PENALIZING NON-ADOPTION OF ADEQUATE SANITATON FACILITIES

Decision Support Tool User Guide

TETRA TECH

February 2022

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GLOSSARY

Control panel	A table in the user dashboard of the model that allows the user to vary the value of key variables that determine the outputs of the model. The values entered in the control panel lead to real-time changes in the output tables in the model
Dashboard	A dashboard is a user interface that consolidates, organizes, and presents information in a way that is easy to read. The dashboard has two parts: a control panel that allows the user to select/ input the parameters of the model; and a table that displays the resultant outputs on the same sheet
Default rate	The percentage of house owners who do not comply with the policy despite receiving a warning. The default rate can be set by the user and can be different for each stage of the enforcement process
Dwelling unit	A specific area or space occupied by a particular household and therefore need not necessarily be the same as a house of which the dwelling unit may be a part. A dwelling can be a structure or group of structures (rooms or buildings), separate or contiguous, occupied by the members of the household. One dwelling is equal to one household
Enforcement schedule	The enforcement schedule is a calculation sheet in the model that details out the different enforcement stages and the number of houses (disaggregated by house type and occupancy type) inspected at each stage. Based on certain inputs, it spreads the number of houses inspected and toilets built over time
House	A structurally separate and independent place of abode such that a person or group of persons can isolate themselves from the hazards of climate such as storms and the sun
House owner	In this document, house owner refers to a person who has an enforceable claim or title to a house/ property, and is recognized as such by law. The person is recognized by the law as having the ultimate control over, and right to use, the house/ property as long as the law permits. The house owner's rights are not affected by whether or not she/ he occupies (live in) the house she/ he owns. This is distinguished from the right of tenants who may occupy a house but only have a temporary right to use/ possess it
Houses with improved sanitation	According to the WHO/ UNICEF Joint Monitoring Program (JMP), an improved sanitation facility is defined as one that hygienically separates human excreta from human contact. In the context of the base model, this refers to W.C.s and Kumasi Ventilated Improved Pit Latrines (KVIP)
Houses without adequate sanitation	For the base model, houses without adequate sanitation have been defined as those where additional sanitation facilities need to be built. For multi-occupancy houses (see definition below), this includes all houses with either unimproved sanitation or improved but shared sanitation. However, for self-contained houses (see definition below), houses without adequate sanitation include only those houses that have unimproved sanitation; this is because it is assumed that self-contained houses with improved but shared sanitation facilities are those in which external households not residing in that house also make use of the sanitation facility. Therefore in these houses, additional toilets are not required, rather the toilets need to be built in the houses where the external households reside

Houses with improved but shared sanitation	For the base model, these are houses in which improved sanitation facilities exist, but are used by more than four households. JMP considers improved sanitation facilities that are shared with any other households to be unimproved. However, given the context of Ghana where compound housing is common, for this model we consider one improved toilet in a compound to be sufficient as long as it is shared by no more than three households
Houses with unimproved sanitation	Open defecation or any type of sanitation facility that does not hygienically separate human excreta from human contact is considered unimproved. Note: as mentioned above, improved facilities shared with three or less households is considered improved in the Ghana context
Key constraints	These are factors that prevent a house owner from building a toilet even if he/ she wanted to build one. For example, inability to afford a toilet, or inadequate space to build a toilet. House owners facing such key constraints should not be penalized under the proposed policy as they would not be able to build a toilet even if they were legally obligated to do so
Key variables	A key variable is one that has a direct and significant impact on the output of the model. These could include the choice of housing segment targeted by the policy lever; the key constraints faced by house owners; and factors influencing compliance with the policy
Landlord	In this document, a landlord refers to a house owner who, in exchange for rent, leases the house to another individual known as the tenant
Multi-occupancy housing	In this type of housing, multiple households live in a single structure that is let out room by room and have shared water supply and toilets or none at all
Occupancy status	Occupancy status refers to whether the dwelling unit is owned by the occupant or is rented. Further, in Ghana, there is a category of rent-free occupancy where the occupant is neither owner nor paying rent. Often this is the case where the house belongs to a relative of the occupant who does not live in the structure
Owned house	This is a house in which the household(s) residing in the house own the house and do not pay any rent to a third party for the right to occupy the premises
Rented house	This is a house in which the household(s) residing in the house do not own the house, but are paying the house owner rent for the right to occupy the premises. For our model, households that are living in a house rent-free (see occupancy status) are also considered as living in a rented house
Self-contained housing	In this type of housing, a single household lives in a separate structure that it does not share with any other household. It includes detached and semi-detached bungalows and apartments. In this type of dwelling, one household is equal to one house
Tenant	In this document, a tenant is a person(s) who occupies or possesses a house by way of a grant of an estate of some type, such as in fee, for life, for years, or at will. The tenant has the right to temporary use and possession of a particular property, which has been conveyed to that person by a landlord
User	In this document, user refers to someone who wishes to apply the penalties model to a specific geography/ market and is therefore interested in adapting it
User-defined duration	The duration for the policy as entered by the user in the Dashboard sheet of the model. The model calculates coverage and cost for the user-defined duration, unless

the target market gets inspected prior to the user-defined duration. In that case, the cost is calculated for the actual number of months taken to cover the target market

1.0 INTRODUCTION

Inadequate access to sanitation remains a significant problem globally. According to the Joint Monitoring Programme (2020), 1.7 billion people still do not have access to basic sanitation facilities, while 494 million people still practice open defecation. Inadequate sanitation is linked to the transmission of numerous communicable diseases—particularly cholera, dysentery, hepatitis A, typhoid, and polio—with a disproportionally large effect on children. The scale of investment required to deliver sanitation goods and services to the hundreds of millions of people around the world that currently lack access is staggering and beyond the capacity of public finance alone.

The private sector has already proven itself a key player in the financing, construction, and operation of municipal water supply and wastewater systems in both developed and developing world settings, and has a significant role to play in the provision of onsite sanitation. Experts increasingly view market-based sanitation (MBS) interventions—through which private sector actors supply toilets and related services to individual households—as a promising approach for scaling the delivery of onsite sanitation to households that are not connected to centralized wastewater collection and conveyance systems. Successful MBS interventions in Southeast Asia and Bangladesh demonstrate the promise of this approach, yet those successes have proven difficult to replicate in other regions, particularly sub-Saharan Africa and India, where the need is greatest.

Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability (WASHPaLS) is a USAID centrally funded research and technical assistance mechanism that focuses on identifying and filling gaps in knowledge concerning behavior change and sanitation product and service delivery. One of WASHPaLS' first tasks was to produce and disseminate an in-depth desk review report on market-based approaches to sanitation. With an overarching aim to illustrate how and when an MBS approach may best work within a given context, the desk review describes the current state of knowledge in market-based sanitation (MBS) and establishes a framework to analyze, design, and improve MBS interventions. It is based on a survey of approximately 600 documents on MBS, in-depth research into 13 MBS intervention case studies across the global south, and interviews with sector experts and program personnel.

The survey of the MBS literature and analysis of case studies made clear that, while the focus of these interventions tended to be the sanitation *market*[1] (the interaction between buyers and sellers), successful interventions also sought to bring about change in the broader sanitation *market system*[2] (e.g., value chains and such supporting functions like banking and infrastructure). In an effort to apply this *systems* lens to MBS, a "framework" for MBS interventions was developed that specifies the various levels at which stakeholders should intervene to bring about systems change.

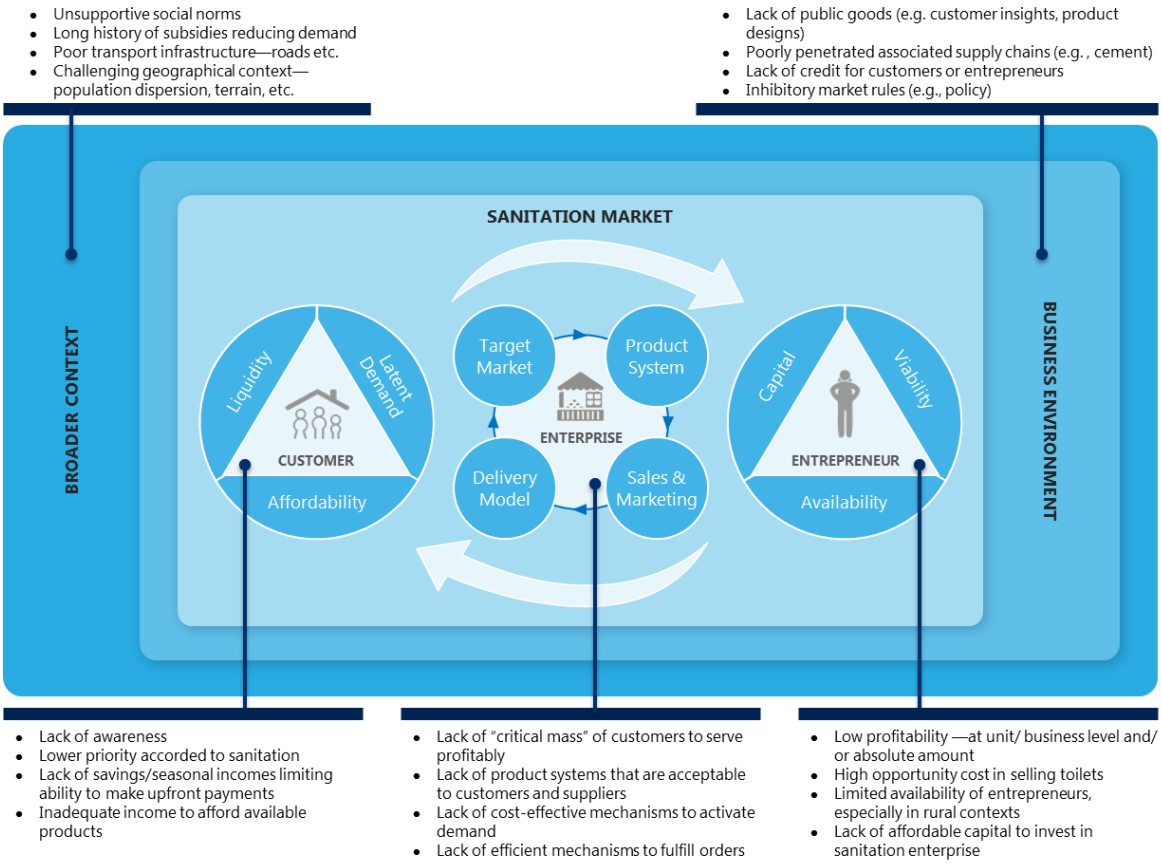
The framework specifies three distinct domains of the sanitation market system, based on the degree of influence in each domain from an intervener's (funder and implementer) perspective: **context**, which

[1] According to the Making Markets Work for the Poor (M4P) approach, a **Market** is "*a set of arrangements by which buyers and sellers are in contact to exchange goods or services; the interaction of demand and supply.*" Alternatively, a market comprises buyers and sellers. In the above figure the market is represented by the customer, the sanitation enterprise, and the entrepreneur

[2] A **Market System**, meanwhile, is "*a multi-function, multi-player arrangement comprising the core function of exchange by which goods and services are delivered **and** the supporting functions and rules which are performed and shaped by a variety of market players.*" A market system therefore comprises value chains and supporting functions (e.g., banking system, infrastructure) that enable the market to function. The market system also includes formal rules (e.g., laws, standards) and informal rules or norms that influence interactions and outcomes.

interveners can understand but typically cannot influence; **business environment**, which interveners may potentially influence depending on the complexity and resources available; and the **sanitation market**, which large-scale interventions largely have the capacity to address. The existence and severity of barriers, or absence thereof, across the sanitation *market system* determines the depth of that market; see Figure 1 (USAID, 2018).

Figure 1: Barriers to scaling MBS across the sanitation market system



At the center of the framework is the **sanitation market**, with the business– the mechanism that facilitates the exchange of products and services between entrepreneur and customer, also known as the "**sanitation enterprise**," at its core. Sanitation enterprises must attract enough customers (a "critical mass") to operate profitably. At the same time, entrepreneurs with the attributes (e.g., skills, assets) and capital necessary to build or sell toilets are needed.

