COST-BENEFIT ANALYSIS OF IMPROVED URBAN SANITATION IN GHANA

BISMARK DWUMFOUR-ASARE, PHD
Senior Lecturer, Environmental sanitation
Department of Environmental Health & Sanitation,
University of Education Winneba

BJORN LARSEN
Independent Consultant, Economist
Vientiane, Lao PDR

NATIONAL DEVELOPMENT PLANNING COMMISSION

COPENHAGEN CONSENSUS CENTER

GHANA PRIORITIES

COPENHAGEN CONSENSUS CENTER

info@copenhagenconsensus.com
www.copenhagenconsensus.com

This work has been produced as a part of the Ghana Priorities project.

PRELIMINARY DRAFT AS OF MARCH 26, 2020

Benefit-cost analysis of improved urban sanitation in Ghana

Ghana Priorities

Bismark Dwumfour-Asare, PhD
Senior Lecturer, Environmental sanitation
Department of Environmental Health & Sanitation, University of Education Winneba

Bjorn Larsen
Independent Consultant, Economist
Oslo, Norway

Brad Wong, PhD
Chief Economist, Copenhagen Consensus Center

Academic Abstract

Urban sanitation coverage in Ghana is abysmal. With improved, non-shared sanitation at only 22% of the urban population in 2017, pragmatic effort is needed from policy and decision makers to improve the situation. This paper assesses the benefits and costs of interventions to improve urban sanitation situation in Ghana. Benefits and costs of two main interventions: toilet subsidy with enforcement, and toilet subsidy only, are evaluated based on the available evidence from practices in the sanitation sector.

Benefit-cost ratios (BCR) expressed as the ratio of the present value of benefits and costs over a 20-year useful life of interventions are presented. Valuation of benefits include the use of value of statistical life years (VSLY) for averted deaths, a monetary value of time savings (productivity benefits) at 50% of wage rates, and the cost-of-illness (COI) approach for averted illness. Cost of interventions include the cost of the toilet facility (biodigesters), operations and maintenance (O&M) cost, opportunity cost of turning rental space into space for toilet facilities, cost of sanitation promotion program, cost of toilet cleaning, and, in the case of the first intervention, the cost of enforcement. Benefits and costs are discounted at annual rates of 5-14% with 8% as the base case.

BCRs for the Subsidy with enforcement intervention are in the range of 3.4 – 4.9 and the Subsidy only intervention produced BCRs of 3.4 – 5.6 depending on discount rates, compliance rates from enforcement, and response rate for the toilet subsidy. The BCRs of the Subsidy only intervention were found to be slightly higher than the Subsidy with enforcement intervention because of the added cost of enforcement.

Any of the two interventions will have beneficial impacts but subsidy with enforcement will have comparatively higher sanitation effect size and thus higher net benefits to the urban population.

Key Words: Benefit-cost ratios, enforcement, household toilet, sanitation, subsidy, urban Ghana

Policy Abstract

The Problem

Urban sanitation coverage in Ghana like in many other developing countries is low with only 25% of the people with access to basic sanitation (improved, non-shared sanitation) (Appiah-Effah et al., 2019). Already, poor urban sanitation is strongly linked to increased disease burdens and associated cost (Berendes et al., 2018; Prüss-Ustün et al., 2019). Poor sanitation situation is attributed to several barriers including the main issues of lack of appropriate and affordable sanitation technologies especially for the urban poor (low-income groups), and poor enforcement of existing regulations like the local authorities bylaws (WSUP, 2017c; Antwi-Agyei et al., 2019). Other attributable reasons include high population densities and compelling demand for rental accommodation instead of toilets, poor physical planning, lack of rights over land as disincentive for sanitation infrastructure investments, mismatch between low-income levels and high cost of toilet facilities (Obeng et al., 2015).

The current urban sanitation situation is compelling and demands immediate attention from policy and decision makers to commit resources for remedial intereventions. The facts from the analysis of the most recent data – the Ghana Maternal Health Survey (MHS) 2017 speak explicitly:

- More than 10 million people, or 58% of urban households, live in housing in which more than 3 households share a toilet facility.
- Consequently, as many as 38% of urban households use public toilets, and
- 7.5% practice open defecation (OD).
- Such housing is rental units in compound houses with anywhere from 2-3 to well over 10 households.

The impacts of this poor sanitation situation include increased incidence of diarrheal morbidity and mortality, productive time loss (due to toilet access time, and illnesses), and large monetary cost in payment for public toilet usage. Several approaches to solving urban sanitation challenges have been experimented in Ghana. However, none is adopted at scale probably because little or not much is evidenced about their benefits and costs.

Intervention 1: Toilet subsidy provision with improved enforcement of sanitation by-laws

Overview

This intervention looks at providing toilet construction subsidy for urban households and/or compounds in addition to supporting Metropolitan, Municipal and District Assemblies (MMDAs) to enforce sanitation by-laws. While the subsidy attempts to lessen the cost burden of building improved household toilets, the enforcement component will incentivize households and/or landlords to meet up their contributions to the subsidies provided.

Implementation Considerations

The intervention will involve setting up program offices, carrying out promotion and awareness campaigns, giving out toilet subsidies, and supporting environmental health officers to effect sanitation regulation enforcement. The target population is urban households and/or compounds who are practicing open defecation, using uimproved facilities, using public toilet, and those who are sharing toilet with more than three households. This target reflects a two-staged approach in which a maximum of three households may share a toilet as an immediate interim improvement measure for compound sanitation challenges. The intervention improves sanitation situation by moving households to at worst three households sharing an improved toilet. Recent most popular urban toilet facility, the biodigestor toilet is the main technology for consideration. The subsidy provided is equivalent to the cost of this toilet facility of approximately GHS 4000. It is assumed in the analysis in this paper that implementation could have the following success or compliance rates: 100%, 75% and 50% uptake. Benefits and costs are assessed over a 20-year period are discounted at an annual rate of 5%, 8%, and 14% with a base case of 8%.

Costs and Benefits

Costs

The present value of the intervention cost, over a 20-year period, is between GHS 8.6 and 25.8 billion depending on compliance rate and discount rate. About 22 – 35% of intervention cost is borne directly by government (implementer of the intervention – cost of sanitation promotion program, enforcement and toilet), and the rest (65 – 78%) is paid by beneficiaries (landlords/households) in a form of toilet O&M, toilet cleaning, and foregone rental space. The

most significant cost component at all times is foregone rental space accounting for 38 – 44% of the total intervention cost (GHS 3.2 – 11.4 billion).

Benefits

The present value of benefits from the intervention over the 20-year period is valued between GHS 34 and 107 billion. The largest share is productivity benefits from time savings amounting to GHS 23 – 68.4 billion (i.e. 63 – 70% of total benefits). Cost savings from no longer having to pay for public toilet usage is also high at GHS 6.8 to 24.1 billion, representing 19 – 24% of total benefits. Health benefits of averted mortality and morbidity contribute 11 – 13% of benefits from the intervention.

Intervention 2: Toilet subsidy provision only

Overview

This intervention only provides subsidy for toilets but without any emphasis on and budget for enforcement of sanitation bylaws. The subsidy equivalent to the 100% toilet cost is to lessen the burden of high cost of installing toilet facilities in urban compounds due to the loss of rental income from having to convert rental space into space for toilet facilities. In this intervention, no attention is given to enforcement moreover, the existing enforcement regime is expected to continue as business as usual without the intervention directly seeking any improvement.

Implementation Considerations

This intervention is similar to the first already presented. Thus, reproducing almost the same cost components except no cost for enforcement. The target population is same as the first intervention. In actual implementation like the first one, households and landlords will pay operation and maintenance (O&M) cost, toilet cleaning, and in most instance incurring the cost of foregone income from rental space released for toilet installation. It is expected that there will be comparatively low success or sanitation response rates associated with subsidy without enforcement because of the high cost besides the cost of toilets. Assessed intervention response rates are 20%, 10% and 1%. \

Costs and Benefits

Costs

The present value of total intervention cost is between GHS 0.23 and 5.1 billion depending on discount rate and sanitation response rate. About 21 – 52% of intervention cost is borne directly by government in the form of sanitation promotion program cost and toilet capital cost, and the rest (48 – 79%) is incurred by landlords/households as cost associated with toilet cleaning, operations and maintenance (O&M), and foregone rental space. Again, foregone rental space is accounting for a high proportion 28 – 44% (GHS 0.06 – 2.3 billion) of the total intervention cost.

Benefits

The present value of the benefits from the subsidy only intervention is between GHS 0.7 and 28.3 billion. The largest benefit, as for the previous intervention, is productivity benefits coming from time savings at GHS 0.6 – 20.6 billion, representing 72 – 74% of the overall benefits. This is followed by cost savings from no longer having to use public toilets (GHS 0.14 – 4.8 billion), representing 16 – 18% of total benefits. Health benefits of averted mortality and morbidity account for 9 – 10% of intervention benefits.

Benefit-cost ratios (BCRs)

The BCRs are slightly higher for the Subsidy provision only intervention (4.14 to 5.20 at the base case discount rate of 8%) than for the Subsidy with enforcement (3.87 – 4.55 at 8% discount rate) (Table 1). This is because the Subsidy only intervention has no enforcement cost. However, the net benefits of the subsidy with enforcement are substantially higher as sanitation compliance rates are likely to be substantially higher.

The quality of evidence supporting the evaluation process for the interventions is medium to strong looking at the nature and sources of data used in the assessment (Table 1).

Table 1: Summary of the benefit-cost ratios

Interventions	Intervention response/uptake rate	Benefit/Cost (GHS in millions)		Quality of Evidence
Toilet subsidy provision with improved enforcement of sanitation by-laws	100%	Benefit	83,712	Medium to Strong
		Cost	21,644	
		BCR	**3.87**	
	75%	Benefit	69,061	
		Cost	16,344	
		BCR	**4.23**	
	50%	Benefit	50,225	
		Cost	11,045	
		BCR	**4.55**	
Toilet subsidy provision only	20%	Benefit	22,099	
		Cost	4,310	
		BCR	**5.13**	
	10%	Benefit	11,384	
		Cost	2,190	
		BCR	**5.20**	
	1%	Benefit	1,169	
		Cost	282	
		BCR	**4.14**	

Notes: All figures at 8% discount rate.

