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TOWARDS A SUSTAINABLE INCENTIVE TO OPEN DEFECATION ERADICATION

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Abstract: This study is aimed at estimating the significant indicators and constructs that directly influence households to recover and reuse faecal waste in Ogun state, Nigeria. Adopting a four-level multi-stage approach, a total of 110, 100, and 120 questionnaires were respectively administered in Ogijo/Likosi, Ilaro I, and Sodeke/ Sale-Ijeun II wards. The selected criteria reflect the variance in the populations of 1,250,435(33%), 1,112,761(30%), and 1,387,944(37%) for Ogun East, Ogun West and Ogun Central, respectively. The pooled confirmatory factor analysis process took the form of several re-estimations,based on the deletion of lowly loading factors and correlation of redundant items, validation of the model, assessment of normality,and full structural model analysis. The structural model established a significant positive relationship between Environmental/Health Factors of Faecal Waste Reusability (EV) and Reusability Factor(RF) (β=0.727, $p<0.05$), and similarly, Economic Factors of Faecal Waste Reusability (EC)and Reusability Factor (RF) (β=0.715, $p<0.05$). The study, among all others, recommends a more flexible sanitation business value chain model that is household inclusive and conforms to the paradigm of green and circular economy.

Keywords: Faecal waste, open defecation, recovery, reuse, modelling.

Introduction

Various strategies have been employed the world over to nip in the bud open defecation, which is practiced by over 892 million people in the world, and has economic and social implications, as clearly shown in Figure 1 (Water Aid, 2016; WHO/UNICEF JMP, 2017). In Asian and African countries, where open defecation is prevalent, municipal authorities, and sometimes government at the center, have enacted laws, which impose fines, arrest, and prosecute sanitation offenders (Osumanu *et al.*, 2016). However, as critiqued by Osumanu *et al*. (2019), bye-laws are hardly enforced, as most households, especially those in rural areas lack the knowledge of the existence of such laws. Apart from the awareness and enlightenment challenge, agencies saddled with the responsibility to enforce sanitation laws usually lack the capacity, both in manpower and mobility resources to effectively monitor households. Moreover, as democracy has started to gain greater traction in most countries plagued with the open defecation challenge, political actors weigh the political costs of punitive actions. Bye-laws such as those of developing countries, which are aimed at disciplining open defecators and raising civic consciousness of households, equally have class and human rights dimensions. Many of the punitive measures are deemed to be elitist and essentially prioritize the upper-class concerns along the lines of aesthetics, health, and leisure under the larger scope of environmental quality in a manner that conflicts with the basic rights of the poor. The inherent shaming in the punitive measures for preventing open defecation appears draconian, race-based, and similar to practices from the colonial era (Synne *et al.*, 2011; Lomas & Hammersley-Mather, 2016). Sumedh (2018) equally submits that the adoption of the punitive and shaming strategies for open defecation prevention violates human rights and ultimately do not achieve intended results.

Another popular measure that had been adopted at different points in history by countries where open defecation is endemic is the provision of subsidies. Subsidies could be in the form of financial incentives to households for toilet construction or direct intervention by central government in mass toilets' provisioning. Both financial incentive variant and direct intervention by the central government in toilet construction have been widely applied in countries like India. According to the Government of India (2017), the Total Sanitation Campaign programme that was the penultimate precursor to the Swachh Bharat Abhiyan (SBA) or "Clean India Mission" afforded households the amount of 3,200 rupees, if they contributed 300 rupees, and monetary reward was given to communities declared as open-defecation free to intensify competition on sanitation improvement. This, however, has been criticised for not being as effective, despite the huge cost burden it places on governments, international donors, and non-governmental organisations, as toilet utilisation by households still remains low (The Ministry of Drinking Water and Sanitation, 2015).

The principle of behavioural change that was the underlining anchor of the Bangladesh National Sanitation Campaign (BNSC) in 2003 adopts smart means, which can also be said to have a shaming but psychologically compelling effect, such as getting technical facilitators to demonstrate to households how open defecation can culminate in the accidental ingestion of faeces (Alexander *et al.*, 2016). Several African countries like Mali and Kenya had also effectively deployed the principle of behavioural change in the implementation of their Community Led Total Sanitation (CLTS). For instance, it led to the construction of 60,000 new latrines and 1,780 villages declared to be open-defecation free in the five regions of Mali where the CLTS operated. In the Kenyan instance, 43% of villages where open defecation was prevalent were declared open-defecation free, four years after the adoption of behavioural change based CLTS (Pickering *et al.*, 2016). Proponents have argued that sole reliance on behaviour-change based campaigns would have far reaching effects than subsidies and punitive measures. Others disagree that, based on findings in Indonesia, Tanzania and India, the quest for open defecation eradication and general sanitation improvement would become more efficacious through means that incentivize households to invest in the construction and maintenance of sanitation facilities and get them even more incentivized to use the facilities more often (Pattanayak, 2015).

One means is the leveraging on the reusability of faecal waste in nudging households to be more selfishly prone to considering containment of their faeces a profitable venture, an area that has not been fully exploited and institutionalised as an open defecation prevention strategy. Resource recovery and reuse affords incentivising opportunities for voluntary investment in the construction of household toilets (Rao *et al.*, 2017). As canvassed by Mittal *et al.* (2017), the incentive alternative of creating values for faecal waste, by virtue of its reusability, offers the promise of greater sustainability as it affords the recovery of both construction and maintenance costs, and the costs recovery is essentially a function of frequent use to make resource available. It needs to be stressed that the scope of faecal waste reuse has now gone beyond the sphere of traditional agricultural application, which was hitherto motivated by easy disposal and not necessarily deliberate commerce driven need to recover and reuse nutrients (Jimenez *et al.*, 2010; Andersson *et al.*, 2016; Olufunke *et al.*,2016). In the same agricultural sphere, faecal waste also commands reuse value in the production of feeds for aquaculture livestock (Danso *et al.*, 2017). According to Olapeju *et al.*(2019), the inorganic elements in faecal waste have been found useful in the construction industry. The incinerator ash residue from sewage sludge incineration, when mixed with dried sludge can be applied as additives in making construction materials like tiles, bricks, artificial lightweight aggregates, and cement material (Semiyaga *et al.*, 2015). The frontiers of reuse, in the light of new interest in green and circular economy and improvements afforded by technology, have extended to applications such as high energy char, which is a product of the microwave thermo-chemical conversion process between 180°C and 200°C, and can be a greener alternative to firewood and charcoal –the main cooking energy sources of poor households in Africa, and eliminating associated environmental impacts (Afolabi *et al.*, 2017). Moreover, as canvassed in Mohson *et al.*(2017), biogas which is a mix of methane, carbon dioxide and other gases in small quantities which can be converted to heat or electricity (Jouhara *et al.*, 2017; Malinauskaite *et al.*, 2017) can be recovered from faecal waste. The foregoing should make the incentive of reuse in the eradication of open defection an imperative for developing economies that are most beset with budget and capacity constraints to implement and sustain the option of direct intervention through subsidies as their open defecation eradication strategy. But there is still a gap between the knowledge of faecal waste reuse and actual premiums placed on the resource by households owing to cultural, social, economic, environmental, technological, and awareness factors. The pragmatism of this incentive strategy should spinoff further investigations as, at the target households' level, recovery and reusability would be a function of how households perceive such factors. Hence, this study is aimed at employing the structural equation model to estimate the significant indicators and constructs that directly influence households to recover and reuse faecal waste in Ogun state Nigeria. The study is planked on the theory of sustainable sanitation, which deems excreta as not being a waste but a valued resource that can be recovered, recycled, and reused (Andersson *et al.*, 2016).

