both the government and the private sector.

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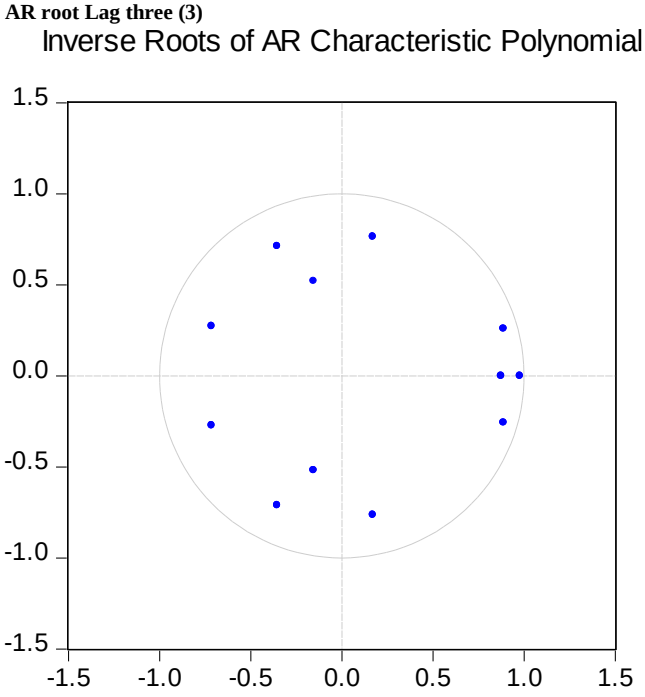
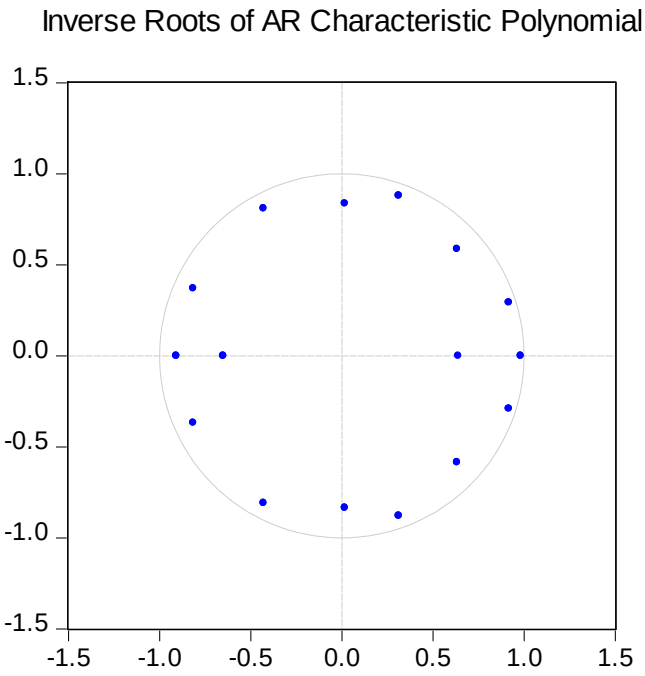
APPEDNIX "A": AUTOREGRESSIVE (AR) ROOTS GRAPH

AR root Lag three (3)



AR root Lag four (4)



APPENDIX "B": VARIANCE DECOMPOSITION

Variance Decomposition of LIT:					
Period	S.E.	LIT	OPD	LOG(PGDP)	SAN
1	1.176364	100.0000	0.000000	0.000000	0.000000
2	1.637155	57.27950	34.94178	5.402839	2.375884
3	2.036631	37.84437	24.89982	23.98578	13.27004
4	2.454362	29.28489	40.45319	19.60096	10.66096
5	2.655760	28.02745	44.38551	18.45791	9.129127
6	2.782512	26.84156	42.16226	17.72585	13.27034
7	2.902365	25.81025	44.11844	17.84068	12.23063
8	2.971583	25.39274	45.89262	17.04533	11.66931
9	2.978448	25.29717	46.06939	16.99776	11.63568
10	2.984404	25.20947	46.14173	17.05865	11.59015

Variance Decomposition of OPD:					
Period	S.E.	LIT	OPD	LOG(PGDP)	SAN
1	0.044376	26.09538	73.90462	0.000000	0.000000
2	0.050035	20.68212	60.89117	13.81409	4.612623
3	0.055431	19.34851	62.63587	13.49098	4.524633
4	0.061274	16.57670	64.50387	13.09328	5.826154
5	0.065724	14.68441	67.24431	11.38932	6.681961
6	0.068574	14.20241	68.90575	10.71398	6.177860
7	0.070781	14.01603	69.96069	10.22460	5.798686
8	0.071070	13.90218	69.52411	10.50723	6.066481
9	0.071788	13.77411	68.72406	11.38293	6.118898
10	0.072432	13.75209	67.69033	11.90357	6.654003

Variance Decomposition of LOG(PGDP):					
Period	S.E.	LIT	OPD	LOG(PGDP)	SAN
1	0.044355	0.017626	7.058917	92.92346	0.000000
2	0.058062	0.453728	6.915505	78.71482	13.91595
3	0.068745	0.912552	9.258404	65.00281	24.82624
4	0.088516	2.759235	39.01563	41.23097	16.99416
5	0.099361	2.761065	45.48059	35.32519	16.43316
6	0.105452	2.809664	48.63479	32.09132	16.46422
7	0.109527	3.373242	50.77875	29.75308	16.09493
8	0.112566	3.763872	52.09293	28.66660	15.47660
9	0.114071	4.015202	51.67876	29.23075	15.07528
10	0.114985	4.203061	50.91250	29.83820	15.04624

Variance Decomposition of SAN:

Period	S.E.	LIT	OPD	LOG(PGDP)	SAN
1	0.031433	8.493729	30.43421	10.81012	50.26194
2	0.033996	8.179660	26.52704	9.261015	56.03228
3	0.042333	18.61009	18.31707	18.94826	44.12458
4	0.044854	17.69278	16.67674	16.94555	48.68494
5	0.048773	18.35896	14.36952	19.35827	47.91325
6	0.050525	18.90810	13.44999	18.10250	49.53941
7	0.053422	19.41083	12.34943	18.83213	49.40761
8	0.056208	18.23199	11.81720	19.48092	50.46988
9	0.058225	19.37359	11.36116	20.48002	48.78524
10	0.060004	19.41200	11.01285	20.84824	48.72690

Cholesky Ordering: LIT OPD LOG(PGDP) SAN