1 Introduction

It is estimated that 1 in 3 people on earth, approximately around 2.5 billion lack access to dignified sanitation service leading to faecal contaminated environments (WSUP, 2017a; Wolf et al., 2019). The stress and consequences of rapid urbanization exacerbate this problem. In Ghana, sanitation coverage is abysmally low, at 20% of the population nationwide with improved, non-shared facilities according to the Ghana Maternal Health Survey (MHS) 2017. With estimated national population of about 30 million and urban fraction in excess of 57%, low sanitation coverage is definitely a daunting challenge. Meanwhile, access to improved sanitation service is a key target in Sustainable Development Goals (SDGs) for 2030 and poor sanitation especially in urban settings is considered a threat to achieving almost all the SDGs (WSUP, 2017a; Wolf et al., 2019).

Studies support strong links between sanitation and health outcomes especially diarrheal diseases (Tidwell et al., 2019). Diarrhoea is a major public health threat and considered a leading cause of morbidity and mortality among children under five years in low- and middle-income countries (WHO, 2018). Poor sanitation also contributes to several neglected tropical diseases and even undernutrition (ibid). Poor sanitation is not only associated with costly illness and deaths, but also loss of productive time in taking care of loved ones especially children, time for searching for a place to defecate, waiting and queuing time for public or compound toilets (Hutton, 2013). The situation is worsened by steady urban population growth which further strains limited sanitation services (PSI et al., 2017).

Meanwhile, one informative approach to assist policy and decision makers in their resource allocation decisions is benefit-cost analysis (Hutton, 2013). There have been a handful of project interventions in the urban sanitation sector in Ghana, yet no massive scale up has been implemented nationwide to facilitate drastic improvement in the exsiting low levels of coverage. It is not particularly clear that there is a one-shot panacea to improve urban sanitation in Ghana. Benefit-cost analysis as an approach to identify more effective interventions that address urban sanitation is currently missing in the Ghanaian context. The current study attempts to fill this gap.

1.2 Context and urban sanitation problem in Ghana

A significant fraction of the world's population currently lives in faecal contaminated environments as a result of low sanitation coverage especially among poor countries (47%) (Berendes et al., 2018; Wolf et al., 2019). The urban sanitation service coverage in Ghana is even worse, with only 25% of the urban populace having access to improved sanitation (Appiah-Effah et al., 2019). Open defecation rates in urban areas stand at 8% according to the Ghana MHS 2017.

Poor urban sanitation is strongly linked to increased diarrheal diseases (Berendes et al., 2018) and the situation in Ghana threatens public health. The poor sanitation situation is attributed to several key barriers, including lack of appropriate and affordable sanitation technologies especially for the urban poor (low-income groups) and poor enforcement of existing regulations (WSUP, 2017c; Antwi-Agyei et al., 2019). Close to 1.4 million urban Ghanaians are considered to be poor, mostly living in low-income communities (GSS, 2018). In the low-income urban settings, only 7% of households have access to improved sanitation without sharing their facilities (i.e private individual household toilet) (Berendes et al., 2018). Thus, shared sanitation is the largest service delivery option in Ghana (WHO and UNICEF, 2010; Mazeau et al., 2013), accounting for over 60% of urban sanitation coverage (WHO/UNICEF, 2019).

Other attributable reasons include high population densities and compelling demand for rental living room accommodation instead of toilets, poor physical planning and lack of rights over land as disincentive for sanitation infrastructure investments (Obeng et al., 2015). The context suggests that any attempt to meet the low-income urban populace at least half-way could bring improvement in this subsector in addition to enforcement of sanitation bylaws to commit people to their civil responsibility.

2 Solving urban sanitation in Ghana – a brief review

There have been several exploratory approaches to address urban sanitation in Ghana. These approaches have been largely modelled on project interventions without necessarily government's emphatic support. The approaches are broadly based on market and financial regimes, and/or psychological and social theories (WHO, 2018). Thus, they include micro-financing arrangements, targeted hardware subsidies, output-based subsidies, and behaviour

change campaigns (ibid). Almost all approaches are considered by proponents to be suitable for achieving improved sanitation service delivery.

2.1 Business models to improve urban sanitation

The business models involve several financing and service levels options as described below especially under the Sanitation Service Delivery Intervention Program (PSI et al., 2017; WHO, 2018):

i. Community pay-for-use toilets: This is where a private enterprise buys and maintains public toilets and consumers or users are charged a small fee to use the facility towards operations and maintenance. Once-daily use of a public toilet by a household could cost between US$ 3.60 - 18 per month depending on the user fees charged (Greenland et al., 2016). The original rationale for public toilets was for use by transient populations in places like markets, lorry parks or bus terminals but most often they are used as the main sanitation option by low-income communities (Rheinlander et al., 2015). This is because landlords refuse and/or are unable to provide households toilets. This creates a vicious cycle where the increasing prevalence of public toilets undermines promotion of household toilets in low-income settings because landlords cite redundancy of building both private and public facilities (Tanko and Renouf, 2018). The widespread reliance on public toilets also stemmed from banning of household pan latrines (Caplan, 2010)..

ii. Compound and household toilet construction: This is where landlords purchase and provide toilets for tenants while equipping the capacity of government agencies to enforce regulations requiring compound and household sanitation uptake.

iii. Packaged product and services: Purchase of toilet through monthly fee subscriptions and the fees paid covering regular emptying of the toilet. Typical version of this model is the container-based sanitation (CBS) service delivery option promoted by the Clean Team Ghana in Kumasi since 2011. A Clean Team Ghana customer (a household) may pay an average of US$ 10 – 11 per month for the service enjoyed (Narracott and Norman, 2011; Greenland et al., 2016).

iv. Micro-financing arrangement: This approach works by improving access to credit to facilitate the purchase of toilets by low-income households. Water and Sanitation for the Urban Poor (WSUP) implemented such sanitation intervention through a partnership with a Ghanaian bank to offer sanitation loans with flexible payment terms.

Such loans for a household go directly to an entrepreneur trained to build and install the sanitation facility.

2.2 Psychological- and social theory-based models

These are many behavior change campaigns targeting behavior and attitudinal changes such as Community-Led Total Sanitation (CLTS), which is adopted in Ghana as the main sanitation strategy (Woode et al., 2018). CLTS for urban sanitation in Ghana is not popular and the modalities for implementation is also not clear (WSP, 2011) although the existing guidelines acknowledges that CLTS is an applicable strategy to both rural and urban settings (MSWR, 2018). UNICEF Ghana recently supported CLTS based urban sanitation project in the city of Tamale in the northern part of Ghana (Addai, 2018). Implementers realized that without rigorous sanitation by-laws enforcement, there was low toilet uptake, although there had been intensive sensitization and behaviour change communication campaigns. It is acknowledged that without availability of funding opportunities to landlords, strict enforcement without a subsidy is not feasible for many landlords.

2.3 Enforcement of sanitation by-laws within MMDAs

The Metropolitan, Municipal and District Assemblies (MMDAs) in Ghana have the legal right to enact and enforce sanitation bylaws in the country. Many of these MMDAs have sanitation bylaws that require landlords to provide acceptable toilet facilities in their compounds (Antwi-Agyei et al., 2019). The legal framework supports sanitation bylaws enforcement especially by prosecuting landlords and/or property owners who refuse to provide toilet facilities to tenants/occupants. The Judicial Services of Ghana has approved of sanitation courts to handle sanitation and related cases arraigned before them by local authorities (Agbezuge, 2018). Landlords fail to comply with the regulations partly because the bylaws are rarely enforced. Some of the factors contributing to non-compliance and weak enforcement include: lack of financial resources, limited space, readily available public toilets, lack of awareness of regulations and penalties, multiple landlords situations, lack of incentives for the regulators, non-gazetting of by-laws, interferences by political and traditional leaders, absence of sanitation courts, limited number of prosecutors, non-prioritization of sanitation offences by the courts, and non-punitive fines (Addai, 2018; Tanko and Renouf, 2018; Antwi-Agyei et al., 2019). Some prosecution of sanitation bylaw defaulters have not been widespread enough to serve as deterrent to others because of the enforcement dilemma (Antwi-Agyei et al., 2019).

2.4 Water and Sanitation for the Urban Poor (WSUP) Projects

2.4.1 Compound Sanitation Strategy (CSS)

It was implemented by WSUP to assist households in compound houses (houses with more than two households) to build better shared latrines (Antwi-Agyei et al., 2019). The strategies were focused on legislation, enforcement, access to finance and developing the private market for compound toilets (WSUP, 2016, 2017b). The CSS was implemented in Kumasi Metropolitan and Ga West Municipal Assemblies (KMA & GWMA) with incentives for landlords to improve sanitation or face warnings, and prosecutions with jail and/or fine (Mikhael et al., 2016).

2.4.2 Cooperative approach to enforcement of sanitation by-laws

Realizing the slow pace of sanitation uptake and widespread noncompliance with weak enforcement of sanitation by-laws, another study was commissioned to develop improved enforcement model. The study looked at use of cooperative approach where regulators worked together with subject population to motivate them to comply willingly through building commitment and capacity to obey regulations (Antwi-Agyei et al., 2019). The enforcement model was formulated through a Negotiation Game that came up with a defined enforcement timetable which allowed landlords more time to start toilet construction, and save the local authority resources to focus on obstinate defaulters (Tanko and Renouf, 2018). The cooperative enforcement model had the ownership of all stakeholders (landlords, tenants, opinion leaders and the regulator) (Antwi-Agyei et al., 2019).

2.4.3 Sanitation surcharge to improve urban sanitation service

The Water and Sanitation for the Urban Poor (WSUP) facilitated piloting of sanitation surcharge implementation as part of property tax in two MMDAs namely Akwapim North and Ga West Municipalities in Eastern and Greater Accra regions respectively. The project evaluation sounded promising with mixed findings that require more improved implementation strategies for successful policy integration. The surcharge is not for directly supporting household toilet construction but for funding general environmental sanitation responsibilities including services and regulation (enforcement of by-laws) undertaken by the MMDAs (Nyarko et al., 2018).

2.5 Subsidy based approach - GAMA-SWP intervention

A typical case of subsidy approach is the Greater Accra Metropolitan Area Sanitation and Water Project (GAMA-SWP) implemented by the government of Ghana through the Ministry of Sanitation and Water Resources (MSWR) with the support from the World Bank. It's considered a successful flagship project and the Ministry announced scaling up nationwide (GhanaWeb, 2018). It is an output-based subsidy approach to improving urban sanitation in low-income communities. The intervention started by offering 50% subsidy for toilet construction but suffered slow and low uptake because toilet cost remained high relative to beneficiaries income (Steel, 2017). Implementers modified the package to 70% subsidy in addition to addressing consumer financing issues after which mass successful uptakes were recorded (World Bank, 2018). Thus, 50% subsidy costed sanitation consumers US$ 500 (half of full cost of US$ 1000), and 70% subsidy costs a beneficiary US$ 300 (i.e GHC 1,100) (Steel, 2017).