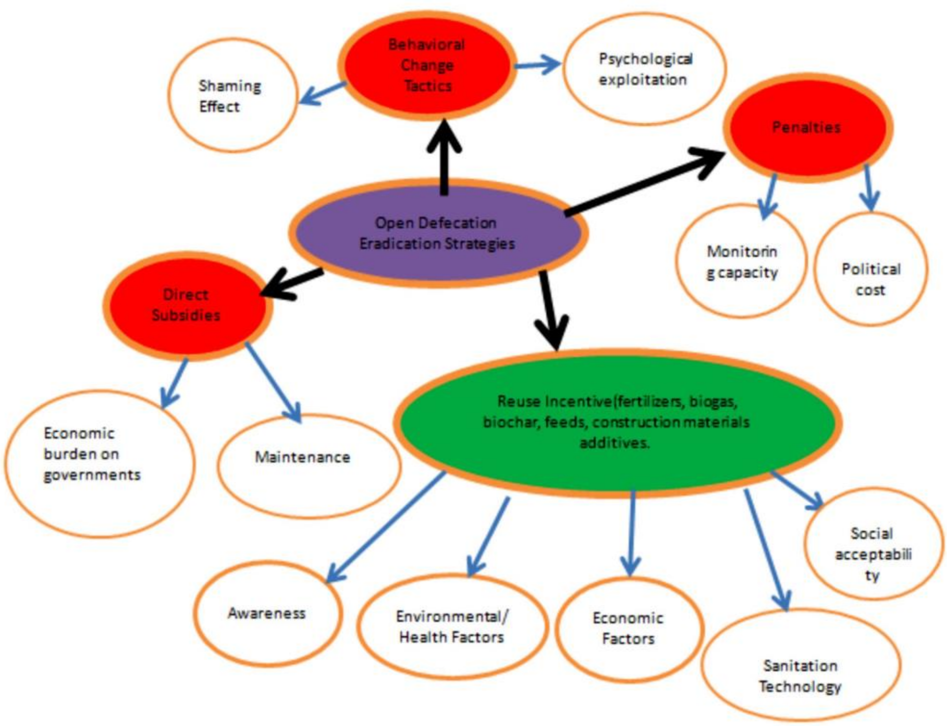

Figure 1: Global Strategies for Discouraging Open Defecation

Methods and Procedures

The study adopted the convergent parallel variant of the mixed-mode technique, which involves the conflation of quantitative and qualitative method of data collection. For the quantitative element, the multistage approach, in a four level manner, was adopted. This is inclusive of all political divisions in the study area. Foremost, as shown in Figure 2, Ogun State is shown as one of the 36 states in Nigeria. Ogun state was classified on the basis of its three main senatorial districts, which are Ogun Central Senatorial District, Ogun East Senatorial District, and Ogun West Senatorial District, as shown in Figure 3. These geographical groupings represent the three major regional divisions within the State. Further, Ogun East Senatorial District consists of nine local governments, which are: Ogun Waterside, Ijebu East, Odogbolu, Ijebu North, Ikenne, Ijebu North-East, Ijebu-Ode, Sagamu, and Remo North. Egbado North, Ado-Odo/Ota, Egbado South, Ipokia, and Imeko-Afon are the five local governments in Ogun West Senatorial District. Moreover, Ogun Central Senatorial District encapsulates six local governments, which are: Odeda, Obafemi/ Owode, Abeokuta South, Abeokuta North , Ewekoro, and Ifo.

In the second stage, the random selection of Sagamu, Egbado South, and Abeokuta South Local Governments as the sampling Local Governments in Ogun East Senatorial District, Ogun West Senatorial District, and Ogun Central Senatorial District, respectively was done. The third stage involves the random selection of a representative ward, based on the wards and polling unit delineations of Independent National Electoral Commission (INEC), from each of the sampling Local governments. In Sagamu Local Government, which consists of 15 political wards namely: Oko/Epe/Itula I; Sabo I, Oko/Epe/Itula II; Sabo II; Ayegbami/Ijokun; Isokun/Oyebajo; Ijagba; Ode-Lemo; Latawa; Ogijo/ Likosi; Simawa/Iwelepe; Surulere; Isote; Ibido/Ituwa/Alara,and Agbowa, Ogijo/Likosi ward was randomly selected as the sampling ward. Out of the 10 political wards in Egbado South, namely Ilobi/Erinja, Ilaro I; Iwoye; Ilaro II; Idogo; Ilaro III; Owode I; OkeOdan; Owode II; and Ajilete, Ilaro I was randomly selected as the sampling ward. Further, Sodeke/Sale-Ijeun II was randomly selected as the sampling ward in Abeokuta South Local Government, which encapsulates 15 political wards, namely, Ake I; Keesi/Emere; Ijemo; Ake II; Ake III; Itoko; Erunbe/OkeIjeun; Ijaye/Idi-Aba; Sodeke/Sale-