Both customers and entrepreneurs may be confronted with a distinct set of barriers, which, individually or in combination, hinder their participation in the market. Customers may lack income or savings to afford toilets that are available in the market (the "affordability" barrier); they may have unstable or seasonal income that prevents them from making the full payment upfront ("liquidity" barrier); or they may not be willing to pay for toilets that are affordable for a range of reasons ("willingness" barrier). On the supply side, the availability of entrepreneurs with attributes (e.g., skills, assets) necessary to build or sell toilets may be limited (the "availability" barrier). Low profitability of selling toilets may discourage entrepreneurs from entering or continuing to operate in the market (the "viability" barrier), or entrepreneurs may lack the capital required to invest in the sanitation enterprise (the "capital" barrier).

The functioning of a sanitation market is governed by the broader **business environment**. The business environment is shaped by factors such as the availability of non-excludable public goods (e.g., market information on product designs in the public domain); the state of associated supply chains (e.g., availability and price of construction raw materials used to build toilets); the state of financial services, which affects the availability of credit for customers and entrepreneurs; and **market rules**, i.e., business-related laws, regulations, and policies (e.g., government programs to provide in-kind hardware subsidies).

Finally, social norms or informal rules can be as powerful as market rules, or even more. Context, beyond the commercial activity related to sanitation, in our framework encompasses social norms, infrastructure, and geographical characteristics, which represent enablers or barriers that tend to shift slowly and can lie outside the influence of funders or implementers.

In order to embed and scale an MBS intervention in a given context, barriers across the three domains of the market system would need to be addressed (Figure 1). **In this document, we focus on efforts to address the barriers in the business environment; specifically, the role market rules can play in creating an enabling environment for MBS interventions.**

Market rules include taxes and tariffs, laws, regulations, and policies. Shaping these to enable the sanitation market, support increasing demand and/or improve enterprise viability, is the role of the government at all levels—national, regional, and local levels (Pedi & Jenkins, 2013).

Market rules can address various barriers to customer participation in the sanitation market, like market-compatible targeted subsidies to poor households that enhance affordability. Market rules that affect willingness to pay take numerous forms, including building codes or by-laws that authorize permits only for properties with toilets or that only release housing subsidies to those who construct toilets. Penalties through denial of service or surcharges on households without toilets also shape customers' willingness to pay. For example, water supply boards in Honduras provide new connections only to households with functioning toilets, while Uganda prohibits the sale or lease of property without toilets. Such policies, however, create challenges because they risk inequitable treatment if applied to households that cannot afford toilets. They also can be difficult to enforce, especially in the context of informal housing.

Market rule adjustments by the government to enhance the viability of the sanitation enterprise can include reducing tariffs and taxes on raw materials used for constructing toilets, providing direct support to entrepreneurs by facilitating priority access to critical raw materials, or providing entrepreneurs with assured product or service orders to institutions like schools or local government offices. For example, in Benin, the government provided incentives to local masons to set up sanitation enterprises in their villages by offering contracts to construct toilets in schools. Market rules (e.g., policy, regulation) have a significant influence on the business environment for MBS interventions since they can address physical, institutional, financial, and social barriers that affect sanitation markets. **However, they cannot be used to overcome enterprise weaknesses resulting from wrong product system, ineffective delivery model, or absence or inadequate demand activation**. While enterprises and customers must ultimately operate independently in the sanitation business environment, key actors such as the government and other stakeholders have a crucial role in shaping market rules to catalyze market activity and depth.

Governments around the world have used various financial and legislative instruments/ actions to influence market rules governing the provision of social services. While there are examples of such instruments being used in the sanitation sector, there is limited evidence available regarding their efficacy. Further, even where policies are present, they are often not enforced.

It is difficult to convince policy makers of the benefit of changing market rules because of the lack of evidence, or an estimate of the costs involved. To help address this lacuna, FSG undertook targeted

research on the role market rules can play in creating a positive environment for sanitation markets. **Our research attempted to answer three key questions:**

A. How do policies that support entrepreneurs in the sanitation market directly impact their viability by enhancing their ability to sell toilets, and/ or improving their profitability and market depth?

B. How do reduced tariffs/ indirect taxes impact toilet prices and the consequent change in toilet sales and entrepreneur viability?

C. What is the impact of penalties on non-adoption of toilets amongst higher-income house owners who can afford, but do not have adequate sanitation facilities in their houses (either self-occupied or rented)?

Note: Henceforth, adequate sanitation may also be referred to as "toilet."

The research was carried out using an economic modeling approach. For each of the three research questions, a base economic model was created to estimate the impact of **specific policy levers** on toilet sales, and/ or viability of entrepreneurs, as well as the costs incurred by the government in enforcing the policy (e.g., loss in revenue, monitoring costs). The intention was to provide stakeholders with a tool to support decision-making. That is, the models are intended to be an additional resource that policy makers, funders, and implementers can draw upon when exploring whether to introduce a particular market rule in the sanitation sector.

It should be noted that these are economic models, not econometric models. Economic models are simplified descriptions of complex systems designed to simulate potential outcomes on the basis of a theory of economic behavior, existing data, and assumptions. Econometric models generally begin with economic models (Hymans, 2008), which are then formulated in a way that is testable (Shalab) through statistical trials. The results of these trials are compared and contrasted with the results from real-life examples. Econometric modeling requires the development of mathematical equations that can estimate the values of all variables in the economic model, as well as assumptions related to how variables outside the model may affect outcomes. In order to do this, econometric models rely on large, reliable data sets.

Given the limited instances of market rules being used in the sanitation sector (and the lack of data available on the outcome of these instances) creating robust econometric models would not be possible for us. Therefore, we decided upon economic modeling as the appropriate approach for our research. The model in this research generates potential outcomes using user input data, variables, and assumptions. Real-world results may vary due to variables and relationships that are unknown or not modeled in this research.

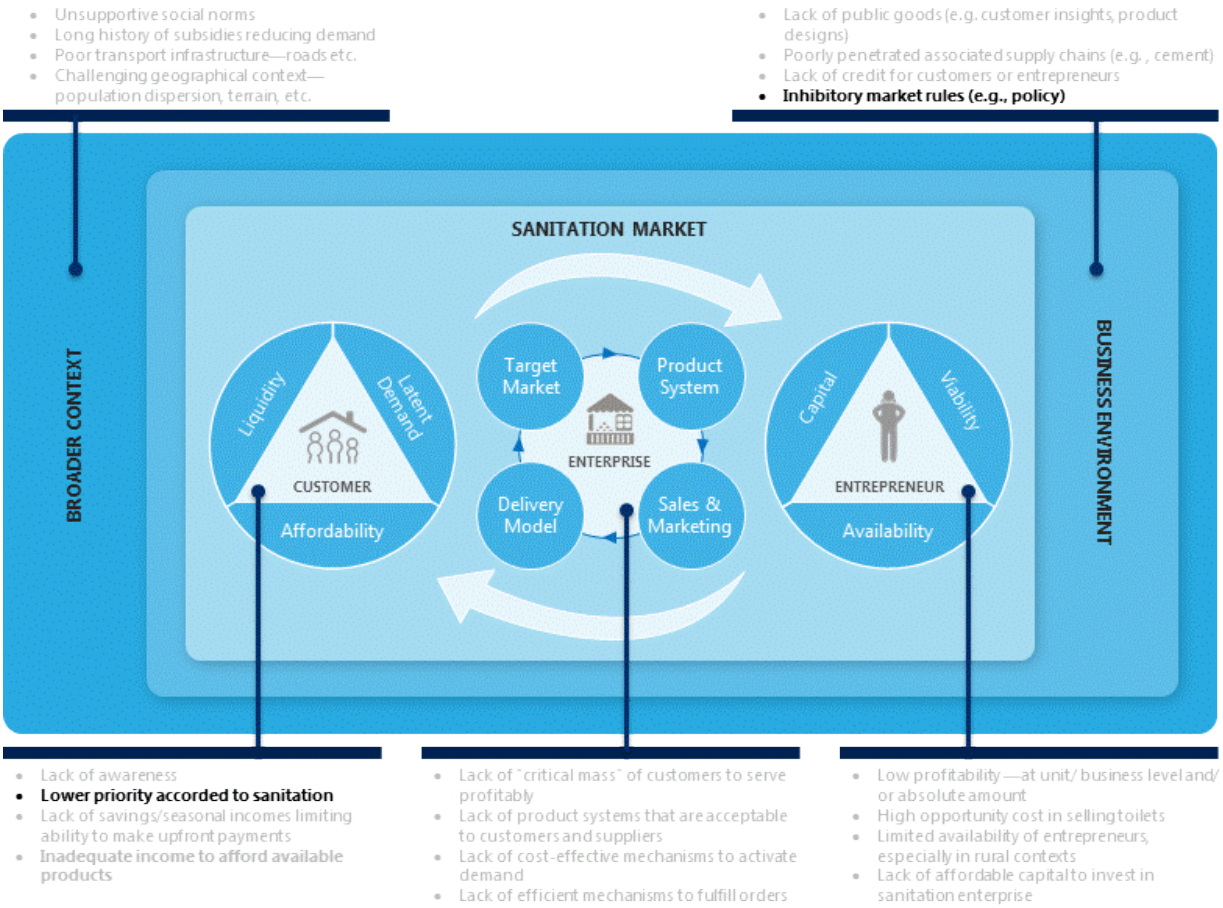
The base economic models were built using actual data from sample geographies where either similar policy levers existed, where analogous policy levers were available from other sectors, or where there was sufficient data to create hypothetical cases. Using actual data from these sample countries ensured that the models were grounded in real-world conditions, and allowed for the outputs of the model to be validated by experts from those countries. Once validated, each of the three base models was applied to an additional geography/ market to study variation in impact across different contexts. The findings from this exercise were documented in a research report. In addition, user guides were created to help stakeholders adapt these base models to other geographies/ markets.

This document is the user guide for the model created to answer Question C, i.e., what is the impact of penalties on non-adoption of adequate sanitation facilities amongst higher-income house owners who can afford, but do not have adequate sanitation facilities in their houses? In this document, the term 'adequate sanitation facilities' refers to improved toilets used by an individual household or shared by up to four households. The definition of 'adequate sanitation,' however, will vary by country-specific standards, which could include quality, technical specifications, among others. **The specific policy**

lever that the model (hereafter referred to as the 'penalties model') evaluates is a financial penalty on property owners who do not provide adequate sanitation facilities to households living at their property (self or tenants). These property owners may not be willing to pay for toilets, even if they can afford them, if they have competing priorities. The proposed penalty is expected to increase the **cost of not owning a toilet**, thereby making owning a toilet more attractive as compared to competing priorities.

Figure 2 highlights where this policy lever fits on our MBS framework. As the proposed policy lever is a market rule aimed at creating a supportive environment for MBS it addresses the "inhibitory market rules" barrier in the business environment. Further, as the intended impact of the policy lever to increase market depth by acting upon customers' willingness to pay for toilets, it also acts on the "willingness barrier" faced by customers.

Figure 2: MBS framework barriers addressed by penalties model



2.0 HOW TO USE THIS DOCUMENT

2.1 PURPOSE OF THIS DOCUMENT

This document serves as a guide to help interested stakeholders understand, adapt, and apply the penalties model to geographies/ markets they are working in. Specifically, the document aims to provide:

- An overview of the penalties model including the overall objectives, the decisions it can support, and its limitations
- A detailed understanding of the workings of the penalties model including the underlying logic, expected outputs (both the benefits and costs), and key variables/ inputs
- A step-by-step guide to adapting the model for application to other markets including the contexts in which the model can be applied, and the minimum data requirements

Funders and implementers can use this document to create context-specific models and use the resultant outputs as a starting point for discussions with government officials regarding potential policy changes. Governments, in turn, can use these context-specific models to support decision-making.