However, the evidence still supports the notion that subsidy alone did not improve coverage, rather a combination of subsidies and institutionalization of rigorous enforcement regimes in the various MMDAs (GAMA-SWP, 2019a). Additional key strategies included 1) promoting a low-cost toilet technology of biodigester toilet which was preferred at least 98% of the time; and 2) households/landlords paid 30% of toilet cost, either as GHC 1,100 for full toilet (biodigester plus superstructure), or GHC 600 for only the biodigester (without any superstructure) (GAMA-SWP, 2019b).

3 Interventions for improved urban sanitation – overview

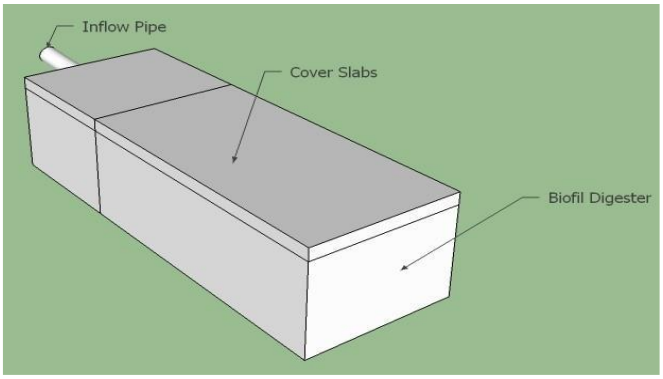
Based on existing myriad of constraints to improved urban sanitation in Ghana, especially the cost burden of building toilets and enforcement of sanitation laws, two key interventions based on subsidy approach are proposed. The interventions are also inspired by the existing flagship urban sanitation project currently implemented in the Greater Accra Metropolitan Area (GAMA) by the Ministry of Sanitation and Water Resources.

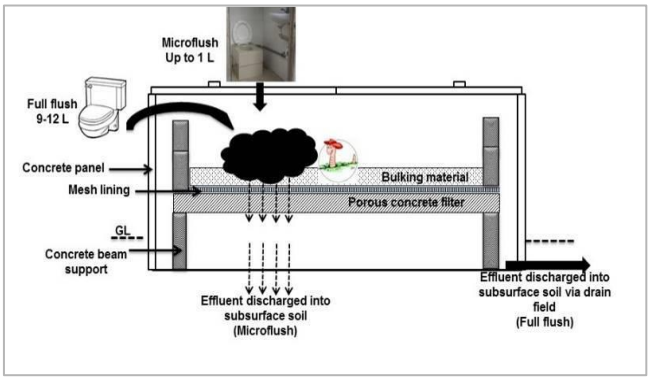
The interventions are provision of i) subsidy with improved enforcement for installation of toilet facilities (biodigester toilet) and ii) subsidy only for installation of toilet facilities without any emphasis on enforcement. Both interventions have assumed a period of 20 years (2020 to

2040) using the useful life typical of the toilet facility being promoted. The subsidy is equivalent to 100% of the cost of a biodigester toilet. Also, there could be a modification to this by government paying for 70% (as subsidy) while landlords/beneficiaries pay the remaining 30% for the cost of toilet facility. This modification is anticipated not to change much with respect to the long-term cost responsibilities between government and landlords/beneficiaries since beneficiaries in any of the interventions pay significantly more than the government in the long term in the form of maintenance and foregone rent.

The anatomy and key features of a biodigester toilet are shown in Figures 1 and 2. The biodigester toilet is an on-site faecal matter treatment facility designed as a normal flush or microflush unit where the digester typically will measure a rectangular shape of 0.6m x 0.6m x 1.8m by width, depth and length (Owusu-Antwi, 2015). The digester operates on rapid solid-liquid separation by a porous filter where the retained solids undergo accelerated decomposition by the activities of micro and macro-organisms in the digester chamber (Figure 1) (Owusu-Antwi, 2015; GAMA-SWP, 2018). The digester normally sitting under a superstructure is designed to replace the traditional septic tank by improving the concept of ecological sanitation by treating faecal matter directly from the water closets or pourflush seat (housed in a superstructure) (GAMA-SWP, 2018). Effluent (liquid) from the biodigester unit undergoes bio-filtration via sub-surface infiltration or through a sand media before disposal (ibid). The biodigester tolet acquisition cost is more likely the most competitive on the urban sanitation market (Table 2).

Figure 1 Typical biodigester in schematic views A) Outer view, and B) cross-sectional view





A B

Source: (GAMA-SWP, 2018)

Figure 2: A typical standalone biodigester toilet

Source: (GAMA-SWP, 2018)

Urban population preference for wet (flush) toilet systems means that sanitation interventions must consider technologies that operate as water closet (WC) or pour flush (PF) systems. The environmental sanitation policy also limits the use of dry toilets like VIPs in urban settings especially where land is limited with high population density (GoG, 2010). In addition, cost should be competitive to encourage uptake since most urban sanitation programs are constrained by acquisition cost of toilet facilities (WSUP, 2019).

The cost comparison for the various toilet options available for urban sanitation adoption especially in low-income communities are shown in Table 2 below.

Table 2: Urban toilet system options, description and cost

Toilet technology	**Brief description**	**Cost range (GHS)**	**Source**
Biodigester	Flush toilet with a digester which replaces the traditional septic tank in flushing toilet facilities.	3,300 – 4,000	Key informant interview and Duku et al (2020)
VIP	Ventilated improved pit toilet which operates on the principle of dry toilet used as an onsite system.	1,400 – 1,700	(Duku et al., 2020)
Flush+Round concrete tanks	Flush toilet (WC or PF) connected to round concrete septic tank provided as an onsite system.	4,400 – 4,600	(WSUP, 2019)
Container-based sanitation (Clean Team Ghana)	Subscriber based service where users only pay for monthly servicing fee (for operation & maintenance) and not cost of investment/capital cost of facility. Catridges used for excreta containment are replaced twice a week	43 per month*	Interview with Clean Team Ghana, Kumasi

* This cost is for operations and maintenance (subscription fee for excreta collection) as at January 2020.

Both interventions (i and ii) target improving sanitation conditions for families by promoting private household toilet ownership and usage, at worst **no more than three households sharing a toilet facility in their compound as a first sanitation target**. The target is an interim measure that recognizes space constraints which make achieving non-shared improved facilities difficult in the short and medium term. Already, urban areas host 63% of compound houses in Ghana (GSS, 2014). Most Ghanaian urban households without toilets reside in compound tenement houses with several other households. At best, these households may be sharing 1 – 2 compound toilets and/or depend on public toilets. For instance, in the city of Kumasi you could get 20 households sharing 1 – 2 compound toilet facilities (Caplan, 2010). Indeed, one-third of Ghanaian families would opt for shared toilets due to private ownership barriers such as land tenure insecurity, lack of funds, space constraints and others (Rheinlander et al., 2015).

Notwithstanding, shared toilet facilities within compound houses could serve as practical alternative to inadequate household sanitation services in low-income urban settings (Simiyu

et al., 2017). At least it could be an interim progressive measure towards ending open defecation and lessening the burden of using public toilets, if such compound toilets are not overcrowded like public toilets. This is probably the strong reason for WHO/UNICEF Joint Monitoring Program (JMP) and WSUP to have recommended shared toilet crowding of 3 and 5 households per a compound (Mara, 2016; Norman and Schelbert, 2018), although WHO/UNICEF JMP later dropped their recommendation without explanation (Mara, 2016).

The administration of the intervention would be done by the program team which could be a composition of representatitves from the Ministry of Sanitation and Water Resources, and staff of Metropolitan, Municipal and District Assemblies – MMDAs including the Environmental Health and Sanitation Departments/Units. Beneficiaries will be identified and registered by the enforcement team of the local government authority (MMDAs) during their routine inspection of houses, with the support of the program team. These beneficiary compounds or houses (without toilet facilities) by their landlords and/or caretakers will have to make binding commitment of providing the necessary space for toilet installation within a couple of days. The enforcement team together with program administrators will then facilitate the toilet construction by using recruited qualified artisans and toilet enterprises under strict supervision by the program teams. The cost of labour and materials for toilet construction are paid directly by the program team to the artisans after completing toilet installation. The recommended approach for administering the toilet subsidy is output-based aid through public-private partnership (PPP) (Steel, 2017).

3.1 Toilet subsidy with improved enforcement of sanitation by-laws

3.1.1 Description of intervention

The intervention seeks to provide government support for toilet construction (subsidy) for urban households in addition to improved enforcement of sanitation by-laws. While the subsidy attempts to make household toilets affordable to landlords and households, the enforcement component will incentivize households to meet up their contributions to the subsidies provided. As already stated, the subsidy could be equivalent to 100% or 70% of the cost of a biodigester toilet. This toilet is chosen because the Ministry of Sanitation in Ghana has extensively promoted it under the GAMA Project. It is believed that the facility's quality has satisfied all consultative processes between government, landlords and sanitation experts. Facilities that do

not create sludge problems such as frequent desludging and other externalities are preferred (GAMA-SWP, 2018).

The sanitation laws already stipulate penalties for landlords and/or responsible households that do not comply with sanitation requirements. Penalties are generally low compared to landlords' compliance cost (Antwi-Agyei et al., 2019). Landlords therefore have little incentive to comply, unless enforcement is coupled with other measures such as threat of court appearance, high court fines, citizen arrest, and public listing of non-compliance especially in newspapers (GhanaWeb, 2017; Mordy, 2017). In addition, enforcement component of the program may include capacity building and resourcing of prosecution teams for preparation and promotion of sanitation by-laws towards effecitve enforcement.

Key assumptions made for the intervention for informed analysis are the level of compliance anticipated from the target beneficiaries (landlords/households). Compliance rates of 100%, 75% and low rate of 50% are assessed.