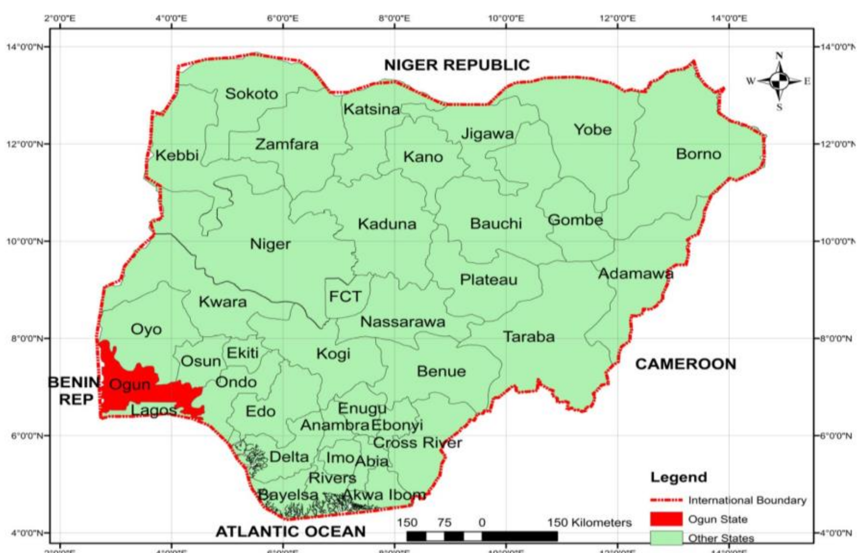

Figure 2: Map of Nigeria

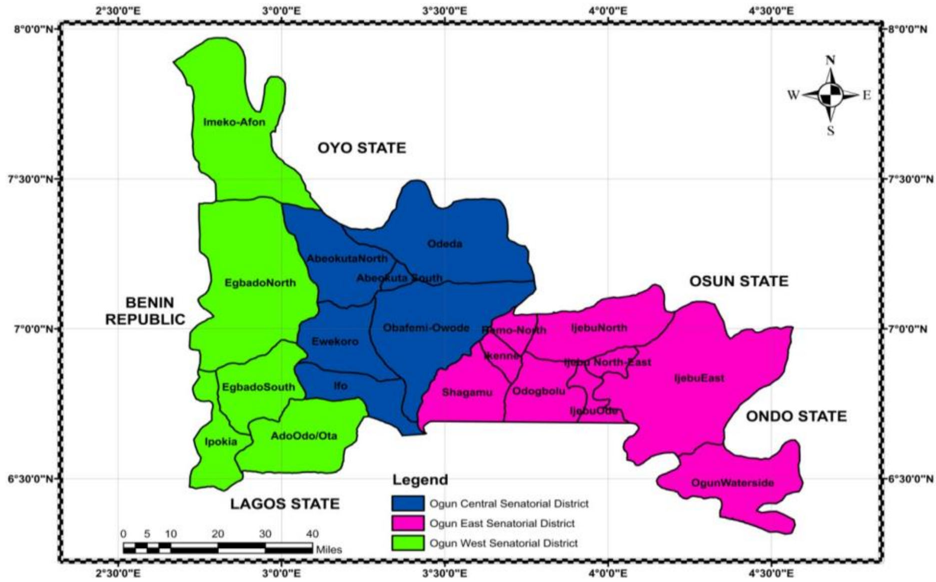

Figure 3: Map of Ogun State

IjeunI; Ago-Egun/Ijesa; Sodeke/Sale-Ijeun II; Imo/Isabo; Igbore/Ago Oba; Ibara I; and Ibara II.

The fourth stage involves the random selection of polling units in each sampling ward, and the random selection of buildings occupying targeted households and locating within 1 kilometre radius from the polling units. The polling units are nationally recognized landmarks for further categorising spatial entities into smaller homogenous units. All the polling units in each of the sampling wards were identified. In Ogijo/Likosi ward, out of the available 19 polling units, 10 namely: St Paul's school Igbode; U.A.M.C School Iraye; St Micheal RCM Fakale; LG school Erefun; St Francis school Igbosoro; St John school Ogijo I; LG school Igbaga; Wesley school Sotunbo; A.U.D school Imushin-Ogijo; and CAC school Ogijo I, were randomly selected. In Ilaro I, out of the available 17 polling units, 10 namely: State hospital; Near Idowu's house Otegbeye street I; Opp Soyinka's house I; U.A.M.C school Pahayi; Oke-Ola area(Eleja); Poly gate; OritaKajola; Egbo Alaparun; Library/rural health care center; and Ita-Iyalode, were randomly selected. In Sodeke/Sale-Ijeun II, out of 25 polling units, 10 namely: Onijoko Mosque OkebodeII; Opposite Oke-Itoku Mosque II; Ile Ogboni OkeItoku; Near Town Planning I; Open space Ojulakijena I; St Joseph RCM. Oke-bode I; Primary school Idipape I; All saint school Kobiti; Open space Kemta Odutolu Mosque; and Opposite Bus Stop Bata Itoku, were randomly selected. Thus, making the total number of polling units within the radius of which households were surveyed in the study area to be 30. Systematic random sampling approach on the basis of the 5th building interval was adopted in selecting 11 household administered questionnaires within 1 kilometer radius of each of the 10 randomly selected polling units in Ogijo/Likosi ward. 10 households administered questionnaires within 1 kilometer radius of each of the 10 randomly selected polling units in Ilaro I; and 12 households administered questionnaires within 1 kilometer radius of each of the 10 randomly selected polling units in Sodeke/Isale-Ijeun II.

Systematic random approach adopted is to the extent of making the selection of households an entirely random process that disregards the arrangements and physical outlook of the buildings in a manner that can suggest the response patterns of households. The questionnaire distribution ratio 1.1: 1.0: 1.23

adopted dovetails with the population variance across the three senatorial districts in Ogun state estimated as 1,250,435(33%), 1,112,761(30%), and 1,387,944(37%) for Ogun East, Ogun West and Ogun Central, respectively, as sourced from NPC(2010). This implies that 110, 100, and 120 questionnaires were administered in Ogijo/Likosi ; Ilaro I, and Sodeke/Sale-Ijeun II, respectively, making a total of 330 households that were surveyed, which represents about 0.06% of the estimated 535,877 households in the study area. Households represent the unit of data collection, and the household heads were the respondents that gave information about their households. The actual quantitative survey was conducted within the first 3 months of the 4 months and two weeks allocated for data collection in the research schedule. Public holidays, mostly Saturdays, which is not a religion sensitive day in Nigeria, were selected as the visitation days for household surveys. This is to ensure high response rates, prevent the disruption of the systematic random approach and the attendant introduction of sampling error that can be caused by respondents' absence, as most potential respondents will be at home on Saturday. It therefore means that surveys were conducted for 12 days in the entire 3 months period.