2.2 RELATED DOCUMENTS

This user guide frequently refers to sheets in the **penalties base model (WASHPaLS_Penalties-Base-Model_Ghana_vf.xlsx) and should therefore be read in conjunction with it**. Throughout the user guide, screenshots of the base model have been inserted to aid in the explanation of the model. In certain instances, the same sheet has been inserted multiple times in the document in order to illustrate different points. A list of figures has been provided at the start of this document to help readers navigate through the different sections. Further, under each figure, the actual name of the sheet depicted is provided. Using this, the reader can review the relevant sheet in the accompanying base mode.

The base model was built using data from Ghana where long-standing municipal bye-laws exist that penalize landlords for not providing their tenants with toilets. However, until very recently these bye-laws were not enforced. A recent USAID-supported program – "A Toilet in Every Compound" is now working with municipal governments to strengthen the enforcement of these bye-laws, including revamping the enforcement mechanism. Using this policy and the proposed enforcement mechanism as a starting point, we constructed a base model to estimate the potential impact the policy would have if enforced. The base model, while drawing heavily on the actual policy and enforcement mechanism found in Ghana, does make modifications in order to enhance the predictive power and replicability of the model. For example, the base model allows users to apply the policy to any type of house (not just compound houses) and to all house owners (not just those who have rented their houses out). The base model was tested by the implementers of the aforementioned USAID program ("A Toilet in Every Compound") in order to ensure that it is realistic.

2.3 INTENDED AUDIENCE

The penalties model and this user guide are intended for use primarily by practitioners who are interested in assessing the possible impact that a similar policy lever can have on sanitation markets in a particular geography or market. Three main stakeholders are identified who may find this document useful, i.e., funders, implementers, and governments. These three groups are defined below:

1. **Governments** are the actors who have the power and the resources to change and enforce market rules. Governments operate at the national, regional and local levels, and each can have

a role in ensuring the successful implementation of market rules. For example, governments set rules that determine how markets function, including regulating products and services, establishing tariff and tax rates (and deciding against whom to levy them), and incentivizing preferred activities through subsidies and other measures

2. **Funders** are understood in this document as bilateral or multilateral aid agencies or large foundations that fund sanitation development with a willingness to intervene in markets in order to drive greater inclusion. Their strength lies in the financial and political capital that they hold. This enables them to push for changes in the larger market system to improve the business environment for market-based sanitation (MBS) interventions.
3. **Implementers** are actors who oversee the design and implementation of market-based sanitation interventions on the ground, and have a strong local presence in the markets where they operate. They are typically supported by funders, and thus often depend on grant conditions to determine where they can intervene and in what way. For the most part, implementers of MBS are local or international NGOs, yet sub-divisions of multilateral organizations (e.g., WSP). In contrast to funders, implementers have limited scope to change market rules and prevailing norms. However, given their hands-on experience, they are often invited by governments to participate in policy forums, and can provide useful inputs into the design of market rules. Further, implementers often aid in rolling out such rules

In addition to these groups, there may be other stakeholders, such as academics, who find this document (and the associated model) useful. Researchers could find the model useful for estimating where the key sources of variability and potential for change in the market system may lie.

2.4 ORGANIZATION OF THE USER GUIDE

The user guide is organized into the following parts:

I. The first part consists of a single chapter **(Chapter 3) that provides an overview of the base model**, explaining its construct, the expected outputs, key variables/ inputs, and main assumptions

II. The second part of the user guide **(Chapters 4 and 5)** deals with how to adapt the base model for use in other markets

- **Chapter 4 takes the user step-by-step through the process** of identifying and collecting relevant input data and customizing the input sheets for a new market; explains the process of modifying the calculation sheets that covert the inputs to desired outputs; and identifies changes that may be needed in the output sheets and user dashboard
- **Chapter 5 guides the user on how to check for errors** in the updated model

III. The final section of the user guide **(Chapters 6 and 7)** deals with how the adapted model can be used, and the limitations to its use

- **Chapter 6 discusses the kind of decision making** that the adapted model can support and illustrates this by providing sample outputs generated from the base model
- **Chapter 7 highlights the limitations of the model**

For definition of terms or concepts, refer to the Glossary and [Scaling Market Based Sanitation: Desk Review on Market-Based Rural Sanitation Development Programs]

3.0 OVERVIEW OF THE BASE MODEL

3.1 GEOGRAPHY SELECTED FOR THE BASE MODEL

To ensure that the base model was grounded in reality, and that no critical logical relationship was missed out in the process of abstraction, actual data from a sample country was used to construct it. Using a real-world example also had the added benefit of allowing us to test the base model with experts who have experience of working in the sanitation sector in the sample country.

To select an appropriate sample country, we conducted desk research to identify countries with an existing policy that penalizes non-adopters of toilets; or those in which a similar policy has been applied to a related sector; or those where there was readily available data that could be used to construct a hypothetical policy. Through this research, we were able to identify Ghana as the sample country for the penalties model.

In Ghana, the municipalities of Greater Accra West (GA West) and Kumasi have existing bye-laws that penalize landlords who do not provide their tenants with toilets. However, until very recently, these bye-laws were not enforced. A recent USAID-supported program – "A Toilet in Every Compound" is now working with municipal governments to strengthen the enforcement of these bye-laws, including revamping the enforcement mechanism. As a result, there was readily available information regarding who is targeted by the policy, and how the policy is enforced. Using this policy and the proposed enforcement mechanism as a starting point, we constructed a base model to estimate the potential impact the policy would have if enforced.

3.2 UNDERLYING LOGIC OF THE BASE MODEL

The intention of introducing a policy lever targeted at customers is to increase the number of people who purchase toilets. As seen in Figure 1, customers face three main barriers to purchasing toilets:

- They can't afford to buy a toilet in absolute terms
- They lack the up-front capital to buy a toilet
- They can afford to buy a toilet but are unwilling to do so due to the low priority given to sanitation

Therefore to encourage greater toilet sales, the policy lever introduced needs to act on one or more of these barriers. Therefore, the policy lever would need to either:

A. Reduce the cost of producing toilets, thereby increasing the ability of customers to afford them;

B. Increase access to consumer finance, thereby making up-front capital available for toilet purchase; or

C. Increase the willingness to pay for toilets by changing the priority accorded to sanitation by customers

Policies that penalize the non-adoption of toilets fall into the third category; i.e., they aim to change the priority accorded to sanitation by customers. Customers who can afford to buy a toilet may not do so if they feel that spending their limited income on an alternate commodity/ service would yield a greater increase in their overall welfare. For example, assume that a customer with limited income can either afford to build a toilet or purchase a two-wheeler. If the customer perceives a greater increase in his/ her overall welfare from the mobility benefits provided by a two-wheeler than from the health or

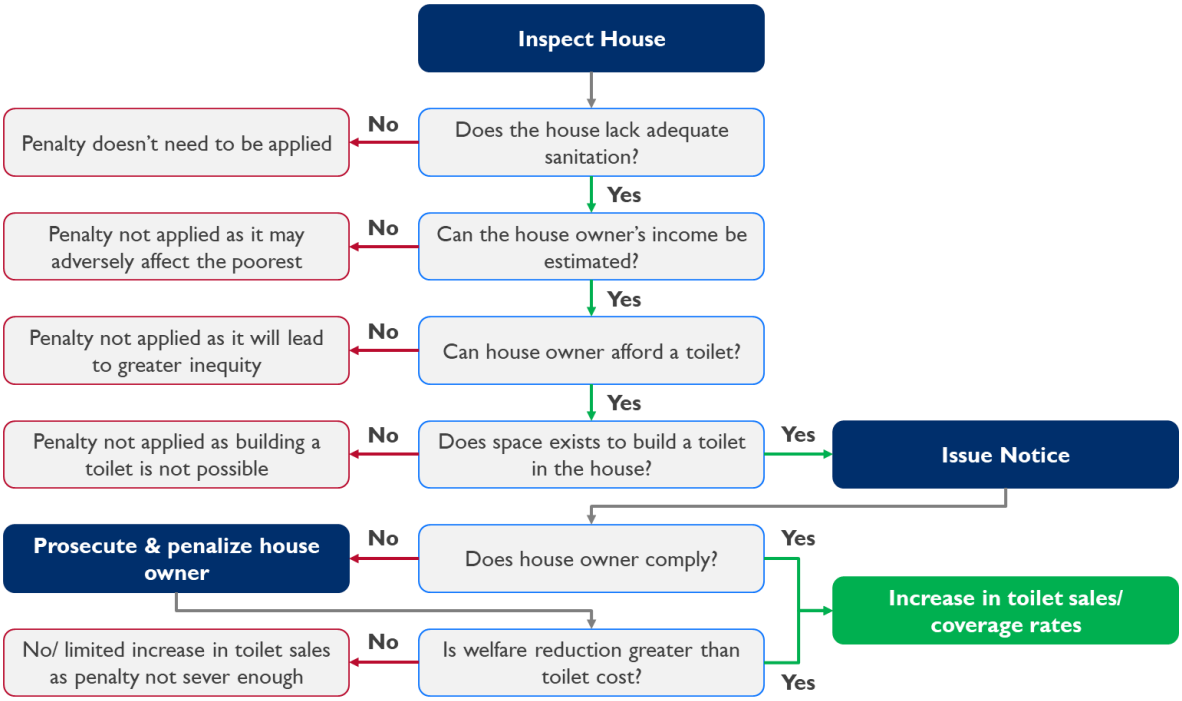
privacy benefits from a toilet, he/ she will choose to buy the two-wheeler and defer the purchase of a toilet to a later date.

A policy that penalizes non-adoption of toilets changes this equation by reducing the overall welfare accruing from the purchase of alternate commodities/ services in comparison to that accruing from buying a toilet. Assuming the penalty takes the form of a monetary fine, if we return to the example of a customer who has a choice between a two-wheeler and a toilet, to purchase a two-wheeler the customer now has to pay the original cost price plus the monetary fine for not buying a toilet. This makes two-wheelers relatively more expensive than toilets. At this relatively higher price, the customer may no longer find the mobility benefits of the two-wheeler to be as attractive. Therefore by introducing a negative incentive, the policy lever is able to increase the relative importance of toilets relative to other competing expenses.

In Ghana, **the policy lever used is a monetary fine levied on landlords of compound houses[3] for not providing their tenants with toilets**. Those landlords who do not purchase a toilet despite the fine can be imprisoned for up to six months. This is a powerful negative incentive that, if enforced, should ensure customers prioritize toilet purchases above most other competing expenses.

It should be noted that the policy lever targets only the willingness barrier, and the aim is not to exacerbate inequalities by further burdening the poorest houses who face affordability barriers. Therefore the policy lever needs to ensure those who genuinely cannot afford to buy a toilet are exempted from the ambit of the policy. Figure 3 depicts the logical flow on the basis of which the penalties base model is built.

Figure 3: Underlying logic of the penalties model



[3] Compound houses: In this type of housing, multiple households live in a single structure which are let out room by room and have shared water supply and toilets or none at all. Such structures can have from one to 30 rooms occupied by anything from one to 150 people.

From Figure 3 we can see that in order to increase toilet sales, houses that lack adequate sanitation facilities (and whose owners have the ability to pay for a toilet) need to be identified. Even if house owners can afford toilets, they may face other genuine constraints that prevent them from building toilets, such as lack of space in urban areas. These genuine constraints need to be identified and accounted for to arrive at the actual number of house owners the policy should target. This subset of house owners would be formally notified to purchase a toilet and penalized if they fail to comply.

By purchasing a toilet, a house owner may have to forego some other competing priority (e.g., purchasing a two-wheeler or a television), therefore there will be some perceived reduction in welfare for the house owner. An effective penalty should lead to a reduction in welfare that is greater than that caused by foregoing the competing priority. If this is not the case, there may be no, or at best limited, increase in the number of toilets purchased.