3.1.2 Data

According to the World Bank (2019), the Ghanaian population for 2020 is around 31 million with 57.3% coming from the urban areas. Accordingly, more than 2.8 million (65%) of urban households in Ghana live in housing in which more than 3 households share a toilet facility or has no facility according to the Maternal Health Survey 2017 data (GSS et al., 2018). Disaggregation of the sanitation access levels is shown in Table 3 with high public toilet usage and quite a number of households also practicing open defecation. The intervention target is to move all households to improved sanitation (non-shared) and/or shared sanitation among of 2 – 3 households in the same compound, as already explained.

Table 3: Urban household toilet access levels pre- and post-intervention

Group	Toilet access levels	Urban household distribution (000)			
		Pre-intervention		Post-intervention	
		%	Number	%	Number
1	Improved sanitation, non-shared	22.4%	1,173	23.8%	1,245
2	Shared sanitation (2-3 households per toilet)	11.0%	575	76.2%	3,993
3	Shared sanitation (4-9 households per toilet)	15.1%	792	-	-
4	Sharing with >=10 households per toilet	4.6%	243	-	-
5	Using public toilet (GLSS7 2016-17)	38.0%	1,990	-	-
6	Unimproved sanitation, non-shared	1.4%	72	-	-
7	Open defecation	7.5%	393	-	-
	Total urban households	**100%**	**5,238**	**100%**	**5,238**

Authors' analysis based on data from Ghana MHS 2017 and GLSS7.

The following were applied to estimate the expected health improvements of moving from the pre- to post-intervention situation:

i) Health improvements: The so-called Potential Impact Fraction (PIF) equation is applied to estimate the reduction in disease burden from the improvements in sanitation. The equation requires data on the pre- and post-intervention population distribution by each type of sanitation (see Table 2) and the risk of disease and mortality associated with each type of sanitation relative to no or unimproved sanitation, or so-called relative risks (RR) (see below). The equation gives the percentage reduction in disease burden expected from the intervention.[1] The percentage reduction in disease is in turn multiplied by the baseline health data (see below), or incidence of disease and mortality, to arrive at the estimated reduction in cases of disease and mortality expected from the intervention.

ii) Baseline health data: Data for Ghana from the Global Burden of Disease 2017 (GBD 2017) are used as the baseline health situation.[2] This includes incidence of morbidity and mortality from diarrheal disease and typhoid/paratyphoid for all age groups, and incidence of infectious disease mortality from acute lower respiratory

[1] $PIF = (\sum_{i=1}^{n} P_i RR_i - \sum_{i=1}^{n} P_i' RR_i) / \sum_{i=1}^{n} P_i RR_i$ where P_i is the pre-intervention population distribution by type of sanitation i=1,…,n; P_i' is the post-intervention population distribution; and RR_i is the risk of disease and mortality associated with each type of sanitation relative to no or unimproved sanitation.

[2] www.healthdata.org

infections (ALRI), measles, malaria and other infectious diseases (i.e., meningitis, acute hepatitis) for children under five years of age. The incidence of infectious disease mortality among children under five is the baseline for estimating an indirect health effect of sanitation (see below).

iii) Reductions in relative risk (RR) of disease from improved sanitation: A recent meta-analysis by Wolf et al (2018) provides updated estimates of RR of childhood diarrheal disease associated with sanitation (and drinking water and hygiene). The overall estimate of effect of improved sanitation relative to unimproved sanitation or open defecation was an RR of 0.75 (25% reduction in risk of diarrheal disease). The effect varied, however, by type of sanitation and community sanitation coverage rates. RR of household improved santitation (without sewer connection) was 0.84 (16% disease risk reduction) while 0.60 (40% disease risk reduction) for sewer connection, relative to unimproved sanitation or open defecation. In relation to community sanitation coverage, the RR was 0.76 (24% disease risk reduction) for interventions that led to community sanitation coverage rates of less than 75% and an RR of 0.55 (45% disease risk reduction) for interventions that led to coverage greater than 75%. The meta-analysis is used by Pruss-Ustun et al (2019) to estimate the disease burden from inadequate sanitation (and drinking water and hygiene) in low- and middle-income countries. Pruss-Ustun et al apply the sanitation related RRs to diarrheal morbidity and mortality for all age groups and to child malnutrition (with stunting as a choice of indicator).

In this paper for urban Ghana, relative risk (RR) of diarrheal disease applied to estimate health benefits of the intervention is 1.0 for open defecation, unimproved sanitation, use of public toilets, and sharing of toilet facility between 4 or more households (Groups 3-7 in Table 2). An RR of 0.7 is applied for improved, non-shared toilet facility such as the biodigester toilet that provides some of the same benefits as improved toilet with sewer connection (Group 1 in Table 2). This RR is somewhat lower than found by Wolf et al (2018) for household improved sanitation without sewer connection (0.84) but higher than for sewer connection (0.60). In the absence of any reported evidence from meta-analyses, relative risk of sharing of toilet facility between 2-3 households is assumed to be the mid-point of 1.0 and 0.7, that is 0.85 (Group 2 in Table 2). As in Pruss-Ustun et al (2019), the RRs are applied to diarrheal morbidity and mortality for all age groups. The RRs are also applied to

typhoid/paratyphoid morbidity and mortality as they are reported separately in the GBD 2017.

iv) Indirect health effects of santitation: Repeated diarrheal infections in early childhood have been found to contribute to poor nutritional status in children under five years of age. This relationship is discussed and documented in Fewtrell et al (2007), World Bank (2008), Pruss-Ustun et al (2019) and Wolf et al (2019). Poor nutritritional status (i.e., child underweight and stunting) in turn increases the risk of child mortality from infectious diseases (i.e., diarrheal disease, ALRI, malaria, measles and other infectious diseases) as documented in Olofin et al (2013). Attributing 50% of child underweight to diarrheal infections[3] and applying urban child underweight prevalence rates from the Ghana Demographic and Health Survey 2014 (GDHS 2014)[4] add an additional 10% mortality to the baseline diarrheal and typhoid/paratyphoid mortality to which the PIF is applied to estimate the health improvements of the sanitation interventions.[5]

3.1.3 Calculation of Costs and Benefits

It must be noted that the same data and sources are used for both interventions except where otherwise stated. Applying the Potential Impact Fraction (PIF) equation to the pre- and post-intervention population distribution in Table 2, and RRs of 1.0 to Groups 3-7, 0.85 to Group 2 and 0.7 to Group 1, gives PIF of 11.1%, meaning that the intervention is expected to reduce diarrheal (and typhoid/paratyphoid) morbidity and mortality among all age groups, and infectious disease mortality from diarrheal disease through underweight among children under five by 11.1%.

The value of statistical life year (VSLY) is used for valuation of mortality benefits of the interventions and is from a benefit-transfer function adopted by Copenhagen Concensus Centre (Wong and Dubosse, 2019). The value is GHS 14,400 per life year in 2020, or 1.3 times GDP

[3] Fewtrell et al (2007) attribute 50% of child underweight to inadequate water, sanitation and hygiene (WASH), implying a somewhat higher share than 50% from all diarrheal infections as WASH is not the only cause of diarrheal infections. The attributate fraction of 50% of underweight from diarrheal infections applied to urban Ghana in this paper is therefore conservative compared to Fewtrell et al.

[4] Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF International. 2015. *Ghana Demographic and Health Survey 2014*. Rockville, Maryland, USA: GSS, GHS, and ICF International.

[5] The additional mortality is only 10% due to the relatively low prevalence of child underweight in Ghana.

per capita, and rising to 2.0 times GDP per capita after 20 years.[6] The cost associated with diarrhoea morbidity for different age groups is presented in (Table 4).

Table 4: Cost per case of diarrhea morbidity (in GHS)

Case groups	Days per case	Untreated/ productivity loss	Treated (% of cases)]	Severe (inpatient) %	Treated (outpatient)	Treated (inpatient)	Total cost per case
Diarrhea U5	5.3	0	24%	16%	57	500	94
Diarrhea 5-14	5.1	81	14%	1%	138	581	94
Diarrhea 15years+	5.1	163	14%	1%	220	663	176

Authors estimated treatment cost based on authors' esitmates and (Aikins et al., 2010).

3.1.3.1 Cost

The cost of the intervention has six components. The sanitation promotion program cost including administration cost for running subsidy intervention is around GHS 55 per toilet facility. Cost of toilet facility promoted under the intervention is GHS 4,000 with a useful life of 20 years. The annual operation and maintenance (O&M) cost of the household toilet is GHS 200 (5% of capital cost). Housebold toilet cleaning cost (time) is GHS 233 per facility/yr based on 10 minutes per day of cleaning valued at 50% of urban wage rates. The cost of enforcement is related to a team of three officials envisioned for ensuring that landlords/households comply with the sanitation target of maximum of three households per toilet facility. For three (3) full working days per person with an average monthly salary of GHS 1,500 per person, and additional budget of GHS 110 for transportation, total enforcement cost around GHS 785 per compound house (GHS 295 per facility). In addition to these costs, the landlords/households are expected to incur the cost of GHS 700/toilet/yr as foregone rental space that will have to be released for toilet construction.

Using the discount rates of 5%, 8% and 14%, the present value of the cost of the intervention and its components over the 20-year period are shown in Table 5. The intervention total cost is between GHS 8.6 and 25.8 billion. About 22 – 35% of intervention cost is borne directly by government (implementer of the intervention – cost of sanitation promotion program, enforcement, and toilet), and the rest (65 – 78%) is paid by beneficiaries (landlords/households) in a form of cost associated with toilet cleaning, operations and maintenance, and foregone

[6] The VSLY in relation to GDP per capita is rising over time due to GDP per capita growth and an income elasticity greater than 1.0.

rental space. The most significant cost component at all times is the foregone rental space accounting for 38 – 44% of the total intervention cost (GHS 3.2 – 11.4 billion).

Table 5: Present value of cost of Subsidy with enforcement intervention

Cost components (GHS million)	100% Compliance			75% Compliance			50% Compliance		
	5%	8%	14%	5%	8%	14%	5%	8%	14%
Program cost - fixed	70	70	70	70	70	70	70	70	70
Enforcement cost - fixed	377	377	377	377	377	377	377	377	377
Capital cost of toilets	5,111	5,111	5,111	3,834	3,834	3,834	2,556	2,556	2,556
O&M cost for toilets	3,441	2,765	1,948	2,580	2,074	1,461	1,720	1,382	974
Toilet cleaning cost	5,386	4,187	2,788	4,039	3,140	2,091	2,693	2,093	1,394
Value of rental space turned into toilet	11,366	9,134	6,436	8,524	6,850	4,827	5,683	4,567	3,218
Total Cost (GHS million)	**25,751**	**21,644**	**16,731**	**19,425**	**16,344**	**12,660**	**13,099**	**11,045**	**8,589**

Note: The base case with discount rate of 8% is shaded grey. Source: Estimates by authors.