The research assistants were equally divided into three groups and distributed across the 3 sampling wards. Each of the 11 trained research assistants administered an average of 30 questionnaires on a face-to- face basis to households for the entire period, at an average of 2-3 questionnaires per Saturday. The face-to-face survey is imperative to ensuring all research questions are well understood by respondents, especially those without sufficient education. The minimal nature of workload on the research assistants offered the benefit of ensuring the exercise did not become too monotonous, rushed, and error prone. The qualitative data adopted the interview approach. The interviews were conducted within the last month of the 4 months and two weeks allocated for data collection in the research schedule. It involved the adoption of flexible semi-structured instrument to interview key informants, which are knowledgeable in key aspects of the research. Altogether, as shown in Table 1, the total number of interviews conducted in respect of qualitative data is 33. Data collected for this study was checked for errors, and necessary

Table 1: Showing the distribution of interviewees considered for the study

Category of Interviewee	**Sagamu Local Government Authority**	**Egbado South Local Government Authority**	**Abeokuta South Local Government**	**Total**
Faecal Waste Emptiers				
Manual Emptiers	2	2	2	6
Mechanical Emptiers	2	2	2	6
Potential Reusers				
Crop Farmers	2	2	2	6
Fish Farmers	2	2	2	6
Brick Industry	2	2	2	6
Regulatory Authorities.				
Environmental Sanitation and Water Supply Departments.	1	1	1	3
				33

corrections made. Coding of variables as well as classification of data was equally carried out to facilitate analysis. Data was subjected to data editing and coding, data file screening for errors, missing data, and outliers' assessment. SPSS was deployed in determining the reliability and execution of exploratory factor analysis of the study's major constructs. However, in order to assess the validity of the constructs influencing faecal waste reusability in the study area, independently, through the confirmatory factor analysis (CFA), Structural Equation Modelling (SEM) was used to develop the best fit indices and construct validity.

Results

Reliability Test

Reliability test was conducted to measure the degree of internal consistency of the research instrument's scale. The Cronbach Alpha test suggests the goodness of internal consistency for items, and the acceptable benchmark is 0.7 and above (DeVellis, 2003). The calculated Cronbach alpha values of constructs like environmental/health factors of faecal waste reusability, social acceptability factors of faecal waste, and factors of sanitation technology were initially below the 0.7 benchmark. This however necessitated the deletion of items from each of the constructs. Items such as 'Faecal Waste Reuse is a Taboo' and 'With the Assurance of Market, I Would Install Containment that can Afford Easier and Greater Yield of Recovery of the constructs -social acceptability factors of faecal waste, and factors of sanitation technology, respectively, were deleted before all the Cronbach alpha values of all the constructs for this study became adequate, as presented in Table 2.

Assessing Content Validity through Exploratory Factor Analysis (EFA)

The Exploratory Factor Analysis (EFA) was used to determine the extent to which measures effectively underpin their underlying constructs. The EFA is a data reduction technique, which processes large research items and specify a way of rescaling them into smaller components (Pallant, 2007, 2013).For EFA, items with factor loadings of less than 0.4 are expected to be deleted (Hair *et al*., 2006; Paschke, 2009). The construct awareness about reuse opportunities associated with sludge construct, as shown in Table 3 consists of seven (7) items. However, for this construct, all items loaded above 0.4. Kaiser-Meyer-Olkin (KMO), which represents the measure of sampling adequacy, at the value of 0.691 is acceptable, as it crossed the 0.5 cut-off value.

The construct Economic Factors of Faecal Waste Reusability (EC), as shown in Table 4, consists of five (5) items. However, for this construct, all items loaded above 0.4. Kaiser-Meyer-Olkin (KMO), which represents the measure of sampling adequacy, at the value of 0.793 is acceptable, as it crossed the 0.5 cut-off value.

Table 2: Summary of pilot study reliability test (Cronbach Alpha)

Constructs	Items	Items Deleted	Reliability
Awareness about reuse opportunities associated with sludge (AW)	7	0	0.720
Economic Factors of faecal waste reusability (EC)	5	0	0.897
Environmental/Health factors of faecal waste reusability (EV)	6	0	0.710
Social acceptability factors of faecal waste reusability (SA)	5	1	0.70
Factors of sanitation technology (ST)	5	1	0.746

Table 3: Exploratory factor analysis of awareness about reuse opportunities associated with sludge (AW)

	Component
Variable	**1**
AW1	.776
AW2	.464
AW3	.895
AW4	.892
AW5	.672
AW6	.770
AW7	982

Table 4: Exploratory factor analysis of economic factors of faecal waste reusability (EC)

	Component
Variable	**1**
EC1	.777
EC2	.855
EC3	.840
EC4	.907
EC5	.892

The Environmental/Health Factors of Faecal Waste Reusability (EV) construct, as shown in Table 5, consists of six (6) items. However, for this construct, all items loaded above 0.4. Kaiser-Meyer-Olkin (KMO), which represents the measure of sampling adequacy, at the value of 0.858 is acceptable, as it crossed the 0.5 cut-off value.

For the Social Acceptability Factors of Faecal Waste Reusability (SA) construct**,** which has four constructs, the item faecal waste reuse is a taboo did not load well, as it was the redundant item in the reliability test. The removal of the item, however, enhanced the construct's performance, as all the remaining four (4) items, as shown in Table 6, adequately loaded above 0.4. Kaiser-Meyer-Olkin (KMO), which represents the measure of sampling adequacy, at the value of 0.614 is acceptable, as it crossed the 0.5 cut-off value.

Table 5: Exploratory factor analysis of environmental/health factors of faecal waste reusability

	Component
Variable	**1**
EV1	.996
EV2	.845
EV3	.854
EV4	.803
EV5	.871
EV5	.882

Table 6: Exploratory factor analysis of environmental/health factors of faecal waste reusability

Variable	Component 1
SA1	.729
SA2	.786
SA3	.814
SA4	.621

Moreover, for the construct Sanitation Technology Factors of Faecal Waste Reusability (ST)**:** The item –with the assurance of market, I would install containment technology that can afford easier and greater yield of recovery of faecal resource- did not load on the sanitation technology factors of faecal waste reusability construct. After removing the item, however, the construct's performance improved. As shown in Table 7, all the remaining four (4) items loaded above 0.4. Kaiser-Meyer-Olkin (KMO), which represents the measure of sampling adequacy, at the value of 0.705 is acceptable, as it crossed the 0.5 cut-off value.