3.3 COMPONENTS OF THE BASE MODEL

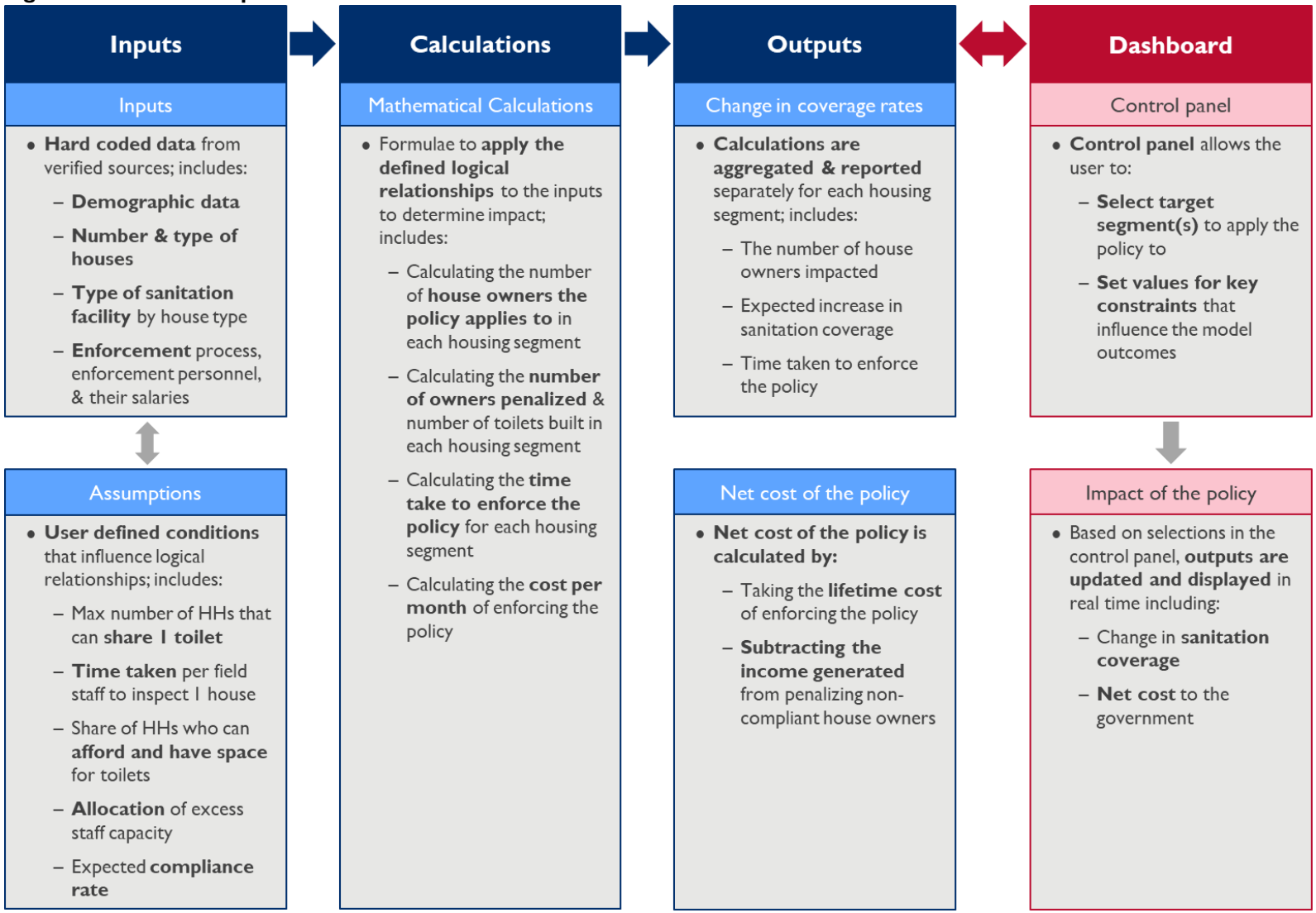
In order to covert this underlying logic into a model, we would need the following components:

1. **Inputs** specific to the selected geography/ market such as data on population, housing stock, type of sanitation facilities available by housing type, and availability of government staff for enforcement of the policy as well as their salaries
2. **Assumptions** regarding how to clean and arrange the input data, and the overall boundaries within which the model would operate. For example, we would need to define assumptions around:
    i. The types of sanitation facilities that are considered adequate, and how many households can share a toilet without it being considered inadequate
    ii. The enforcement process and mechanism, including the number of stages, the frequency of inspection, the time allowed between stages for compliance, the number of individuals required to enforce the policy, the time spent on enforcement, etc.
    iii. The percentage of house owners who face the identified constraints and those who default after receiving a formal warning
3. **Mathematical calculations** that convert the inputs to outputs in line with the logical flow and assumptions defined above. This includes equations to calculate the number of house owners the policy applies to; the number of house owners who comply versus the number penalized; the time taken to enforce the policy; and the cost of enforcement
4. **Outputs** that arise from these inputs, assumptions, and calculations, viz., increase in the number of toilets purchased and the associated costs of implementing the policy

Figure 4 provides a visual representation of the components described above. As depicted, the inputs and assumptions are the base of the model, upon which formulae are applied to arrive at the outputs. In addition, a dashboard is overlaid on the model. This is an interactive sheet that allows the user to vary the values of the key variables, and see the impact on outputs instantaneously.

These components are described in more detail in the following paragraphs. To help the reader keep track of the different components, the explanation provided for each component is preceded by a simplified version of the schematic seen in Figure 4, with only the component being discussed highlighted.

Figure 4: Schematic of penalties model



3.3.1 Inputs and assumptions used in the base model

When building the base model, we started with the inputs required to estimate the effect of the policy lever; Figure 5 highlights the specific component we refer to. From Figure 5, we can see that three types of inputs were required:

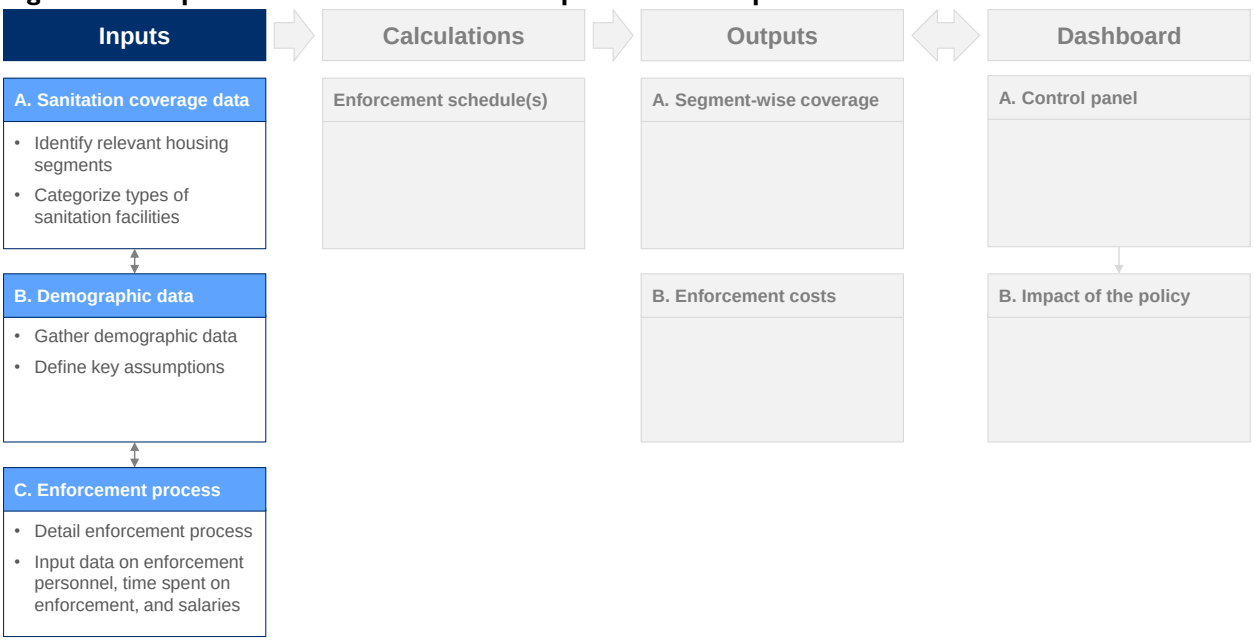
A. **Sanitation coverage data:** This refers to the various types of sanitation facilitates found in the different houses in Ghana. This information is essential to help target the policy

B. **Demographic data:** This includes data such as the number of households living in a house, and the average household size. This data was needed in order to determine the increase in sanitation coverage as a result of a toilet being built in a house

C. **Enforcement process data:** Finally, we needed data related to the enforcement process in Ghana so as to ascertain how many of the houses without toilets would be penalized, the duration it would take to enforce the policy, and how much it would cost to enforce the policy

These three types of inputs are discussed below:

Figure 5: Components of the base model – inputs and assumptions



A. Sanitation coverage data

To create the base model, we first needed to identify the houses/ house owners to target under the selected policy lever. To do this, data was required regarding:

- The categories of houses in Ghana, and the number of houses in each category
- The type of toilets (if any) found in each category of house
- The number of households living in each category of house

Secondary research on the housing situation in Ghana revealed that there was a fair degree of variation in house types across the country, but that most of the major house types could be clubbed into two distinct categories: self-contained houses, and multi-occupancy houses. Self-contained houses are those occupied by a single household, whereas multi-occupancy houses are those in which several households live in a single structure or several structures in a compound. As per the dataset, the term household refers to persons living together, sharing house-keeping arrangements, and sharing a kitchen; while

house refers to a single structure or a compound consisting of several structures. In this document, adequate sanitation is ascertained at a house and household level. In Ghana, multi-occupancy houses are very common (over 73% of urban households, and 76% of rural households live in such houses), and on average, four households live in one multi-occupancy house. As the policy in Ghana clearly identifies the target population as landlords of compound houses that do not provide toilets to their tenants, we disaggregated the housing data by rented vs. owned to arrive at four categories of houses; viz., "rented – multi-occupancy", "owned – multi-occupancy", "rented – self-contained", and "owned – self-contained". We note that the terms 'residential property' and dwelling may be used in some contexts to distinguish between single and multiple household occupancy. The dataset, however, uses the term dwelling and house interchangeably, and we chose to retain the term house from the dataset. Users should choose nomenclature that aligns with their objectives and audience.

In order to obtain reliable data on the number of houses in each of these four segments and the type of sanitation facility they have, we turned to a large sample survey study conducted by the Government of Ghana – The Ghana Living Standards Survey Round Six, 2014 (GLSS6). The GLSS6 is a household survey that contains details of the number of households living in each type of house, whether they own the house they live in or are tenants, and the type of sanitation facility they have access to. As with the housing type, there are multiple types of sanitation facilities as well. For the model, we consolidated the different types of toilets into three categories: improved toilets, improved but shared, and unimproved (including no facility). These categories are in line with the UNICEF/ WHO Joint Monitoring Program (JMP) classification of toilets with one important distinction; while the JMP considers improved but shared toilets (called "limited access to sanitation" by JMP) as unimproved toilets, for the model we only considered shared toilets to be unimproved if they were shared by more than four households. This assumption was made due to the high prevalence of multi-occupancy houses in Ghana. Multi-occupancy houses tend to have a constraint on the space available to build toilets and, as on average, four households live in a compound house; one toilet was assumed to be adequate for up to four households. However, this is a government policy decision that can be adjusted in the model and tested, to understand the impacts of this threshold for adequate sanitation in different contexts. While sanitation coverage and facilities are increasingly expressed per the revised JMP terminology aligned with the Sustainable Development Goals (SDGs). In this document, however, we use the erstwhile terminology of improved, unimproved, and OD for consistency with the classification of toilets available in the country-level datasets used to develop the model. As explained in section 4.3, the revised JMP classifications are a good starting point, but other classifications may be required per the local context.