3.1.3.2 Benefits

The main benefits attributed to the intervention are health benefits (averted morbidity and mortality), productivity benefits accrued from time savings (e.g. time spent looking for a place to defecate outside the home/compound including queueing at public toilets), and averted cost of paying for public toilet (GHS 900 per household/yr, or GHS 0.7 per person per day (WSUP, 2019)). Time savings per person per day are assumed to be 5 minutes for households currently sharing with 4-9 households, 15 minutes for households currently sharing with10 or more households, 25 minutes for households currently using public toilets, and 15 minutes for households currently practicing open defecation.[7] Also, with <100% compliance, the remaining households who will continue to depend on public toilets are expected to benefit from time savings externalities (i.e. enjoy less waiting time than before). Time savings are valued at 50% of average urban wage rate for pesons 15+ years of age and at ½ this rate for children 5-14 years of age. No value of time is imputed for children under five years of age.

Improved sanitation in rental properties is also likely to yield an increase in rental values for landlords. Tenants are likely to be willing to pay more for rental units with improved sanitation because the tenants will realize time savings, health benefits, and averted expenditure on using public toilets. Thus, the increase in rental value is already captured in these benefits and

[7] The Economics of Sanitation Initiative (ESI) in studies in six countries in East Asia found that average time spent on OD was 14 minutes per person per day: https://www.wsp.org/content/east-asia-economic-impacts-sanitation

separately including the increase in rental value as a benefit would therefore represent double counting.

The present value of overall benefits from the intervention over a 20-year period are valued between GHS 34 and 107 billion (Table 6). The largest benefit is productivity benefits coming from time savings at around GHS 23 – 68.4 billion, accounting for 63 – 70% of total benefits. This is followed by cost savings from no longer having to use public toilets – GHS 6.8 to 24.1 billion, representing 19 – 24% of total benefits. Health benefits of averted mortality and morbidity are around GHS 3.6 – 14.5 billion, claiming 11 – 13% of total benefits from the intervention.

Table 6: Present value of benefits derived from Subsidy with enforcement intervention

Benefits (GHS million)	**100% compliance rate**			**75% compliance rate**			**50% compliance rate**		
	5%	**8%**	**14%**	**5%**	**8%**	**14%**	**5%**	**8%**	**14%**
Morbidity averted cost	6,701	5,209	3,468	5,026	3,907	2,601	3,350	2,605	1,734
Mortality averted cost	7,812	5,934	3,791	5,859	4,450	2,843	3,906	2,967	1,896
Time savings	68,426	53,194	35,418	59,394	46,172	30,743	44,979	34,966	23,282
Public toilet cost averted	24,110	19,375	13,653	18,083	14,531	10,240	12,055	9,687	6,826
Benefits (GHS million)	107,049	83,712	56,331	88,361	69,061	46,427	64,290	50,225	33,738

Note: The base case with discount rate of 8% is shaded grey. Source: Estimates by authors.

3.1.3.2 Benefit-cost ratios (BCRs)

The Copenhagen Consensus Center prefers to use BCRs instead of Net benefits for developing countries strategic context for reasons well articulated in the Economic Brief for Ghana Priorities Project (Wong and Dubosse, 2019). Table 7 presents the BCRs for the intervention for the three compliance rates of 100%, 75% and 50%.

The BCRs are in the range of 3.37 – 4.91 meaning that benefits are approximately GHS 3 - 5 for every GHS 1 spent on the intervention. The ratios for lower compliance rates are slightly larger than for higher compliance rates. This is due to the value of time savings among those who continue to use public toilets at <100% compliance rates (because of less waiting time than before) is larger than the increase in enforcement and promotion program cost per household (due to these costs being fixed). One interpretation of this result is that it is not socially optimal to have very high uptake rates since that creates redundant public sanitation infrastructure. Net benefits of the intervention are, however, substantially larger at higher compliance rates.

The BCRs are somewhat sensitive to the expected time savings of the intervention as this benefit account for 63-70% of total benefits. Of total time savings, nearly 80% are no longer having to use public toilets with a saving of 25 minutes per person per day. If this saving on the contrary is only 15 minutes, the BCR declines from 4.23 to 3.27 for the scenario of 75% enforcement at the base case 8% discount rate.

Table 7: BCRs for subsidy with enforcement intervention

Interventions	Compliance rate	BCR at Discount rates		
		5%	8%	14%
Toilet subsidy with enforcement	100%	4.16	3.87	3.37
	75%	4.55	4.23	3.67
	50%	4.91	4.55	3.93

Note: Base case with discount rate of 8% is shaded grey. Source: Estimates by authors.

3.2 Toilet subsidy (only) provision for household toilet construction

3.2.1 Description of intervention

This intervention also provides subsidy for households/landlords to construct toilets in their homes or compounds. This subsidy (equivalent to 100% of toilet facility cost) is to lessen the burden of high cost of improved toilet facilities recommended for urban settings in Ghana. This intervention is similar to the previous one presented except that no attention is given to enforcement. Similarly, the government will bear the cost of sanitation promotion program and capital cost of toilet while landlords and households will incur the cost associated with toilet upkeep (cleaning, O&M), and releasing rental space for toilet construction. Also, there could be modification to the responsibility for the capital cost of toilet for instance to mimic an existing project like the GAMA-SWP where landlords pay at least 30% of the capital cost.

3.2.2 Data

The data and sources are all similar to the previous intervention except that the enforcement activities and cost are not considered in this case. Also, the assumptions for uptake or response rates are different from the the first intervention. Here, the three main scenarios are i) best responses rate of 20%, ii) moderate response rate of 10%, and iii) worst response rate of 1%. The basis for the low response rates assumption is that landlords already perceive that the subsidy (if even 100%) provides insufficient incentive to install toilet facilities because cost of

toilet facilities are nowhere near their total cost contributions in terms of rental space loss, operation and maintenance and others.

3.2.3 Calculation of Costs and Benefits

The data and sources for cost and benefits calculations are same except where explicit additions are made.

3.2.3.1 Cost

Similar cost calculations from the first intervention are carried out here except that there is no enforcement cost. Thus, no budget is created to support enforcement teams unlike in the other intervention. However, it is expected that the regulatory team from the Metropolitan, Municipal and District Assemblies (MMDAs) will be doing their normal work – which could be what we call business as usual or even better without any budget to that effect.

Using discount rates of 5%, 8% and 14%, the present value of the total cost of intervention and its components over a useful life of 20 years are shown in Table 8. The intervention total cost is between GHS 0.23 to 5.1 billion. About 21 – 52% of intervention cost is borne directly by government (intervention implementer in the form of promotion program cost and toilet capital cost), and the rest (48 – 79%) is paid by landlords/households in a form of cost associated with toilet cleaning, operations and maintenance, and foregone rental space. The most significant cost component at all times is the foregone rental space accounting for 28 – 44% (GHS 0.06 – 2.3 billion) of the total intervention cost.

Table 8: Present value of cost of Subsidy only intervention

Cost components (GHS million)	20% Response rate			10% Response rate			1% Response rate		
	5%	8%	14%	5%	8%	14%	5%	8%	14%
Program cost - fixed	70	70	70	70	70	70	70	70	70
Capital cost of toilets	1,022	1,022	1,022	511	511	511	51	51	51
O&M cost for toilets	688	553	390	344	276	195	34	28	19
Daily toilet cleaning cost	1,077	837	558	539	419	279	54	42	28
Value of rental space turned into toilet	2,273	1,827	1,287	1,137	913	644	114	91	64
Total Cost (GHS million)	5,131	4,310	3,327	2,601	2,190	1,699	323	282	233

Note: Base case with discount rate of 8% is shaded grey. Source: Estimates by authors.

3.2.3.2 Benefits

The same input data and sources used in the previous interventions are replicated here as well. Also, households who will continue to depend on public toilets are expected to benefit from

time savings externalities (i.e. enjoy less queueing time than before). The present value of total benefits with specific components are presented in Table 9.

The present value of the overall benefit from the subsidy only intervention is between GHS 0.7 and 28.3 billion. The largest benefit, like in the previous intervention is productivity benefits coming from time savings to the value of GHS 0.6 – 20.6 billion, accounting for 72 – 74% of the overall benefits. This is followed by cost savings from not having to use and pay for public toilets (GHS 0.14 to 4.8 billion), representing 16 – 18% of total benefits. Health benefits of averted mortality and morbidity account for about 9 – 10% of intervention benefits.

Table 9: Present value of benefits of Subsidy only intervention

Benefits (GHS million)	**20% Response rate**			**10% Response rate**			**1% Response rate**		
	5%	**8%**	**14%**	**5%**	**8%**	**14%**	**5%**	**8%**	**14%**
Morbidity averted cost	1,340	1,042	694	670	521	347	67	52	35
Mortality averted cost	1,562	1,187	758	781	593	379	78	59	38
Time savings	20,575	15,995	10,650	10,718	8,332	5,548	1,111	863	575
Public toilet cost averted	4,822	3,875	2,731	2,411	1,937	1,365	241	194	137
Benefits (GHS million)	28,300	22,099	14,833	14,580	11,384	7,639	1,497	1,169	784

Note: Base case with discount rate of 8% is shaded grey. Source: Estimates by authors.

3.2.3.2 Benefit-cost ratios (BCRs)

The Table 10 presents BCRs for the intervention for the three response rates of 20%, 10% and 1%. The BCRs are in the range of 3.3 – 5.6 meaning that benefits are GHS 3.3 – 5.6 for every GHS 1 spent. The BCRs of the intervention are quite high even with the least uptake or response rate of 1%.

The BCRs are somewhat sensitive to the expected time savings of the intervention as this benefit account for 72-74% of total benefits. Of total time savings, nearly 80% are no longer having to use public toilets with a saving of 25 minutes per person per day. If this saving on the contrary is only 15 minutes, the BCR declines from 5.20 to 3.75 for the scenario of 10% compliance at the base case 8% discount rate.

Table 10: BCRs for subsidy only intervention

Interventions	Compliance rate	BCR at Discount rates		
		5%	8%	14%
Toilet subsidy only	20%	5.52	5.13	4.46
	10%	5.61	5.20	4.50
	1%	4.63	4.14	3.36

Note: Base case with discount rate of 8% is shaded grey. Source: Estimates by authors.