Table 7: Exploratory factor analysis sanitation technology factors of faecal waste reusability (ST)

Variable	Component 1
ST1	.849
ST2	.868
ST3	.663
ST4	.619

Structural Equation Modelling Analysis and Significant Factors of Faecal Waste Reusability

Structural Equation Modeling adopting the AMOS version 22 was used to validate the hypothesized measurement model of the factors of faecal waste reusability. The pooled measurement model is a second-order-construct that premises the faecal waste reusability (RF) on five factors conceptualized as constructs. The endogenous constructs hypothesized in measurement model as shown in Figure 4 are Awareness about Reuse Opportunities Associated with Sludge (AW), Economic Factor of Faecal Waste Reusability (EC), Environmental/Health Factor of faecal waste reusability, Social Acceptability Factor of faecal waste reusability, Sanitation Technology Factor of Faecal Waste reusability.

The sub-construct -Awareness about Reuse Opportunities Associated with Sludge (AW) contains seven measuring items namely, AW1 - AW7. Five items, namely EC1- EC5 measure the sub-construct- Economic Factor of Faecal Waste Reusability (EC). The first order construct- Environmental/Health Factor of faecal waste reusability was measured with six items, namely, EV1 - EV6. Moreover, Social Acceptability Factor of faecal waste reusability sub-construct was measured with four items, after one item had indicated a poor reliability result. The items are SA1 - SA4. Finally, the sub-construct Sanitation Technology Factor of Faecal Waste reusability was measured with four items, after one of the items failed thereliability test. The items are ST1 - ST4.

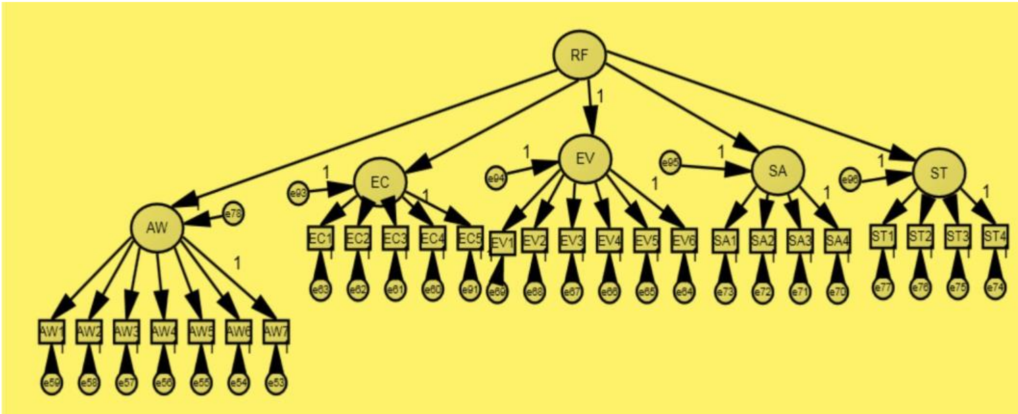

Figure 4: Hypothesized measurement model using pooled CFA estimates

Confirming the Measurement Model Significant Factors of Faecal Waste Reusability Using Pooled Confirmatory Factor Analysis (PCFA)

This study adopted the pooled CFA to validate the hypothesized model. This study, following Jonathan (2016) and Ndalai (2017), adopts RMSEA and GFI as the fitness indexes from the absolute fit category; CFI, TLI, and NFI from the incremental fit category. For the parsimonious fit category, the chi-square/df index was selected.

The outcome of the pooled measurement modelat RMSEA = 0.116; GFI = 0.748, TLI = 0.749, NFI = 0.759, CFI =0.773 and Chisq/ Df = 12.445, were grossly inadequate, and necessitates improvement.

Table 8: Statistics of proposed model for significant factors of faecal waste reusability

Model Identification				**Model Fit Statistics**			
Number of distinct sample moments:	=	351		RMSEA=	.116	NFI=	0.759
Number of distinct parameters to be estimated	=	57		GFI=	.748	CMIN/ Df=	12.445
Degrees of freedom	=	294		TLI=	.749	CFI=	0.773
			Model is identified				
			Factor Loadings				
Item		Variable	SE	CR	p	SMC	Comment
EV	<---	RF	.760	.646	.518	.577	Convergence does not hold
AW	<---	RF	.342			.117	Convergence does not hold
EC	<---	RF	.679	.647	.518	.461	Convergence does not hold
ST	<---	RF	.242	-.641	.521	.058	Convergence does not hold
SA	<---	RF	.330	.644	.519	.109	Convergence does not hold
AW7	<---	AW	.023			.001	Convergence holds

AW6	<---	AW	.726	.649	.516	.527	Convergence does not hold
AW5	<---	AW	.519	.649	.517	.269	Convergence does not hold
AW4	<---	AW	.978	.649	.516	.957	Convergence does not hold
AW3	<---	AW	.949	.649	.516	.901	Convergence does not hold
AW2	<---	AW	.307	.647	.517	.094	Convergence does not hold
AW1	<---	AW	.144	.641	.521	.021	Convergence does not hold
EC5	<---	EC	.947	59.549	***	.897	Convergence holds
EC4	<---	EC	.962			.926	Convergence holds
EC3	<---	EC	.803	35.341	***	.624	Convergence holds
EC2	<---	EC	.765	31.702	***	.585	Convergence holds
EC1	<---	EC	.691	26.072	***	.477	Convergence holds
EV6	<---	EV	.862			.742	Convergence holds
EV5	<---	EV	.895	35.269	***	.801	Convergence holds
EV4	<--	EV	.805	29.276	***	.648	Convergence holds
EV3	<---	EV	.790	28.371	***	.624	Convergence holds
EV2	<---	EV	.868	33.402	***	.754	Convergence holds
EV1	<---	EV	.397	11.725	***	.157	Convergence holds
SA4	<---	SA	.591			.349	Convergence holds
SA3	<---	SA	.899	13.892	***	.808	Convergence holds
SA2	<---	SA	.541	12.721	***	.293	Convergence holds
SA1	<---	SA	.458	11.141	***	.210	Convergence holds
ST4	<---	ST	.335			.112	Convergence holds
ST3	<---	ST	.531	8.399	***	.282	Convergence holds
ST2	<---	ST	.909	9.256	***	.826	Convergence holds
ST1	<---	ST	.823	9.324	***	.667	Convergence holds

Improving the Model Fitness

In order to improve the model's fitness indexes, all constructs and items with low factor loadings were expunged from the mode, as shown in Figure 5. This is in line with Zainudin (2015) that items or first order constructs with factor loading less than 0.5 are considered poor and should be deleted from models. In light of this, three constructs (AW, ST, and SA) and one item EV1 were removed, after which the model was re-estimated. As shown in Table 9, after the re-estimation based on low factor removal, only two fitness indexes, NFI and CFI, at 0.913 and 0.917, respectively, achieved their required fitness levels, despite all items loading above 0.5. The RMSEA (0.116), GFI (0.864), TLI (0.890), and CMIN/Df (19.276) values did not achieve their required level of fitness.