The housing and sanitation coverage data was disaggregated by urban and rural areas and inputted in two separate sheets; refer to the sheets "Toilet by HH type – Urban" and "Toilet by HH type – Rural" in the accompanying base model. Figure 6 provides an illustration of how the raw data was inputted into the model. The rows show the different housing segments and occupancy types, while the columns show the classification of different types of toilets. The raw data contains all the different house types and toilet types; these were then consolidated into the categories described above. The effect of consolidating the house, occupancy, and toilet types can be seen in Figure 7 where the table with the red border depicts the four consolidated housing segments and the three consolidated toilet types.

The sanitation coverage data was available at the household level, i.e., the number of households living in a particular type of house with access to a particular toilet type; however, inspection of toilets is done at the house level and not the household level. Therefore the data had to be further refined to arrive at the number of houses with a particular type of toilet. This was done by using ratios of the number of households living in a house. The yellow bordered table in Figure 7shows the result of converting the household level data to house level data.

Figure 6: Sample input sheet from base model

	B	C	D	E	F	G	H	I	J
22			Type of Sanitation Facility (%)						
23	Type and occupancy status of dwelling unit		No facility	W.C.	Pit Latrine	KVIP	Bucket/ Pan	Public toilet	Other
24	Separate House	Owned	0.38%	2.78%	1.24%	0.79%	0.00%	1.33%	0.00%
25		Rented	0.15%	1.55%	0.39%	0.36%	0.01%	0.79%	0.01%
26		Rent-free	0.24%	1.60%	0.47%	0.28%	0.00%	0.62%	0.00%
27		Other	0.00%	0.03%	0.00%	0.00%	0.00%	0.01%	0.00%
28	Semi-detached House	Owned	0.58%	0.63%	0.69%	0.47%	0.00%	1.00%	0.00%
29		Rented	0.12%	0.61%	0.24%	0.26%	0.00%	1.21%	0.00%
30		Rent-free	0.15%	0.44%	0.20%	0.13%	0.00%	0.54%	0.00%
31		Other	0.03%	0.01%	0.00%	0.00%	0.00%	0.01%	0.00%
32	Flat/ Apartment	Owned	0.07%	1.29%	0.20%	0.16%	0.01%	0.22%	0.00%
33		Rented	0.03%	1.34%	0.12%	0.04%	0.03%	0.22%	0.00%
34		Rent-free	0.11%	1.28%	0.11%	0.11%	0.01%	0.23%	0.00%
35		Other	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
36	Compound House (rooms)	Owned	3.11%	2.46%	2.97%	2.60%	0.01%	7.45%	0.00%
37		Rented	1.76%	5.07%	3.86%	5.00%	0.15%	13.69%	0.00%
38		Rent-free	1.84%	2.53%	2.57%	2.31%	0.07%	9.24%	0.00%
39		Other	0.01%	0.04%	0.07%	0.03%	0.00%	0.07%	0.00%
40	Huts/ Buildings (same compound)	Owned	1.16%	0.13%	0.44%	0.20%	0.01%	0.43%	0.00%
41		Rented	0.08%	0.19%	0.09%	0.08%	0.01%	0.39%	0.00%
42		Rent-free	0.13%	0.11%	0.16%	0.11%	0.00%	0.46%	0.00%
43		Other	0.03%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
44	Huts/ Buildings (different compound)	Owned	0.09%	0.01%	0.01%	0.00%	0.00%	0.03%	0.00%
45		Rented	0.00%	0.00%	0.00%	0.01%	0.00%	0.03%	0.00%
46		Rent-free	0.00%	0.01%	0.03%	0.00%	0.00%	0.03%	0.00%
47		Other	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
64	Other	Owned	0.08%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
65		Rented	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
66		Rent-free	0.03%	0.01%	0.00%	0.00%	0.00%	0.03%	0.00%
67		Other	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
68		Net	10.58%	22.42%	14.34%	13.29%	0.35%	38.99%	0.04%

Sheet name as per attached penalties base model: "Toilet by HH type – urban

Figure 7: Housing segmentation used in base model

# HOUSEHOLDS by type of house, occupancy, and sanitation facility				
House type	Occupancy status	Type of sanitation facility		
		Improved	Shared with >= 4 HHs	Unimproved
Self-contained	*Owned*	240,102	31,577	252,614
	Rented (plus rent-free)	284,787	69,707	265,721
	Misc.	1,787	596	2,383
Multi-occupancy	*Owned*	132,265	107,242	696,476
	Rented (plus rent-free)	195,418	487,950	1,532,366
	Misc.	2,383	596	8,341
Other	*Owned*	4,766	2,383	25,619
	Rented (plus rent-free)	9,533	9,533	57,791
	Misc.	-	1,192	7,149

--->

# HOUSES by type of house, occupancy, and sanitation facility		
Type of sanitation facility		
Improved	Shared	Unimproved
240,102	31,577	252,614
284,787	69,707	265,721
1,787	596	2,383
38,901	15,320	204,846
57,476	69,707	450,696
701	85	2,453

Sheet name as per attached penalties base model: "Toilet by HH type – urban"

B. Demographic data

In order to convert the raw data into the final segments, certain demographic data was required. This included the urban and rural population (in terms of people and households) and average household sizes. This data, along with assumptions on the number of households that can share a toilet without it being considered unimproved were captured in a separate input sheet; refer to "General inputs" in the accompanying base model.

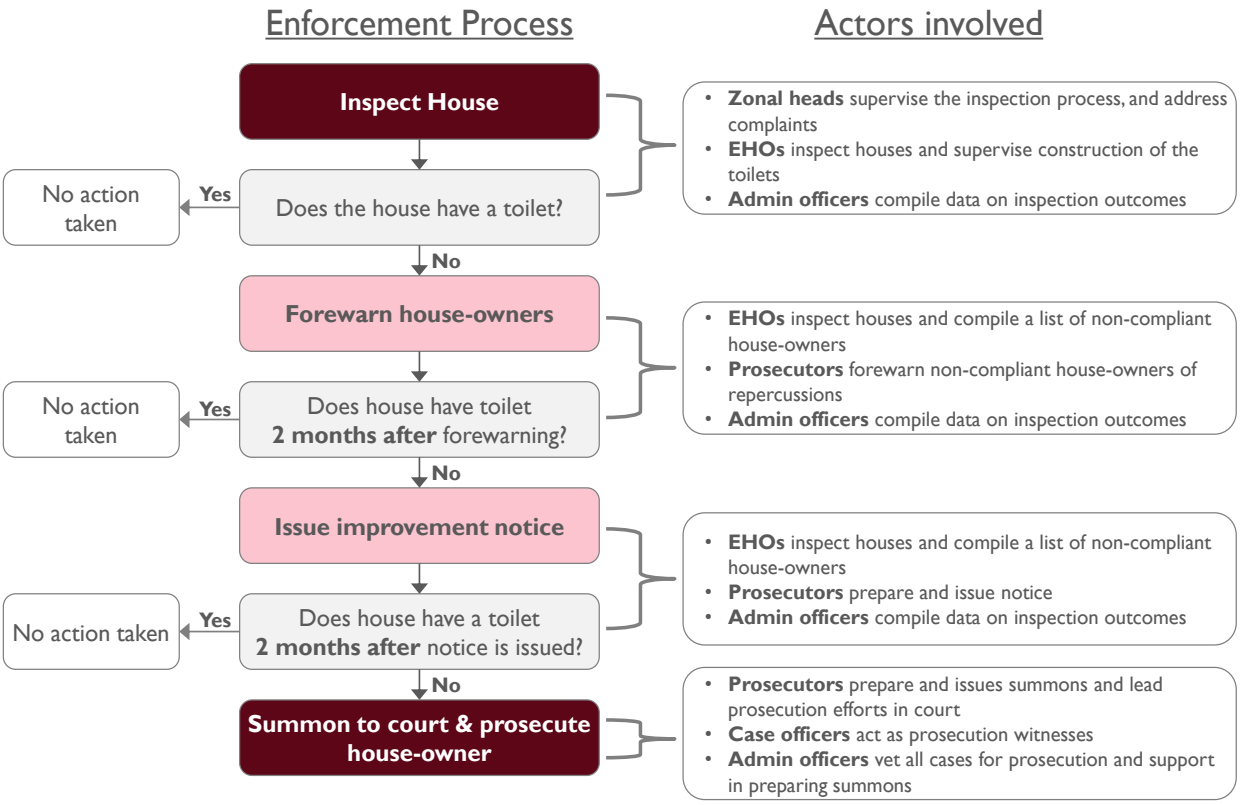
C. Enforcement process data

The final set of inputs required to create the base model related to the enforcement process. The enforcement process used in Ghana is detailed below:

- Compound houses are inspected by government Environment and Health Officers (EHOs), and if a house lacks adequate sanitation facilities, the landlord is forewarned about the consequences of not providing a toilet and given two months to build one. The EHOs work with the landlords who agree to purchase toilets, providing them with information about appropriate sanitation solutions and existing sanitation providers. At this stage, the EHOs also identify landlords who cannot afford a toilet and link them to government subsidy schemes. While absentee landlords appear to be common in Ghana, we did not find data to distinguish the share of such houses. The model assumes tenants will assist EHOs in identifying and communicating with landlords.
- After the two months are over, the EHOs re-inspect the houses and those landlords that have not yet purchased toilets are issued a formal improvement notice. The landlords are then given an additional two months to comply with the policy. Once again, the EHOs support the landlords who agree to purchase a toilet by sharing information about toilet options and service providers.
- After the additional two months have lapsed, a third round of inspections is carried out and the landlords who have failed to comply are identified and issued with summons to appear before specially constituted sanitation courts. If they are found guilty by the court, the landlords are fined and instructed to purchase a toilet within a specified time frame.
- Failure to comply with the court's order within the specified time frame can result in the non-compliant landlords being jailed for up to six months.

While constructing the base model, the essence of the policy as described above and the main steps of the enforcement process were considered. However, the enforcement process was simplified to an extent, while additional complexity was added in other areas of the model. Specifically, we decided to limit the mechanism to a one-time process ending at the monetary fine. This means, the model follows a house owner who hasn't purchased a toilet from identification and forewarning, to issue of an improvement notice, to prosecution, and up to when the house owner is fined. However, the effect of prosecution and fining of non-compliant property owners is not considered, i.e., the fate of the house owners who do not build a toilet even after being fined is not considered within the scope of the model. The enforcement process as used in the model is depicted below in Figure 8.

Figure 8: Enforcement process used in base model



The inputs and assumptions related to the enforcement process were entered in a dedicated sheet; refer to "Enforcement inputs" in the accompanying base model. This included data related to:

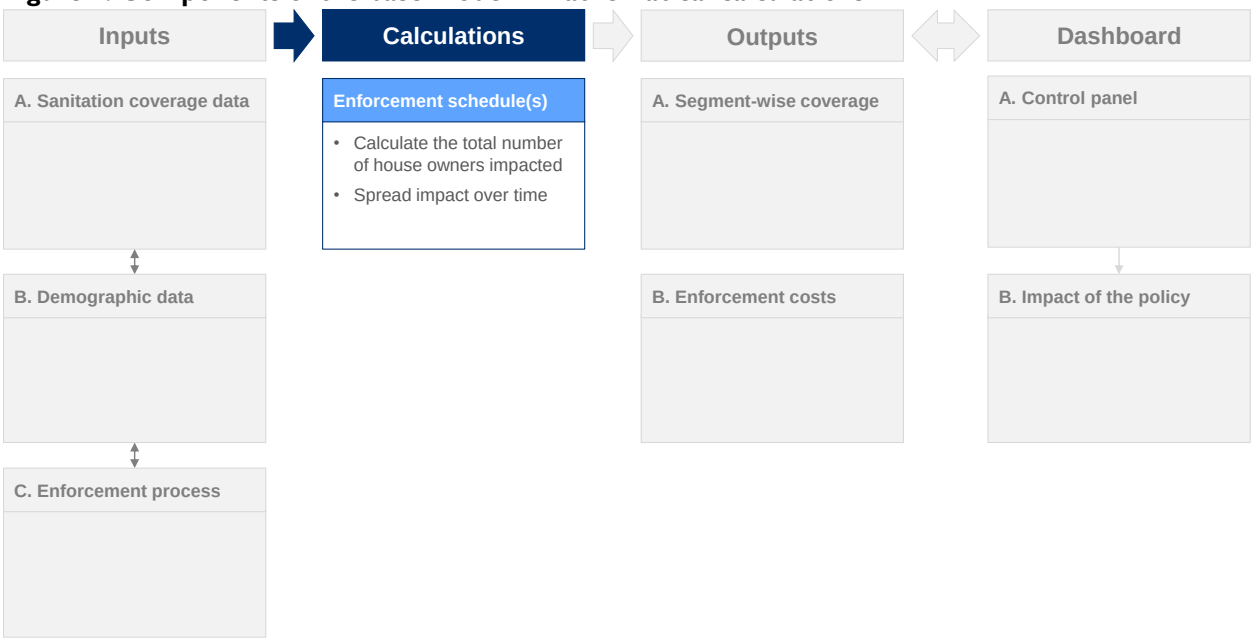
- Number of enforcement personnel (including field staff, prosecutors, and administrative officers)
- Average time spent by personnel on sanitation-related enforcement
- Average salaries of enforcement personnel
- Time taken to inspect one house
- Frequency of inspections
- Time given to house owners to comply between stages

This data was used to determine the time taken to enforce the policy, as well as the cost of enforcement.