3.3 Assessment of Quality of Evidence

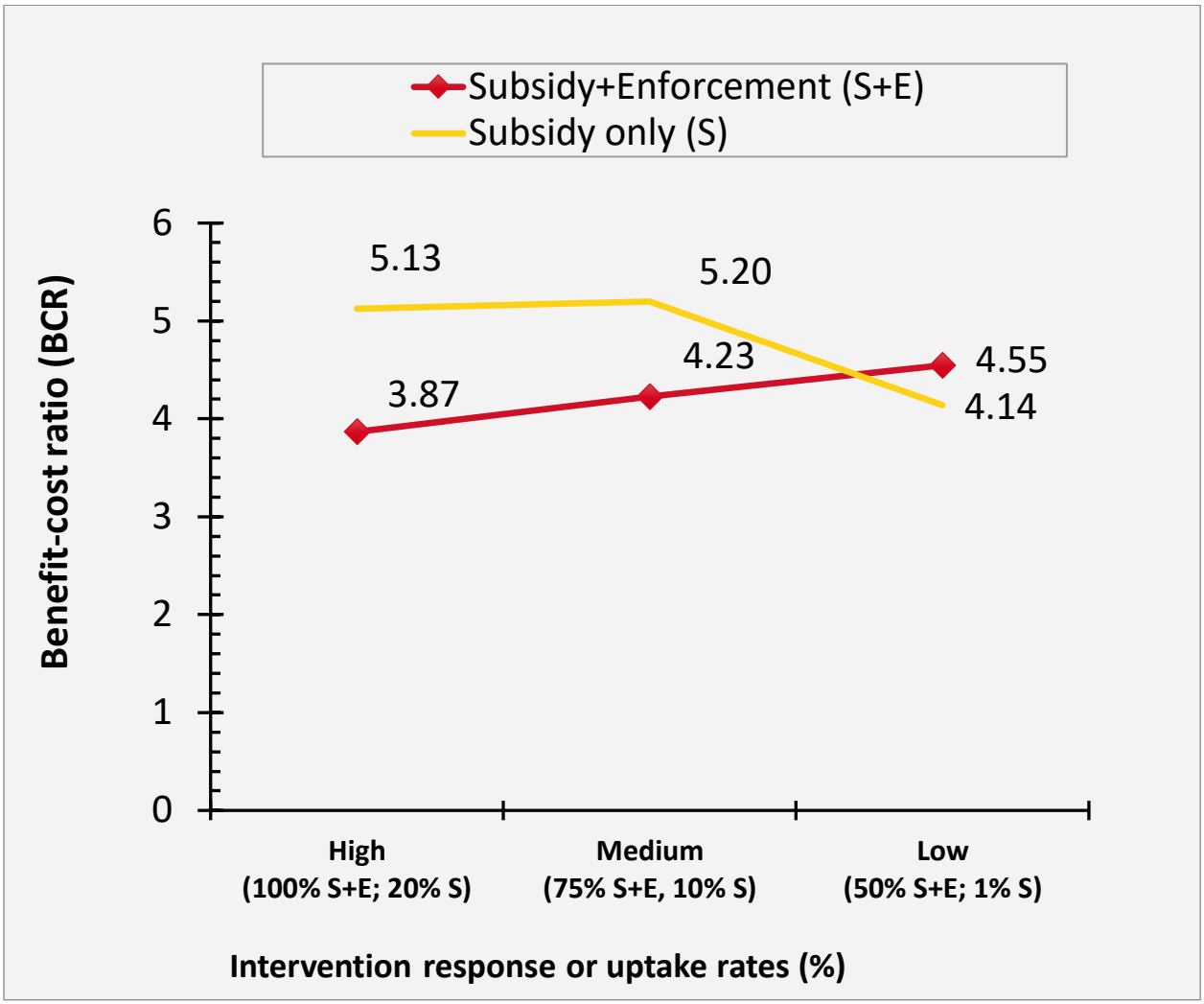
The quality of evidence could be ranked medium to strong based on the evidence base for costs and benefits (Table 11, see Appendix). Figures are obtained from on-going urban sanitation projects reports, a published research work on the cost of diarrhoeal diseases in Ghana; limited interviews on enforcement cost. The value of benefits is based on data from global burden of disease study report 2017 on morbidity and mortality averted (meta analysis), national Maternal Health Survey 2017 report, time for open defecation study in similar developing countries in Asia, and meta analysis of ten pooled studies of indirect effect of diarrhoea in children under 5 years etc.

3.4 Sensitivity Analysis

The sensitivity analysis is based on the trend of the BCRs in response to the intervention uptake rates at 8% discount base rate as presented in Figure 3. The intervention uptake rates are three scenarios of buy-in from landlords/households: i) for first intervention (subsidy with enforcement – S+E), the scenarios are 100%, 75% and 50% compliance, and ii) second intervention (subsidy only – S), the scenarios are 20%, 10% and 1% response rates. High compliance/response rates are 100% (S+E) vrs 20% (S), medium 75% (S+E) vrs 10% (S), and low 50% (S+E) vrs 1% (S) (Figure 3).

The BCRs are quite sensitive to the uptake rates. For subsidy with enforcement intervention, BCRs increases (3.87 – 4.55) along with decrease in compliance rate (high to low). For subsidy provision only, BCR increases from response rate of high to medium (5.13 to 5.20) but drops to 4.14 at the low response rate.

Figure 3 Benefit-cost ratios response to intervention uptake rates



Values are discounted at 8%

4 Discussion – Intervention effects

The intervention "Toilet subsidy provision alone", even with subsidy at 100% of cost of toilet facility, provides little incentive for landlords to install toilet facilities because of other costs incurred by landlords. The cost of toilet facilities (considered as subsidy by government or intervention implementer) constitutes on average only half of the total cost to landlords. In fact, half of cost to landlords is lost rental income from allocating space for toilet facilities that otherwise is rented out. Subsidy alone is therefore likely to have very minimal impact (intervention uptake or response) on installation of toilet facilities. Although low uptake rates such as 1% could still present impressive BCRs (3.4 – 4.6), the total net benefits are low across all response rates (GHS 0.6 – 23.2 billion) compared to the other intervention (GHS 25.1 – 81.3 billion) (see Table 12 & Table 13 in the Appendix). This is because of comparatively small effect size coming from the "subsidy only" intervention. As subsidy schemes involve fixed start-up and administration cost, the BCRs for subsidy only could go well below 1 when the response rate hits a level even lower than the barest minimum of 1% assessed in this study.

The effect of the intervention "subsidy coupled with enforcement" is somewhat sensitive to the compliance rate. The size of the effect has some impact on the BCRs (3.9 at 100% to 4.6 at 50% compliance rates) although enforcement cost is a very small fraction (1.5 – 4.4%) of total intervention cost. Moreover, low compliance rates reduce total net benefits (see Table 12 in the Appendix) of the intervention in nearly direct proportion. Yet, this intervention can be promoted and perceived as a goodwill from the government to share sanitation cost with the owners of private (including rental) houses for the common good of the urban population. And, in fact, landlords are most likely going to share or pass on their cost as well to potential tenants, since the rental value of housing units with access to toilet facilities are higher than for units without facilities (Osumanu et al., 2016).

5 Conclusions

Two interventions which could improve urban sanitation in Ghana are evaluated. The benefit-cost ratios (BCRs) for toilet Subsidy only intervention are higher for both high uptake rate (4.5 – 5.5) and medium uptake rate (4.5 – 5.6) than the corresponding BCRs for toilet Subsidy with enforcement intervention (high uptake: 3.4 – 4.2; and medium uptake: 3.7 – 4.6). However, for the low response/uptake rates, BCRs are seen vice versa – Subsidy with enforcement have higher ratios (3.9 – 4.9) than Subsidy only intervention (3.4 – 4.6).

The decision to implement any of the two interventions will come with beneficial impacts in magntidues of about 3 – 6 times. For Subsidy only intervention, BCR is high even with as little as 1% response rate, however the total net benefits are low compared to subsidy with enforcement because of the intervention's low response rates (small effect size).

There is enough confidence in the quality of evidence associated with the evaluation due to the medium to strong data source quality rating.

6 References

Addai, E. (2018). *Enforcement of Sanitation Bye-Laws – The Tamale Experience* [Online]. ODF Ghana Campaign, Accra, Ghana. Available at: odfghanacampaign.org/?page_id=26420 [Accessed September 5, 2019].

Agbezuge, S. (2018). Environmental sanitation: A human right to Ghanaians. *Journal of Law, Policy and Globalization*, 72, 30-37.

Aikins, M., Armah, G., Akazili, J. & Hodgson, A. (2010). Hospital Health Care Cost of Diarrheal Disease in Northern Ghana. *J Infect Dis*, 202, S1**,** S126-S130. doi:10.1086/653573

Antwi-Agyei, P., Monney, I., Dwumfour-Asare, B. & Cavil, S. (2019). Toilets for tenants: a cooperative approach to sanitation bye-law enforcement in Ga West, Accra. *Environment & Urbanization*, 31, 1**,** 293-308. doi:https://doi.org/10.1177/0956247818800654

Appiah-Effah, E., Duku, G. A., Azangbego, N. Y., Aggrey, R. K. A., Gyapong-Korsah, B. & Nyarko, K. B. (2019). Ghana's post-MDGs sanitation situation: an overview. *Journal of Water, Sanitation and Hygiene for Development*, 9, 3**,** 397-415. doi:10.2166/washdev.2019.031

Berendes, D. M., Kirby, A. E., Clennon, J. A., Agbemabiese, C., Ampofo, J. A., Armah, G. E., Baker, K. K., Liu, P., Heather, Reese, E., Robb, K. A., Wellington, N., Yakubu, H. & Moe, C. L. (2018). Urban sanitation coverage and environmental fecal contamination: Links between the household and public environments of Accra, Ghana. *PLOS ONE*, 13, 7**,** e0199304. doi:10.1371/journal.pone.0199304

Caplan, K. (2010). Situational analysis of public toilets in Kumasi, Ghana: Initial recommendations for WSUP. *BPD WATER AND SANITATION*. WSUP, UK.