Modification Indices (MI)

Considering the fact that fitness indexes were not achieved with the removal of items and constructs with low factor loadings, recourse was sought to modification indices. This is in view of the likelihood of redundant items in the model. As recommended by Zainudin (2015), the options available under modification indices are either the deletion of redundant items or the setting of items with the highest modification indices /per change as free parameters by correlating the errors. For this study, the latter option was repeatedly adopted till fitness indexes were achieved. Foremost, e61 and e62 were correlated. Model finesses were not achieved. This was followed by subsequent correlations of e62 and e63; e62 and e66; e67 and e 97; e61 and e67; e63 and e66; e 65 and e91; e62 and e93; e66 and e68, e67 and e68, and e62 and e67, until all fitness indexes, as evident in Table 10 (RMSEA = .041; GFI = .987, TLI = .991, NFI = .993, CFI =.996 and Chisq/Df = 2.429) were achieved.

Validating the Measurement Model

The model's construct was validated via the assessment of unidimensionality, validity, and reliability. Unidimensionality had been attained following the removal of the low factor items and constructs, and correlation of errors with high modification indices, the output of the model re-estimation indicates the achievement of all fitness indexes. Validity verification took the forms of convergent validity, construct validity and discriminant validity. Convergent validity was achieved with Average Variance Extracted (AVE) of every construct estimated to be above 0.5. Construct Validity was attained with the adequacy of fitness indexes for each

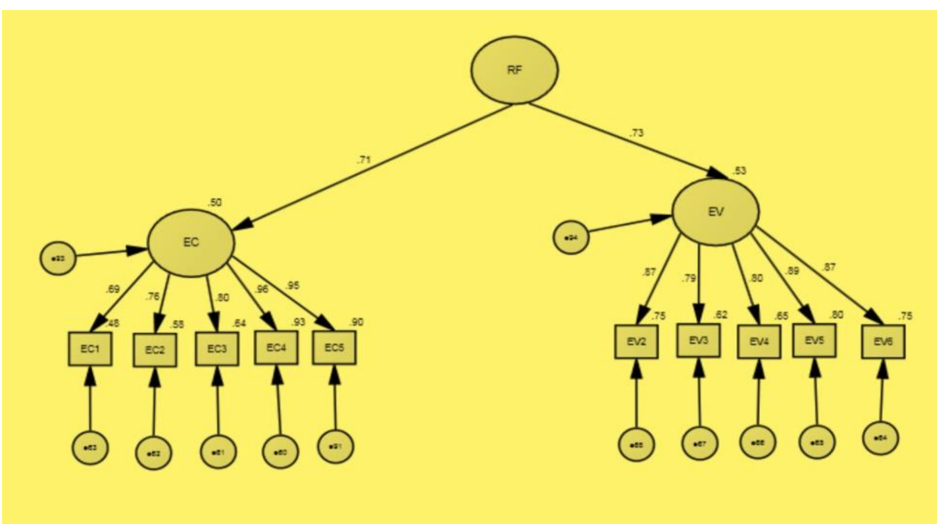

Figure 5: Measurement model after the removal of lowly loading factors

Table 9: Statistics of proposed model for significant factors of faecal waste reusability after removing lowly loading factors

Model Identification				**Model Fit Statistics**			
Number of distinct sample moments:	=	55		RMSEA=	.116	NFI=	.913
Number of distinct parameters to be estimated	=	21		GFI=	.864	CMIN/ Df=	19.276
Degrees of freedom	=	34		TLI=	.890	CFI=	.917
			Model is identified				
			Factor Loadings				
Item		Variable	SE	CR	p	SMC	Comment
EV	<---	RF	.725	.646	***	.577	Convergence holds
EC	<---	RF	.710	.647	***	.461	Convergence holds
EC5	<---	RF	.947	59.699	***	.897	Convergence holds
EC4	<---	EC	.963			.926	Convergence holds
EC3	<---	EC	.803	35.366	***	.624	Convergence holds
EC2	<---	EC	.764	31.672	***	.585	Convergence holds
EC1	<---	EC	.689	26.003	***	.477	Convergence holds
EV6	<---	EV	.866			.742	Convergence holds
EV5	<---	EV	.894	35.515	***	.801	Convergence holds
EV4	<--	EV	.805	29.433	***	.648	Convergence holds
EV3	<---	EV	.790	28.530	***	.624	Convergence holds
EV2	<---	EV	.865	33.454	***	.754	Convergence holds

of the constructs. For this study, discriminant validity assessment is shown in Table 11. The AVEs, which measure the variance between constructs and their items, are indicated by the diagonal values in the table, and the other values indicate the correlation between constructs. The result showed that the square roots of AVE of constructs EC and EV are greater than the correlations among constructs them.

Reliability

Two criteria are essential in the assessment of reliability of any measurement model: Composite Reliability and Average Variance Extracted. According to Zainudin (2015), a standardized value of CR of ≥ 0.600 is required for the attainment of composite reliability of latent constructs. The simplest manual method for calculating composite reliability was

Table 10: Statistics of proposed model for significant factors of faecal waste reusability after errors with the highest modification indices have been correlated

Model Identification				Model Fit Statistics			
Number of distinct sample moments:	=	55		RMSEA=	.041	NFI=	.993
Number of distinct parameters to be estimated	=	32		GFI=	.987	CMIN/ Df=	2.429
Degrees of freedom	=	23		TLI=	.991	CFI=	.996
				Model is identified			
				Factor Loadings			
Item		Variable	SE	CR	p	SMC	Comment
EV	<---	RF	.727	.646	***	.577	Convergence holds
EC	<---	RF	.715	.647	***	.461	Convergence holds
EC5	<---	RF	.949	61.281	***	.897	Convergence holds
EC4	<---	EC	.970			.926	Convergence holds
EC3	<---	EC	.786	33.926	***	.624	Convergence holds
EC2	<---	EC	.738	30.343	***	.585	Convergence holds
EC1	<---	EC	.677	25.604	***	.477	Convergence holds
EV6	<---	EV	.876			.742	Convergence holds
EV5	<---	EV	.906	37.016	***	.801	Convergence holds
EV4	<--	EV	.786	28.714	***	.648	Convergence holds
EV3	<---	EV	.778	28.443	***	.624	Convergence holds
EV2	<---	EV	.831	31.195	***	.754	Convergence holds

Table 11: Discriminant validity index summary

Constructs	**EV**	**EC**
EV	**0.83**	
EC	**0.52**	0.774

provided by Fornell and Larcker (1981), and Zainudin (2015):

$CR = (\sum K)^2 / [(\sum K)^2 + \sum (1-K^2)]$ --- Equation (1)

K is the factor loading of every item.