3.3.2 Mathematical calculations developed for the base model

Once the inputs and assumptions were defined, mathematical calculations were developed to calculate how many house owners would be targeted, how many would comply, and how many would be penalized (see Figure 9).

Figure 9: Components of the base model – mathematical calculations



To do this, the enforcement process depicted in Figure 8 was converted into an excel table (Figure 10) with successive rows for houses inspected, house owners forewarned, house owners issued improvement notices, and house owners penalized. The columns of the table represent the number of houses/ house owners that fall into each of these categories based on the number of houses inspected in a month. The actual number of houses inspected, and the number of house owners progressing from one stage of the enforcement process to the next, depends on certain assumptions and key user-inputted variables. These are discussed below:

- **The number of EHOs:** The enforcement of the policy depends on the government's ability to inspect houses and determine whether sanitation facilities are present and adequate. Inspections are carried out by EHOs, and it was assumed that the government has a fixed number of EHOs for urban areas, and a separate set of EHOs for rural areas (based on a ratio of number of households per EHO). It was further assumed that urban EHOs cannot inspect houses in rural areas and vice versa. However, within their geographic areas, EHOs are deployed in a way that ensures full utilization of all EHOs. Therefore, if there are 100 urban EHOs and 50 rural EHOs, and the policy is targeted only at urban areas, the number of houses inspected will depend on the time taken to inspect houses by the 100 urban EHOs only. The 50 rural EHOs are not be included in the enforcement mechanism
- **Targeted geographic area:** Data on the housing segments described in subsection 3.3.1 was recorded separately for urban vs. rural areas. It was assumed that the policy can be restricted to either urban or rural, or applied to both simultaneously
- **Targeted housing segments:** The raw housing data was collapsed into four housing segments: self-contained owned houses; self-contained rented houses; multi-occupancy owned houses; and multi-occupancy rented houses (see subsection 3.3.1). The user can choose to

apply the policy to any of these four segments. It was assumed that no matter which segment is selected, all houses in the geographic area(s) targeted (urban only, rural only, or urban and rural) be inspected at least once in order to determine which segment they fall into. However, the number of houses forewarned is based on the actual number of houses without adequate sanitation in the segment selected. For example, if only urban multi-occupancy rented houses are targeted, then all urban houses will be inspected, but only those urban multi-occupancy rented houses that do not have adequate sanitation facilities will be forewarned; even if other houses (e.g., multi-occupancy owned houses) are found to lack adequate toilets, they are not forewarned. The number of houses forewarned is determined on the basis of the actual GLSS6 data entered in the input sheet

- **Constraints faced by the house owner:** It is unrealistic to expect that 100 percent of houses forewarned would comply with the policy and build toilets. In reality, there are a number of constraints that may prevent a house owner from complying with the policy. The model considers two such constraints: inability to afford the toilet; and lack of space to build a toilet. It does not make sense to penalize house owners who face these constraints as it is not feasible for them to build a toilet even if they wanted to. Therefore, an equation was put in place to remove the percentage of 'forewarned' house owners who cannot afford to pay for a toilet from consideration. Further, a second equation was introduced to remove the percentage of owners who can afford a toilet but do not have the space to build one. The percentage of house owners who cannot afford a toilet and the percentage that do not have the space for one are both values that can be set by the user based on their experience of on-ground realities
- **Expected default rate:** It was assumed that even from the subset of house owners actually targeted, not all will comply with the policy as some house owners may prefer to pay the penalty amount rather than forego competing priorities. Therefore, equations were introduced to calculate the number of house owners that are likely to default after each warning given by the EHO (forewarning and improvement notice). The values of the default rates are left to the user to input based on their experience. The number of house owners who will ultimately build toilets is calculated by subtracting the number of house owners who default from the total number of forewarned house owners without any constraints
- **Number of toilets needed in a house:** Self-contained houses have one household living in the house, and hence only one toilet needs to be built in them. However, multi-occupancy houses have multiple households living in them. We have assumed that up to four households can share a toilet in such houses without the sanitation facility being considered inadequate. However, houses with more than four households living in them, on average support seven households. This means these houses need two toilets each at the minimum. Due to this, equations were introduced that calculate the actual number of toilets that will be built in a house depending on the segment(s) of houses selected

The equations that give effect to all the above assumptions were inserted into the excel table resulting in an "enforcement schedule" as depicted in Figure 10. Two separate enforcement schedules were created, one for urban areas and one for rural. Refer to "Enforcement schedule urban" and "Enforcement schedule rural" sheets in the accompanying base model.

Figure 10: Enforcement schedule used in base model

		C	D	E	F	G
22		Head	Total			
23				1 month	2 month	3 month
24	Impact over time	Total number of houses inspected		2,75,453	2,75,453	2,75,453
25		Stage 1: Identify & register		2,75,453	2,75,453	1,72,502
26		Stage 2: Forewarn				1,02,951
31		# forewarned who can afford a toilet				69,561
36		# forewarned house owners who can afford toilets and have space to build them				38,606
41		Stage 3: Issue improvement notice				
46		Stage 4: Penalize				
51		# house owners who comply with the policy				
56		# toilets built				
63		Cumulative number of houses inspected each year				
64		Cumulative number of house owners forewarned each year				
65		Cumulative number of toilets built each year				
66		Total number of house owners penalized each year				

Sheet name as per attached penalties base model: "Enforcement schedule urban"

3.3.3 Outputs of the base model

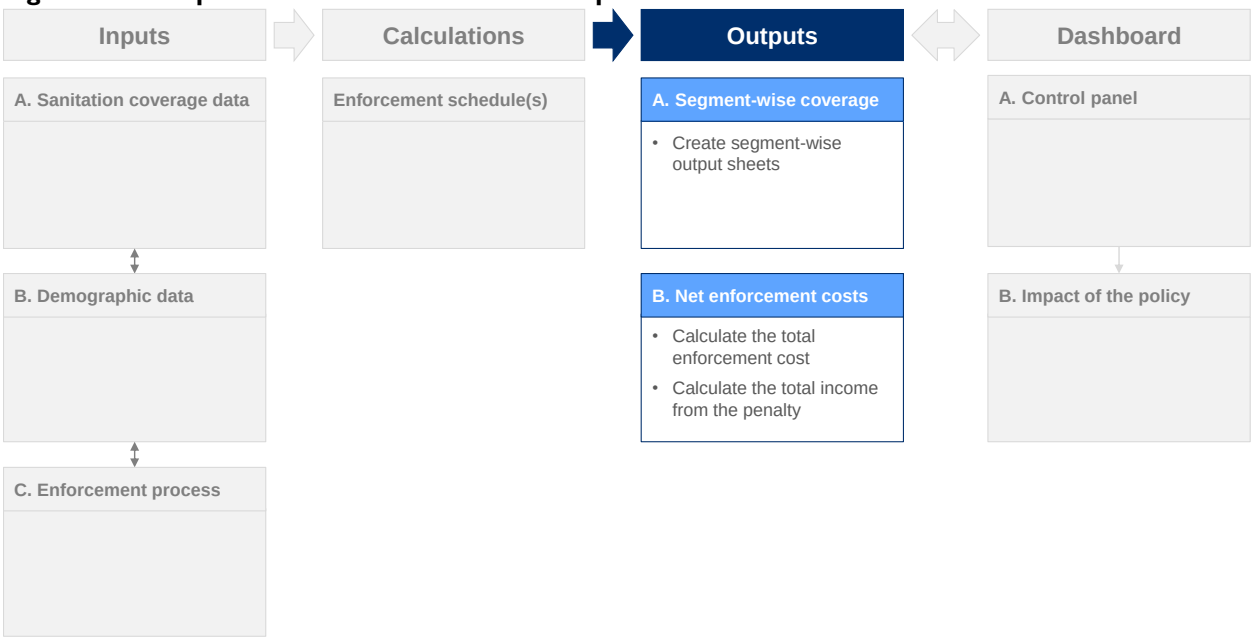
In order to serve as a tool to support decision-making, the penalties base model provides stakeholders with an assessment of both the benefits and the costs that could arise from enforcing the chosen policy lever. As seen in Figure 11, the outputs of the base model have accordingly been split into two:

A. **Segment-wise coverage:** This refers to the main benefits arising as a result of the policy lever; viz., an increase in sanitation coverage due to increased purchase of toilets by house owners. The coverage data is calculated for each housing segment targeted by the policy

B. **Net enforcement costs:** This refers to the net costs borne by the government in setting up and running the enforcement mechanism. The government's expenditure is primarily the salaries of personnel engaged in inspecting and prosecuting non-compliant house owners. The income earned by the government through fines paid by non-compliant house owners is subtracted from the government's expenditure to arrive at the net enforcement cost

Taken together, details of the increase in sanitation coverage and the net enforcement cost can help stakeholders determine whether the policy lever should be enforced or not.

Figure 11: Components of the base model – outputs



A. Segment-wise sanitation coverage

The main output of the model – change in sanitation coverage as a result of the policy – is expressed using the following indicators:

- The number of toilets built as a result of the policy
- The number of households that gain access to toilets as a result of the policy
- The number of individuals that gain access to toilets as a result of the policy

The enforcement schedules were constructed in a way that the impact of the policy could be determined for any combination of housing segments the user chooses to apply the policy to. Therefore the output figures change depending on whether the user decides to apply the policy to one, two, three, or all four segments.

However, as the enforcement schedules provide outputs only for a particular geographical area, it is difficult to determine the entire impact of the policy on a particular housing segment and the extent to which change in that particular housing segment influences the overall impact. Therefore, to aid in analysis, four output sheets were created, one for each of the four housing segments.

These sheets sort the relevant data from the enforcement schedules and input sheets, and display the impact of the policy on households living in the houses of one particular housing segment only. Each sheet displays information related to the existing sanitation coverage in a specific housing segment, the number of houses inspected in that segment, the number of toilets expected to be built, and the number of households and individuals who gain access to these toilets; see Figure 12.

Each sheet is further disaggregated to show the impact on urban versus rural areas. In addition, these sheets pull information from the enforcement schedules related to the number of house owners who will be penalized from each segment and the expected income to the government from the penalties imposed.

The limitation of these output sheets is that the user needs to toggle between the four sheets in order to get a sense of the relative impact each segment has.