Duku, G. A., Appiah-Effah, E., Nyarko, K. B. & Dwumfour-Asare, B. (2020). Early live-prototype testing of a low-cost latrine technology for rural and peri–urban communities: The case of a modified pour-flush latrine. *Scientific African*, 8, e00338. doi:10.1016/j.sciaf.2020.e00338

GAMA-SWP, Greater Accra Metropolitan Area - Sanitation and Water Project (2019a). Creating demand for household toilets through law enforcement. *GAMA-SWP Technical Brief*. February 2019 ed. Greater Accra Metropolitan Area - Sanitation and Water Project (GAMA-SWP), Accra, Ghana.

GAMA-SWP, Greater Accra Metropolitan Area - Sanitation and Water Project. (2019b). *Greater Accra Metropolitan Area (GAMA) Sanitation and Water Project – GAMA-SWP* [Online]. Greater Accra Metropolitan Area (GAMA) Sanitation and Water Project, Accra, Ghana. Available at: http://www.mswrpcu.com/ [Accessed September 5, 2019].

GAMA-SWP, Greater Accra Metropolitan Area - Sanitation and Water Project (2018). Training of selected SPIs and MMDAs on household toilets. *GAMA-SWP Training report*. March 2018 ed. Greater Accra Metropolitan Area - Sanitation and Water Project (GAMA-SWP), Accra, Ghana.

GhanaWeb. (2018). *Sanitation ministry to replicate GAMA water, sanitation project nationwide* [Online]. GhanaWeb, Accra, Ghana. Available at: https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Sanitation-mi...ry-to-replicate-GAMA-water-sanitation-project-nationwide-710853 [Accessed September 15, 2019].

GhanaWeb. (2017). *KMA lauds citizen action against sanitation law breakers* [Online]. GhanaWeb, Accra, Ghana. [Accessed July 24, 2019].

GoG, Government of Ghana (2010). Environmental Sanitation Policy (Revised 2010). September 2010 ed. Government of Ghana/ Ministry of Local Government and Rural Development, Accra, Ghana.

Greenland, K., de-Witt Huberts, J., Wright, R., Hawkes, L., Ekor, C. & Biran, A. (2016). A cross-sectional survey to assess household sanitation practices associated with uptake of "Clean Team" serviced home toilets in Kumasi, Ghana. *Environment and Urbanization,* 28, 2**,** 583-598. doi:10.1177/0956247816647343

GSS, Ghana Statistical Service (2014). Housing in Ghana. *2010 Population and Housing Census.* October 2014 ed. Ghana Statistical Service, Accra, Ghana.

GSS, Ghana Statistical Service (2018). Ghana Living Standards Survey Round 7 (GLSS 7) *Poverty trends in Ghana, 2005 - 2017.* Ghana Statistical Service Accra, Ghana.

GSS, Ghana Statistical Service , GHS, Ghana Health Service & ICF, Inner City Fund (2018). Ghana maternal health survey 2017. August 2018 ed. Ghana Statistical Service, Ministry of Health & Inner City Fund (ICF), Accra, Ghana.

Hutton, G. (2013). Global costs and benefits of reaching universal coverage of sanitation and drinking-water supply. *J Water Health,* 11, 1**,** 1-12. doi:10.2166/wh.2012.105

Mara, D. (2016). Shared sanitation: to include or to exclude? *Trans R Soc Trop Med Hyg,* 110, 5**,** 265-7. doi:10.1093/trstmh/trw029

Mazeau, A., Tumwebaze, I. K., Luthi, C. & Sansom, K. (2013). Inclusion of shared sanitation in urban sanitation coverage? Evidence from Ghana and Uganda. *Waterlines,* 32, 4**,** 334-348. doi:10.3362/1756-3488.2013.034

Mikhael, G., Craig, R. & Musah, I. B. (2016). A toilet in every compound improving access to compound sanitation in Kumasi and Ga West, Ghana. *39th WEDC International Conference*. WEDC Kumasi, Ghana.

Mordy, J. T. (2017). *Judges abandon sanitation court over 'insanitary' condition* [Online]. MyJoyOnline.com., Accra, Ghana. Available at: https://www.myjoyonline.com/news/2017/august-9th/judges-abandon-sanitation-court-over-insanitary-condition.php [Accessed September 5, 2019].

MSWR, Ministry of Sanitation and Water Resources (2018). Guidelines for targeting the poor and vulnerable for sanitation services in Ghana. *WASH Sector Guidelines.* June 2018 ed. Ministry of Sanitation and Water Resources, Government of Ghana, Accra, Ghana.

Narracott, A. & Norman, G. (2011). Clean Team, a human-centred approach to sanitation: initial trials in Ghana. *WSUP Practice Note* [Online]. Water & Sanitation for the Urban Poor (WSUP).

Norman, G. & Schelbert, V. (2018). High-quality shared sanitation: how can we define that? *WSUP Policy Brief.* August 2018 ed. Water and Sanitation for the Urban Poor (WSUP), UK.

Nyarko, K. B., Oduro, C. Y. & Appiah-Effah, E. (2018). Research around sanitation surcharges included in property rates in Ghana Synthesis of findings in Akuapem North, Ga West and Kumasi. *WSUP Presentation Report* [Online]. Water and Sanitation for the Urban Poor (WSUP), UK. Available at: https://www.wsup.com/content/uploads/2018/02/Synthesised-Sanitation-Surcharge-Report-presentation-WSUP-format.pdf [Accessed July 28, 2019].

Obeng, P. A., Keraita, B., Oduro-Kwarteng, S., Bregnhøj, H., Abaidoo, R. C. & Konradsen, F. (2015). The latrine ownership ladder. *Management of Environmental Quality: An International Journal,* 26, 5**,** 752-763. doi:10.1108/MEQ-05-2014-0079

Osumanu, I. K., Kosoe, E. A. & Dapilah, F. (2016). Residential housing in Ghana's low-income urban areas: An analysis of households living conditions in the Wa Municipality. *J. Geogr. Reg. Plann.,* 9, 7**,** 139-153. doi:10.5897/JGRP2016.0557

Owusu-Antwi, P. (2015). Occurrence of on-site sanitation technologies in poor urban communities: A case of the biofil toilet technology. *SusanA Forum* [Online]. SuSanA. Available at: https://forum.susana.org/media/kunena/attachments/6563/PETEROWUSU-ANTWI_PhD_OccurenceofOSSinurbancommunitiesinGhana.pdf [Accessed January 14, 2020].

Prüss-Ustün, A., Wolf, J., Bartram, J., Clasen, T., Cumming, O., Freeman, M. C., Gordon, B., Hunter, P. R., Medlicott, K. & Johnston, R. (2019). Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes: An updated analysis with a focus on low- and middle-income countries. *International Journal of Hygiene and Environmental Health,* 222, 765-777. doi:10.1016/j.ijheh.2019.05.004

PSI, PATH & WSUP (2017). Catalyzing markets for urban sanitation in West Africa: Sanitation Service Delivery (SSD) Program: Benin, Cote D'Ivoire, Ghana. *Program Brief.* June 2017 ed. PSI, PATH, USAID and WSUP, Washington DC, USA.

Rheinlander, T., Konradsen, F., Keraita, B., Apoya, P. & Gyapong, M. (2015). Redefining shared sanitation. *Bull World Health Organ,* 93, 7**,** 509-510. doi:10.2471/BLT.14.144980

Simiyu, S., Swilling, M., Cairncross, S. & Rheingans, R. (2017). Determinants of quality of shared sanitation facilities in informal settlements: case study of Kisumu, Kenya. *BMC Public Health,* 17, 1**,** 68. doi:10.1186/s12889-016-4009-6

Steel, W. F. (2017). Final Report: Developing the market for sanitation investments in Ghana. *GAMA-SWP report.* December, 2017 ed. Greater Accra Metropolitan Area Sanitation and Water Project, Ministry of Sanitation and Water Resources, Accra, Ghana.

Tanko, A. & Renouf, R. (2018). Smart enforcement of sanitation by-laws in Ghana. *WSUP Policy Brief.* Water and Sanitation for the Urban Poor (WSUP), UK.

Tidwell, J. B., Terris-Prestholt, F., Quaife, M. & Aunger, R. (2019). Understanding demand for higher quality sanitation in peri-urban Lusaka, Zambia through stated and revealed preference analysis. *Social Science & Medicine,* 232, 139-147. doi:10.1016/j.socscimed.2019.04.046

WHO & UNICEF (2010). JMP Technical Task Force Meeting on Sanitation and Methods for Estimating Progress, 27-28 July 2010. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP), New York, USA.

WHO, World Health Organization (2018). Guidelines on sanitation and health. *WHO Guidelines.* World Health Organization, Geneva, Switzerland.

Wolf, J., Johnston, R., Hunter, P. R., Gordon, B., Medlicott, K. & Prüss-Ustün, A. (2019). A Faecal Contamination Index for interpreting heterogeneous diarrhoea impacts of water, sanitation and hygiene interventions and overall, regional and country estimates of community sanitation coverage with a focus on low- and middle-income countries *International Journal of Hygiene and Environmental Health,* 222, 270-282. doi:10.1016/j.ijheh.2018.11.005

Wong, B. & Dubosse, N. (2019). Economist brief for Ghana priorities. *Copenhagen Consensus Economic Brief.* June 2019 ed. Copenhagen Consensus.

Woode, P. K., Dwumfour-Asare, B., Nyarko, K. B. & Appiah-Effah, E. (2018). Cost and effectiveness of water, sanitation and hygiene promotion intervention in Ghana: the case of four communities in the Brong Ahafo region. *Heliyon,* 4, 10**,** e00841. doi:10.1016/j.heliyon.2018.e00841

World Bank (2018). GH-GAMA Sanitation and Water Project (P119063). *Implementation Status & Results Report* The World Bank.

WSP, Water and Sanitation Program (2011). Water Supply and Sanitation in Ghana: Turning Finance into Services for 2015 and Beyond. *An AMCOW Country Status Overview.* Water and Sanitation Program–Africa Region, The World Bank, Nairobi, Kenya.

WSUP, Water & Sanitation for the Urban Poor (2017a). The world can't wait for sewers - Advancing container-based sanitation businesses as a viable answer to the global sanitation crisis. EYGM Limited, UK.

WSUP, Water & Sanitation for the Urban Poor. 2016. Can we get a toilet into every compound? *News* [Online]. Available from: https://www.wsup.com/blog/can-we-get-a-toilet-into-every-compound/.