It is evident from the Table that all the constructs in the measurement model have composite reliability values that cross the 0.6 benchmark and can therefore be deemed adequate. For Average Variance Extracted (AVE), Zainudin (2015) recommends that the AVE value ≥ 0.500 is the optimal requirement for all constructs in a measurement model. The formula recommended by the same author which had been adopted in this study:

$AVE = \sum K^2/n$ ---------------- Equation (6.2)

Where K = factor loading of every item, and n = number of items in a model.

It is evident from the Table 12 that the AVE values for the measurement model constructs exceed the 0.5 mark and can therefore be deemed adequate.

Table 12: Factor loadings of the constructs, CR and AVE

Constructs	Items	Factor Loadings	Composite Reliability (CR)	Average Variance Extracted (AVE)
EV	EV2	0.831	0.91	**0.7**
	EV3	0.778		
	EV4	0.786		
	EV5	0.906		
	EV6	0.876		
EC	EC1	0.677	0.916	**0.69**
	EC2	0.738		
	EC3	0.783		
	EC4	0.970		
	EC5	**0.949**		

Assessment of Normality Distribution of Items in the Overall Model

Normality is generally assessed by the skewness measure of each model item. However, as expatiated in Zainudin, (2015), the absolute value of skewness of 1.5, especially when sample size is above 200, indicates normality. This implies that all items in measurement model should have skewness values that are lower than 1.5. As presented in Table 13, the absolute values of skewness of all the measurement model's items in the table are below 1.5. This however indicates normality for the measurement model.

The Full Structural Modelling Analysis

The full structural modelling further reduced the hypothetical model's constructs and items from five and twenty-six to two and ten, respectively, as shown is Figure 6. The structural estimates for the model also afford the presentation of the constructs' squared multiple correlations and the standardized regression paths coefficients and their level of significance, as presented in Table 14.

In this study, as evident in the squared multiple correlations obtained, 53% (R^2=0.53) of variation of inclination to reuse faecal waste is essentially explained by Environmental/health factors, while 51% (R^2=0.51) of the information on faecal waste's reusability can be estimated by the impacts of economic factors.

Moreover, as evident in the column labeled p in Table 14, the structural model established a significant positive relationship between EV and RF (β=0.727, $p<0.05$), and similarly, EC and RF (β=0.715, $p<0.05$). The model revealed

Table 13: Normality distribution of items in the overall model

Variable	min	max	skew	c.r.	Kurtosis	c.r.
Ecreus5	1.000	5.000	-1.127	-13.375	1.462	8.676
Evreus2	1.000	5.000	-1.026	-12.174	1.093	6.483
Evreus3	1.000	5.000	-1.001	-11.878	1.353	8.031
Evreus4	1.000	5.000	-.567	-6.725	-.071	-.422
Evreus5	1.000	5.000	-.987	-11.707	1.348	7.998
Evreus6	1.000	5.000	-1.305	-15.484	2.255	13.378
Ecreuse1	1.000	5.000	-.997	-11.826	.279	1.657
Ecreuse2	1.000	5.000	-.881	-10.451	-.020	-.121
Ecreus3	1.000	5.000	-.403	-4.783	-.171	-1.017
Ecreus4	1.000	5.000	-.921	-10.925	.952	5.649
Multivariate					110.987	104.127

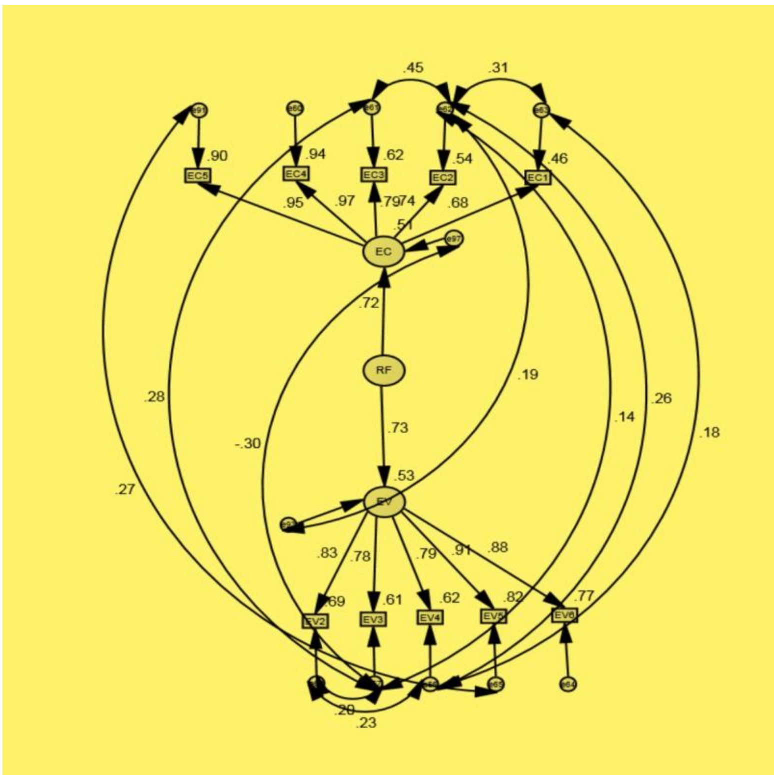

Figure 6: The structural model showing the path of interest to be tested

Table 14: Constructs' Regression Path Coefficients and their Significance and Squared Multiple Correlations (R^2) of Measurement Model

Construct	Path	Construct	Actual Beta Values	SE	Critical Ratio	p	SMC	Comment
EV	<---	RF	.727	.469	1.55	***	.53	Convergence holds
EC	<---	RF	.715	.462	1.54	***	.51	Convergence holds

that 0.727 increment in the value of EV would culminate in a unit increase in RF. It further indicates that the possibility of achieving the regression weight estimate of 1.55 standard error above zero (Critical Ratio) is lesser than 0.05. This implies that the beta coefficient of EV in the determination of RF is significant. Similarly, a unit increase in the tendency for faecal waste reuse would be a function of 0.715 increments in EC. The probability of achieving a critical ratio of 1.54 is less than 0.05, which also indicates the significance of EC in the prediction of RF.