Figure 12: Segment-wise output sheet in the base model

		Urban	Rural	National
Existing Sanitation coverage - Households	**Total # households living in rented multi-occupancy houses**	**2,215,735**	**691,199**	**2,906,934**
	# households with improved sanitation	195,418	29,832	225,250
	# households with improved but shared sanitation (> 4 HHs)	487,950	40,869	528,820
	# households with unimproved sanitation	1,532,366	620,498	2,152,865
Existing Sanitation coverage - Houses	**Total # rented multi-occupancy houses**	**577,879**	**197,466**	**775,345**
	# houses with improved sanitation	57,476	8,774	66,250
	# houses with improved but shared sanitation (> 4 HHs)	69,707	6,192	75,899
	# houses with unimproved sanitation	450,696	182,500	633,195
	% of total houses that are rented multi-occupancy houses	**29%**	**16%**	**24%**
	Total # rented multi-occupancy houses without adequate sanitation	**520,403**	**188,692**	**709,095**
	% of houses without adequate sanitation that have shared toilets (> 4HHs)	13.4%	3.3%	10.7%
	% of houses without adequate sanitation that have unimproved toilets	86.6%	96.7%	89.3%
Impact of policy	**# rented multi-occupancy houses inspected by EHOs**	**577,879**	**197,466**	**775,345**
	# toilets built	**158,560**	**-**	**158,560**
	# households living in rented multi-occupancy houses that gain access to toilets	**539,105**	**-**	**539,105**
	# individuals living in rented multi-occupancy houses who gain access to toilets	**1,940,778**	**-**	**1,940,778**
	# house owners penalized as a result of the policy	**36,591**	**-**	**36,591**
	Income from penalties (USD)	**4,866,582**	**-**	**4,866,582**

Sheet name as per attached penalties base model: "Rented – Multi Occupancy"

B. Enforcement costs

The other key output of the model is the cost related to enforcing the policy, i.e., the costs incurred by the government in inspecting houses and prosecuting defaulters. The information entered in the "Enforcement inputs" sheet (the number of enforcement personnel involved, their total working hours, the amount of time spent by them on sanitation enforcement, and their salaries) was used to calculate the monthly enforcement costs. Further, the amount of time taken (in months) to inspect all the houses in the selected housing segments was determined from the "Enforcement schedule" sheets. The monthly enforcement cost multiplied by the number of months taken to enforce the policy gives the total enforcement cost. This was done separately for urban and rural areas as it was assumed that there are different and non-overlapping enforcement mechanisms in these two geographical areas.

Additionally, the base model has been set up to run for the duration that the user defines in the Dashboard. However, if all the houses that need to be inspected get inspected before the duration as defined by the user, then the policy runs for only as many months which are required. For example, a user defines the duration of the policy in the Dashboard to be 60 months. However, if the total number of target market houses that need to be inspected get fully inspected in 16 months, then the duration of the policy will be the lesser duration, i.e., 16 months.

Figure 13 depicts the "Enforcement costs" sheet in the accompanying base model.

Figure 13: Calculation of enforcement costs in the base model

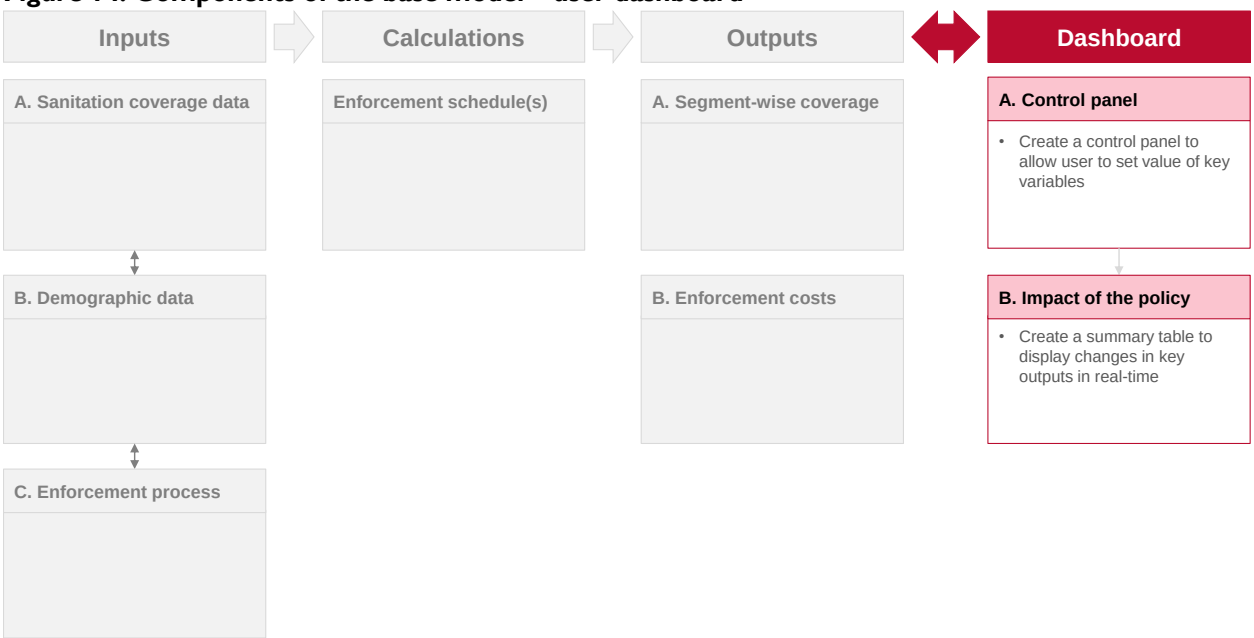
	A	B	C	D
3		Personnel	Urban	Rural
4		Supervisor costs (zonal head)/ month	9,956	-
5		Field staff costs (EHOs)/ month	152,968	-
6		Additional cost of reallocating field staff	20%	20%
7		Total field staff costs/ month	183,561	-
8		Prosecutor costs/ month	110,619	-
9		Case officer costs/ month	132,743	-
10		Administrative costs/ month	21,239	-
11		Total cost/ month	458,119	-
12		Total number of months	16	-
13		Cost for entire enforcement period	7,329,903	-

Sheet name as per attached penalties base model: "Enforcement costs"

3.3.4 User dashboard created for the base model

Taken together, the four segment-wise output sheets, the enforcement schedule, and the enforcement costs output sheet provide the user with information that can help them take a decision of whether the policy is suitable and effective in the given context or not. However, the dense information in these sheets and the need to toggle between output sheets reduce the usability of the model. To resolve this issue, a user dashboard was created (Figure 14).

Figure 14: Components of the base model – user dashboard



From Figure 14, it can be seen that the user dashboard has two components:

A. Control panel:

The dashboard was constructed to **allow users to easily update the value of the key variables** in order to see the impact this has on the outputs. Changing the value of these key variables will update the outputs in real-time. Figure 15 shows the user dashboard that can be found in the accompanying base model. **The green table is the control panel** where users can select the housing segment to apply the policy to ('1' to select a segment and '0' to deselect it) and input values for the other key variables

B. Impact of the policy

The blue "impact of the policy" table shown in Figure 15 is where the outputs are updated depending on the values set in the control panel. In order to effectively support analysis and decision-making, the dashboard provides only the most relevant information in a way that is easy to read and understand. Therefore, this sheet focuses only on the number of houses that gain access to toilets, the number of individuals that gain access to toilets, the increase in improved sanitation coverage rates, and the net economic cost of the policy. This information is displayed at an aggregate level (rather than month-wise) along with information regarding the time taken to enforce the policy. If, upon seeing the outputs in the dashboard, the user wants to delve into greater details of what is happening, they can go to the relevant output sheet or enforcement schedule

Figure 15: User dashboard in the base model

Control Panel - Input data in the yellow highlighted cells below to see effect of the policy

	Parameter	Geographic coverage		Constraints				Default rate (non-compliance with policy)			
		To apply policy select 1 from drop-down		Select % without toilets who can afford them		Select % that can afford toilets and have space		Select % who default after 1st warning		Select % who default after 2nd warning	
	House and occupancy type	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Policy parameters	Owned self-contained houses	0	0								
	Rented self-contained houses	0	0								
	Owned multi-occupancy houses	1	0	50%		75%		75%		25%	
	Rented multi-occupancy houses	1	0	75%		50%		75%		25%	
	Enforcement cost-benefit data	Urban	Rural								
	Input desired penalty amount (USD)	133									
	Input % of time spent by field staff on sanitat	25%									
	Time duration of the policy	20 months									

Impact of the policy

	Head	Urban	Rural	National	Description
Change in sanitation coverage	# toilets built due to the policy	225,642	-	225,642	The number of toilets built is calculated by adding the figures from the relevant calculation sheets, i.e. "Owned - Self Contained", "Rented - Self Contained", "Owned - Multi Occupancy", and "Rented - Multi Occupancy". Changing the default rates in the table above would change this number
	# individuals who gain access to toilets due to the policy	2,761,860	-	2,761,860	The number of individuals who gain access to the toilets is calculated by adding the figures from the relevant calculation sheet, i.e. "Owned - Self Contained", "Rented - Self Contained", "Owned - Multi Occupancy", and "Rented - Multi Occupancy"
	Net increase in coverage rate of improved sanitation	17.3%	0.0%	9.6%	The net increase in coverage is the difference between the new coverage rate (D23:F23) and the existing coverage rate (D22:F22)
	Existing number of individuals with access to toilets	3,135,750	633,666	3,769,416	The number of individuals in the selected target market who already have access to toilets prior to enforcement of the policy
	Existing coverage rate of people with improved sanitation	19.7%	4.9%	13.1%	The existing coverage rate is calculated by dividing the existing number of individuals with access to toilets (D19:F19) by the total urban/ rural/ national population of the country as given in the "General Inputs" sheet
	New coverage rate of people with improved sanitation	37.0%	4.9%	22.7%	The new coverage rate is determined by adding the number of individuals who gain access to toilets as a result of the policy (D19:F19) to the existing number of individuals with access to toilets (D22:F22) to and dividing the total by the urban/ rural/ national population as given in the "General Inputs" sheet
	Duration taken to enforce the policy (months)	16 months	-		The duration it will take to enforce the policy given the default rates selected and the percentage of time field staff spend on enforcing the policy

Sheet name as per attached penalties base model: "Dashboard"

4.0 ADAPTING THE BASE MODEL

In this chapter, we discuss the different contexts in which the penalties model can be applied, as well as the minimum data required to apply it to another geography/ market. We then describe how each component of the model (inputs, assumptions, mathematical equations, outputs, and user dashboard) can be modified for other markets.

4.1 APPLICABILITY AND DATA REQUIRED

MBS is based on the premise that customers' demand for toilets exists and suppliers from the private sector are willing to fulfill that demand. The penalties model aims to estimate how the demand for toilets can be strengthened by creating a negative incentive for house owners who can afford to purchase toilets but choose not to. The assumption is that the negative incentive would increase the relative importance of sanitation for these house owners, thereby activating their latent demand for toilets. However, **the implicit assumption in the model is that the provision of toilets to meet this increased demand will be through existing private sanitation enterprises**. Therefore, there are minimum contextual conditions that need to be met for the model to be applied:

- **Demand for toilets exists:** the model is based on the assumption that demand exists, but needs to be unlocked. If households do not feel there is any need for sanitation in the first place, demand generation activities rather than MBS approaches may be required
- **A functioning sanitation market exists:** this means that there is a sufficiently large pool of customers to make private provision of sanitation viable; that private sanitation entrepreneurs are present in the market; and that there are no major obstacles (physical or policy-related) that prevent these entrepreneurs from supplying toilets in the target geography/ market
- **Stable economic and political environment:** a certain amount of economic and political stability is required for any policy to be implemented effectively. This model does not take into account the effect of political or economic instability, and or any kind of conflicts as it is difficult to predict how these could affect implementation

Further, the policy modeled is targeted at a particular subset of house owners – those that can afford to purchase a toilet but don't provide one in the houses they own (whether it is self-occupied or rented). Therefore, it is important to be able to identify who the occupants of a house are, and whether they own or rent it. Finally, to measure the impact of the policy lever modeled, it is important to determine what the current level of sanitation is amongst the population segment targeted by the policy. Keeping these requirements in mind, ***there is a minimum amount of data required*** to adapt this model to other markets, specifically the following data is required:

- **Housing data** segregated by ownership (i.e., number of owned vs. rented houses)
- **Sanitation coverage data** by house type and occupancy status
- **Household income data**, or some other means of determining ability to pay for sanitation

It would not be possible to adapt the penalties model to a geography/ market where these conditions, and/ or data, do not exist. If the model was to be applied to a geography/ market where these conditions are not met, the predictions arising from the model would be purely speculative and not grounded in reality. Therefore, before attempting to apply this model to other markets, we strongly recommend that the user check for the existence of these conditions and the availability of the required data.