WSUP, Water and Sanitation for the Urban Poor (2019). Why are toilets so expensive in Ghana? Experience from Kumasi. *WSUP Practice Note.* November 2019 ed. Water and Sanitation for the Urban Poor (WSUP), UK.

WSUP, Water and Sanitation for the Urban Poor (2017b). A toilet in every compound: improving access to compound sanitation in Kumasi and Ga West. *WSUP Practice Note.* July 2016 ed. Water and Sanitation for the Urban Poor (WSUP), UK.

WSUP, Water and Sanitation for the Urban Poor (2017c). Urban Sanitation Research Initiative 2017-2020: Driving sector change in urban sanitation. Water & Sanitation for the Urban Poor (WSUP), London, UK.

Appendix - BCR Summary Tables

Table 11: BCRs summary table with quality of evidence

Interventions	Compliance/ Response rate	Benefit/Cost (GHS in millions)	Discount rate			Quality of Evidence	Evidence base for benefits	Evidence base for costs
			5%	8%	14%			
Toilet subsidy provision with improved enforcement of sanitation by-laws	100%	Benefit	107,049	83,712	56,331	Medium to Strong	Baseline health data from the Global Burden of Disease 2017; morbidity and mortality averted based on meta analysis of relative risks; National Maternal Health Survey 2017 for sanitation data; open defecation study in similar developing countries in Asia; meta analysis of ten pooled studies of indirect effect of diarrhoea in children <5, etc.	Costs figures obtained from on-going urban sanitation projects reports, a published research work on diarrhea among children under 5 years in northern Ghana; limited interviews on enforcement cost.
		Cost	25,751	21,644	16,731			
		BCR	**4.16**	**3.87**	**3.37**			
	75%	Benefit	88,361	69,061	46,427			
		Cost	19,425	16,344	12,660			
		BCR	**4.55**	**4.23**	**3.67**			
	50%	Benefit	64,290	50,225	33,738			
		Cost	13,099	11,045	8,589			
		BCR	**4.91**	**4.55**	**3.93**			
Toilet subsidy provision without any particular attention to enforcement (keeping the status quo or business as usual for enforcement)	20%	Benefit	28,300	22,099	14,833			
		Cost	5,131	4,310	3,327			
		BCR	**5.52**	**5.13**	**4.46**			
	10%	Benefit	14,580	11,384	7,639			
		Cost	2,601	2,190	1,699			
		BCR	**5.61**	**5.20**	**4.50**			
	1%	Benefit	1,497	1,169	784			
		Cost	323	282	233			
		BCR	**4.63**	**4.14**	**3.36**			

Note: All benefits and costs are present values. Source: Estimates by the authors.

Table 12: Benefit-cost analysis of Subsidy with enforcement

Benefit and cost categories	Compliance or uptake rates								
	100% Intervention uptake or compliance			75% Intervention uptake or compliance			50% Intervention uptake or compliance		
	Discounting rates			Discounting rates			Discounting rates		
No Externalities*	5%	8%	14%	5%	8%	14%	5%	8%	14%
Benefits (GHS million)	107,049	83,712	56,331	80,286	62,784	42,248	53,524	41,856	28,165
Morbidity averted cost	6,701	5,209	3,468	5,026	3,907	2,601	3,350	2,605	1,734
Mortality averted cost	7,812	5,934	3,791	5,859	4,450	2,843	3,906	2,967	1,896
Time savings	68,426	53,194	35,418	51,319	39,895	26,564	34,213	26,597	17,709
Public toilet cost averted	24,110	19,375	13,653	18,083	14,531	10,240	12,055	9,687	6,826
Cost (GHS million)	25,751	21,644	16,731	19,425	16,344	12,660	13,099	11,045	8,589
Program cost	70	70	70	70	70	70	70	70	70
Enforcement cost	377	377	377	377	377	377	377	377	377
Capital cost of toilets	5,111	5,111	5,111	3,834	3,834	3,834	2,556	2,556	2,556
O&M cost for toilets	3,441	2,765	1,948	2,580	2,074	1,461	1,720	1,382	974
Daily toilet cleaning cost	5,386	4,187	2,788	4,039	3,140	2,091	2,693	2,093	1,394
Value of rental space turned into toilet	11,366	9,134	6,436	8,524	6,850	4,827	5,683	4,567	3,218
Net Benefits (GHS million)	81,298	62,068	39,600	60,862	46,439	29,588	40,426	30,811	19,577
BCR	4.16	3.87	3.37	4.13	3.84	3.34	4.09	3.79	3.28
Externalities*									
Benefits (GHS million)	107,049	83,712	56,331	88,361	69,061	46,427	64,290	50,225	33,738
Morbidity averted cost	6,701	5,209	3,468	5,026	3,907	2,601	3,350	2,605	1,734
Mortality averted cost	7,812	5,934	3,791	5,859	4,450	2,843	3,906	2,967	1,896
Time savings	68,426	53,194	35,418	59,394	46,172	30,743	44,979	34,966	23,282
Public toilet cost averted	24,110	19,375	13,653	18,083	14,531	10,240	12,055	9,687	6,826
Cost (GHS million)	25,751	21,644	16,731	19,425	16,344	12,660	13,099	11,045	8,589
Program cost	70	70	70	70	70	70	70	70	70
Enforcement cost	377	377	377	377	377	377	377	377	377
Capital cost of toilets	5,111	5,111	5,111	3,834	3,834	3,834	2,556	2,556	2,556
O&M cost for toilets	3,441	2,765	1,948	2,580	2,074	1,461	1,720	1,382	974
Daily toilet cleaning cost	5,386	4,187	2,788	4,039	3,140	2,091	2,693	2,093	1,394
Value of rental space turned into toilet	11,366	9,134	6,436	8,524	6,850	4,827	5,683	4,567	3,218
Net Benefits (GHS million)	81,298	62,068	39,600	68,936	52,716	33,768	51,191	39,180	25,149
BCR	4.16	3.87	3.37	4.55	4.23	3.67	4.91	4.55	3.93

Note: All benefits and costs are present values. * Externalities refer to the addional time savings at compliance rates of 75% and 50% that will accrue to those who continue to use public toilets but post-intervention experience less waiting time. The case with externalities is the scenario presented in the main body of the paper. Source: Estimates by the authors.

Table 13: Benefit-cost analysis of Subsidy only intervention

Benefits and cost categories	**Response Rates**								
	20% Intervention uptake or compliance			10% Intervention uptake or compliance			1% Intervention uptake or compliance		
	Discounting rates			Discounting rates			Discounting rates		
No Externalities - Subsidy only*	5%	8%	14%	5%	8%	14%	5%	8%	14%
Benefits (GHS million)	21,410	16,742	11,266	10,705	8,371	5,633	1,070	837	563
Morbidity averted cost	1,340	1,042	694	670	521	347	67	52	35
Mortality averted cost	1,562	1,187	758	781	593	379	78	59	38
Time savings	13,685	10,639	7,084	6,843	5,319	3,542	684	532	354
Public toilet cost averted	4,822	3,875	2,731	2,411	1,937	1,365	241	194	137
Cost (GHS million)	5,131.04	4,309.64	3,327.00	2,600.66	2,189.96	1,698.64	323.32	282.25	233.12
Program cost	70	70	70	70	70	70	70	70	70
Capital cost of toilets	1,022	1,022	1,022	511	511	511	51	51	51
O&M cost for toilets	688	553	390	344	276	195	34	28	19
Daily toilet cleaning cost	1,077	837	558	539	419	279	54	42	28
Value of rental space turned into toilet	2,273	1,827	1,287	1,137	913	644	114	91	64
Net Benefits (GHS million)	16,279	12,433	7,939	8,104	6,181	3,934	747	555	330
BCR	4.17	3.88	3.39	4.12	3.82	3.32	3.31	2.97	2.42
Externalities - Subsidy only*									
Benefits (GHS million)	28,300	22,099	14,833	14,580	11,384	7,639	1,497	1,169	784
Morbidity averted cost	1,340	1,042	694	670	521	347	67	52	35
Mortality averted cost	1,562	1,187	758	781	593	379	78	59	38
Time savings	20,575	15,995	10,650	10,718	8,332	5,548	1,111	863	575
Public toilet cost averted	4,822	3,875	2,731	2,411	1,937	1,365	241	194	137
Cost (GHS million)	5,131	4,310	3,327	2,601	2,190	1,699	323	282	233
Program cost	70	70	70	70	70	70	70	70	70
Capital cost of toilets	1,022	1,022	1,022	511	511	511	51	51	51
O&M cost for toilets	688	553	390	344	276	195	34	28	19
Daily toilet cleaning cost	1,077	837	558	539	419	279	54	42	28
Value of rental space turned into toilet	2,273	1,827	1,287	1,137	913	644	114	91	64
Net Benefits (GHS million)	23,169	17,789	11,506	11,980	9,194	5,941	1,173	886	551
BCR	5.52	5.13	4.46	5.61	5.20	4.50	4.63	4.14	3.36

Note: All benefits and costs are present values. * Externalities refer to the addional time savings at compliance rates of 75% and 50% that will accrue to those who continue to use public toilets but post-intervention experience less waiting time. The case with externalities is the scenario presented in the main body of the paper. Source: Estimates by the authors.

GHANA PRIORITIES

The Ghanaian economy has been growing swiftly, with remarkable GDP growth higher than five per cent for two years running. This robust growth means added pressure from special interest groups who demand more public spending on certain projects. But like every country, Ghana lacks the money to do everything that citizens would like. It has to prioritise between many worthy opportunities. What if economic science and data could cut through the noise from interest groups, and help the allocation of additional money, to improve the budgeting process and ensure that each cedi can do even more for Ghana? With limited resources and time, it is crucial that focus is informed by what will do the most good for each cedi spent. The Ghana Priorities project will work with stakeholders across the country to find, analyze, rank and disseminate the best solutions for the country.

FOR MORE INFORMATION VISIT WWW.GHANAPRIORITIES.COM

Copenhagen Consensus Center is a think tank that investigates and publishes the best policies and investment opportunities based on social good (measured in dollars, but also incorporating e.g. welfare, health and environmental protection) for every dollar spent. The Copenhagen Consensus was conceived to address a fundamental, but overlooked topic in international development: In a world with limited budgets and attention spans, we need to find effective ways to do the most good for the most people. The Copenhagen Consensus works with 300+ of the world's top economists including 7 Nobel Laureates to prioritize solutions to the world's biggest problems, on the basis of data and cost-benefit analysis.