Discussion

The study is an insight into the assessment of how the constructs of awareness about opportunities associated with reuse, environmental/ health factors, economic factors, social acceptability, and sanitation technology are the significant determinants of faecal waste reusability, considering that perceptions about reusability of faecal waste are logically linked to the behavioral tendencies to contain and recover faecal waste, and consequently afford both sanitation cost recovery the enhancement of households' sanitation system. However, the reduction of hypothesized factors to economic and environmental/ health factors is a slight deviation from Semiyaga *et al.* (2015) and Rao *et al.* (2017) that had suggested the initial five constructs that were considered in the hypothetical model. However, the novelty of the model is in its ability to capture the most important latent determinants of faecal waste reusability within the clearer contexts of how households would be willing to deem faecal waste an economic resource that can be sold, and its products, patronized; their perceptions about faecal products being a cheaper alternative to other substitute variants; and their affirmativeness about whether in their patronage of faecal waste products, they are creating a viable market for sanitation and ultimately helping to optimize its value chain. The other contexts considered are the extent to which treatments and otherwise possibility of germinal contamination can influence households' perceptions about faecal waste reuse; how the circularity and greenness afforded by faecal waste products influence their perception about faecal waste reuse; and how their patronage of faecal waste products can create the vista for enhanced household health and environmental sanitation. These have not been previously explored as environmental and economic considerations had only been previously linked to how agriculture can be a sustainable reuse destination for faecal waste from farmers' point of view (Hall, 2015; Danso *et al.*, 2017).

Information extracted qualitatively to explore the significant factors of faecal waste reusability were considered from the point of views of the emptiers, potential reusers, and the environmental regulators- the other major actors in the faecal waste management value chain. Half of the mechanical emptiers (Mechanical emptiers D, E, and F), claimed they would deem faecal sludge a resource, which they could buy at price ranging from N3000 to N10, 000 (8USD to 27 USD) provided they could cover the cost of their services from the price they will sell to end-users. Others claimed they won't pay to households, but they could reduce the prices of their services, provided there were going to be buyers of the resource. Majority of the manual emptiers claimed they would deem faecal sludge a resource, which they could buy at price ranging from N3000 to N5,000 (8USD to 13USD) provided they could cover the cost of their services from the price they will sell to end-users. Others (Manual emptiers D and E) doubted the possibility of households willingly assenting to the idea of selling their faecal waste, as most households could be suspicious of whether their faecal waste could be used for diabolical fetish purposes. All the manual and mechanical emptiers interviewed claimed they had not been selling faecal waste evacuated from household latrines, but they would sell, provided that the selling price would compensate for the loss of not charging households, which produce the evacuated resource and leave out profit. The farmers are aware of the effectiveness of faecal waste as a veritable manure source, but they currently do not make use of the resource. They use synthetic fertilizers like NPK and sometimes cow dung. They mostly claim faecal waste smells, attract flies, and can occasion the spread of diseases. However, they all agreed they would pay an amount ranging from N5000 to N12, 000 (13 USD -33USD) per bag for faecal resource if it had been de-watered, well treated, odourless and well packaged. The fish farmers mostly are not aware of this finding by Danso *et al.* (2017) that faecal waste can be beneficial in the production of fodder or feeds for livestock in aquaculture. They claim aquaculture business is very expensive, and they would not want to risk feeding their breeds with substances that could have adverse effects on their breeds. Similarly, operators of construction companies are not aware of another finding by Semiyaga *et al*.(2015) that the incinerator ash produced from the incineration of sewage sludge disposal, when mixed with dried sludge can be used as additives in the production of construction materials such as artificial lightweight aggregates, tiles, cement material and bricks. They currently do not make use of faecal waste, and really do not see the need to adopt its usage since they are not aware of its advantages. Furthermore, the Directors of Water Resources and Environmental Sanitation Departments when interviewed agreed that possibilities offered in the reuse of faecal waste can create value for recovered waste and present an incentive to households in the construction of toilets. Director A operating in Egbado South Local Government jurisdiction specifically claimed his department had in the past supported an engineering initiative that was aimed at making households install sanitation technologies that can allow the conversion of faecal waste to biogas for their domestic use, but the project failed because of the prohibitive cost (N1, 200,000 (3,333 USD) proposed by the project's inventor. The foregoing offers a clue on how effective treatment and better packaging of faecal waste products like manure and bio-char can be a good measure of reining in deforestation occasioned by constant felling of trees for cooking charcoals. This could spur households to be more disposed to placing values on their faecal waste.

Conclusion

Punitive measures, governmental interventions, and psychologically exploiting behavioural change tactics adopted by governmental authorities around the world could not prevent over 800 million people from defecating in the open. The study strongly recommends a more flexible and household inclusive economic incentive approach to open defecation eradication, in line with the paradigm of green and circular economy. With the prospect of toilets construction and maintenance cost recovery, households, mostly poor ones, that defecate in the open, would be better incentivised to be favourably disposed to faecal waste containment and management options that allow for greater yields of recovery as opposed to the use of chemicals and burying that are the commonplace in the study area. By creating value for faecal waste and optimizing the sanitation value chain, households that already have sanitation facilities whose technology would not afford economically viable recoveries and those not yet served with sanitation facilities would be nudged to adopting simple onsite low-cost technologies such as urine diversion dry toilets (UDDTs) canvassed by Rao *et al*. (2017) and anaerobic biogas latrine, that can afford in-situ resource (energy or nutrient) recovery, represent a business model for poor households and ultimately culminate in the improvement of the households' sanitation. Moreover, the reuse angle to enhancing sanitation can be better materialised by environmental planners and regulators. Investment in treatment plants and expanded research into technology leveraging innovative opportunities of faecal reuse afford the authorities the opportunity to expand business vistas in the faecal waste management value chain, improve the state of utilities, and ultimately improve environmental sanitation. The cost recovery and the effective inclusion of households and emptiers in the sanitation value chain is more economically rewarding than offering subsidies to households to build toilets or directly construct toilets that would not be utilised. Costs incurred through the purchase of faecal waste from the middlemen who buy the resource from households can be somewhat recovered from the sale of faecal products emanating from treatment plants. As a result of the financial incentive, households' urge to contain their faecal waste and evacuate when due would improve.

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