4.2 VARIATIONS SUPPORTED

The description of the underlying logic of the penalties base model and the process of creating it provided in the previous chapter should help readers understand how to similar models for other market rules that they wish to study. However, users may be interested in applying a variation of the policy lever as described to another geography/ market. In this case, the user can choose to adapt the base model itself rather than create a completely new model. The subsequent subsections in this chapter provide a step-by-step guide to doing this.

There are certain limitations to the extent the base model can be adapted without revamping the basic structure, and re-writing the major formulae. The structure of the model is constrained by the number of housing segments that can be supported, and by the extent of geographical differentiation allowed. The base model, as constructed, supports up to four housing segments and differentiation between two geographical areas (urban and rural). Given this, we envisage three types of variations that the base model can support:

i. In the first variant, the user maintains some form of geographic differentiation (e.g., urban vs. rural; or hilly areas vs. plains; or coastal areas vs. interiors), but identifies less than four housing segments

ii. In the second variant, the user decides not to differentiate between geographical areas, but identifies at most four housing segments

iii. In the third variant, the user decides not to differentiate between geographical areas, but identifies more than four housing segments

The first two variants can easily be accommodated by the existing base model without the need for any major structural changes or editing of the existing formulae. However, the third variant, while possible, requires both significant restructuring of the base model and editing of the major formulae used. The changes required to accommodate these three types of variations are called out in the following subsections wherever they are relevant.

It should be noted that while there are limited variations supported within the existing structure of the base model, interested stakeholders can apply the basic principles highlighted in this document to create completely new models with more complex variations.

4.3 PROCESS OF ADAPTING THE BASE MODEL

Figure 16 provides a snapshot of the process to be followed in adapting the base model to a different geography/ market. The process has been broken down into sixteen steps spread across four stages. These stages are aligned to the schematic of the base model introduced in Figure 4 in subsection 2.4. The four stages have been summarized below:

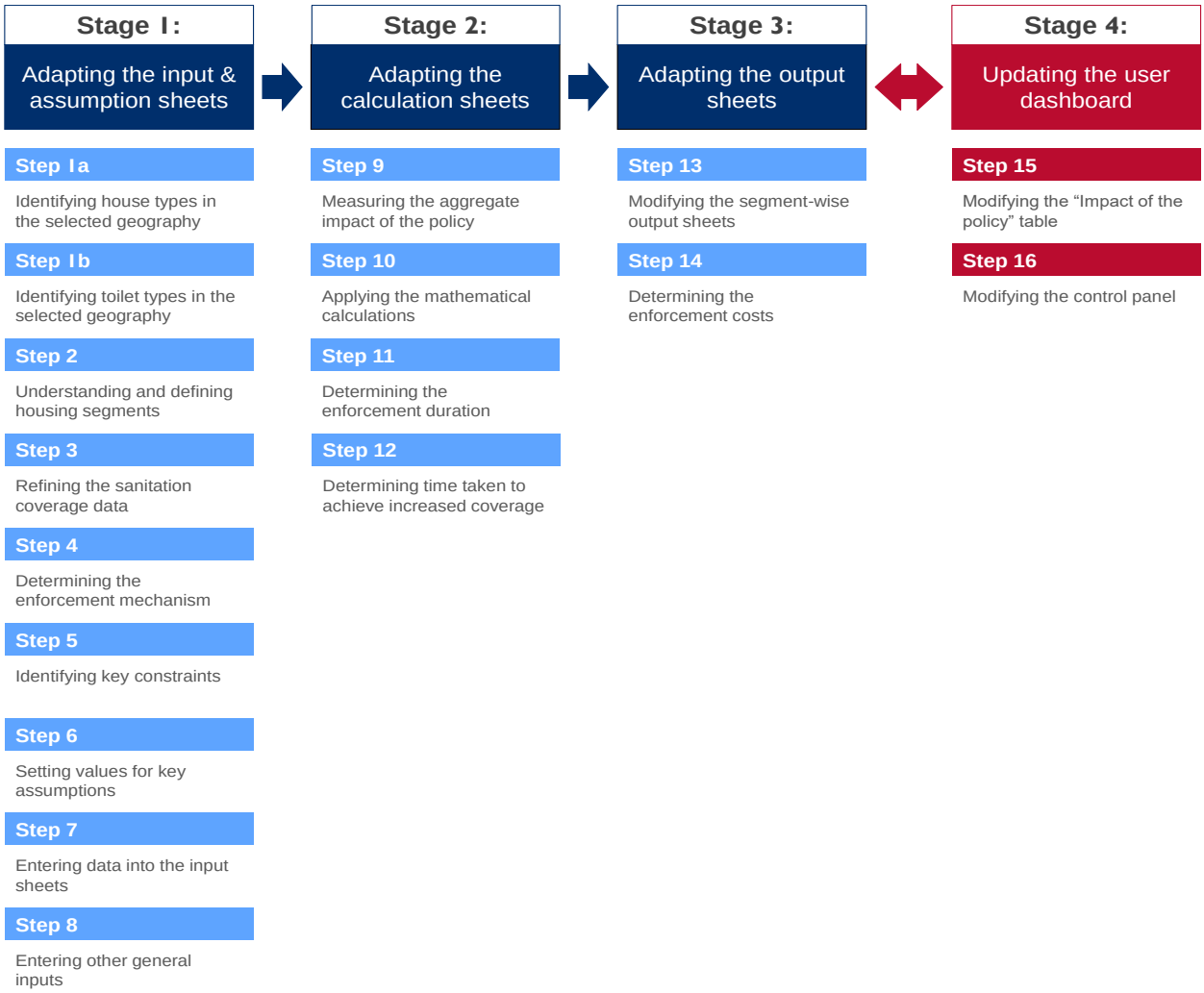
- **Stage 1: Adapting the inputs and assumption sheets –** The first stage in the process is to collect and input all relevant sanitation coverage data, demographic data, and data related to the enforcement mechanism for the chosen geography/ market. **Steps 1 – 8,** as seen in Figure 16, deal with how to identify and select the relevant data, and how to analyze, consolidate, and enter it into the model. Special emphasis is given to modifications to the structure of the input sheets required depending on the choice of housing segments and toilet types. In addition, this stage discusses how to introduce the key constraints into the model and what assumptions need to be made regarding what is considered adequate sanitation

- **Stage 2: Adapting the calculation sheets –** The second stage takes the reader through the steps involved in adapting the calculation sheets of the base model (**Steps 9 -12** in Figure 16). These steps explain the formulae that have been used to convert the input data into outputs

using the key constraints and other assumptions. The reader is guided through the modifications that may be required to either the input data or the formulae in the calculation sheets in order to arrive at the desired outputs

- **Stage 3: Adapting the output sheets –** Stage 3, consisting of **Steps 13 and 14,** describes how to display the outputs calculated in Stage 2 (both sanitation coverage and cost of enforcement). The output sheets may need to be modified significantly depending on how the user has decided to segment house types and toilet types. For example, the segment-wise sanitation coverage sheets in the base model disaggregate the outputs in a particular housing segment by rural and urban areas. However, if the user does not wish to disaggregate the outputs in this manner, they can delete the segment-wise output sheets and observe the outputs either in the enforcement schedules (calculation sheets) or the user dashboard
- **Stage 4: Updating the user dashboard –** The final stage is updating the user dashboard. **Step 15** elaborates on how the "impact of the policy" table would need to be updated to reflect the choices made regarding housing segments and toilet types in the preceding stages. Finally, **Step 16** describes how the control panel has been linked to other sheets in the model, and guides the user through the modifications that need to be made to it depending on the choice of key constraints introduced in Stage 1

Figure 16: Steps to be followed in adapting the base model



STAGE 1: ADAPTING THE INPUT AND ASSUMPTION SHEETS

Step 1: Identifying house and toilet types in the selected geography/ market

Once the user has ascertained that prerequisite contextual conditions exist, and that the data needed is available, the first step to adapting the model is determining who is to be targeted by the policy. To do this, the user needs to determine the types of houses present in the selected geography/ market, the nature of ownership and occupancy of these houses (i.e., whether they are owner occupied or not), and the type of sanitation facility they have access to. For most countries, this data should be available through secondary sources such as government household census or sample surveys, or through reports of international organizations and NGOs (see Box 1 for potential data sources). This step has been broken down into two sub-steps:

a. **Identifying house types:** Using these secondary sources, the user should create a comprehensive list of the major house types that exist in the chosen geography/ market and gather information related to the number of houses in each type disaggregated by ownership status. At this stage, the user also needs to determine whether the raw data needs to be disaggregated by geographic unit (e.g., urban vs. rural). The base model disaggregated the sanitation coverage data by urban and rural areas, and hence two separate input sheets were created: "Toilet by HH type – urban" and "Toilet by HH type – rural". In the case of Ghana, data on housing types was available through the Ghana Living Standards Survey Round 6 (GLSS6). The survey revealed that there were a large variety of house types, including:
    - Separate houses
    - Semi-detached houses
    - Flats/ apartments
    - Compound houses (rooms)
    - Huts/ buildings in the same compound
    - Huts/ buildings in different compounds
    - Others (consisting of mainly non-formal housing)

b. **Identifying toilet types:** After identifying the different house types that exist in the chosen geography/ market, the user needs to determine what type of toilets are present in these different house types. For the base model, this information was again obtained from the GLSS6 report, which classified toilet types into the following categories:
    - Water Closet (W.C.)
    - Kumasi Ventilated Improved Pit Latrine (KVIP)
    - Bucket/ pan latrine
    - Pit latrine
    - Public toilet
    - No facility
    - Others

This raw data on the type of toilet facility by type of house needs to be entered into the input sheet provided in the base model (see Figure 17). The cells outlined in red in Figure 17 (marked as step 1a) show the different housing segments and occupancy types, while those outlined in yellow (marked as step 1b) show the classification of different types of toilets. For each occupancy type under each housing segment, the percentage of total houses with a particular type of toilet has been entered. As the data available was for a sample of the total population, the percentages provided in the sample survey were applied to the entire number of urban and rural households to arrive at the existing sanitation coverage in Ghana.

Figure 17: Identifying relevant housing segments and toilet types

	B	C	D	E	F	G	H	I	J
22			1b Type of Sanitation Facility (%)						
23	1a Type and occupancy status of dwelling unit		No facility	W.C.	Pit Latrine	KVIP	Bucket/ Pan	Public toilet	Other
24	Separate House	Owned	0.38%	2.78%	1.	0.79%	0.00%	1.33%	0.00%
25		Rented	0.15%	1.55%	0.3	0.36%	0.01%	0.79%	0.01%
26		Rent-free	0.24%	1.60%		0.28%	0.00%	0.62%	0.00%
27		Other	0.00%	0.03%		0.00%	0.00%	0.01%	0.00%
28	Semi-detached House	Owned	0.58%	0.63%		0.47%	0.00%	1.00%	0.00%
29		Rented	0.12%	0.61%	0.24%	0.26%	0.00%	1.21%	0.00%
30		Rent-free	0.15%	0.44%	0.20%	0.13%	0.00%	0.54%	0.00%
31		Other	0.03%	0.01%	0.00%	0.00%	0.00%	0.01%	0.00%
32	Flat/ Apartment	Owned	0.07%	1.29%	0.20%	0.16%	0.01%	0.22%	0.00%
33		Rented		1.34%	0.12%	0.04%	0.03%	0.22%	0.00%
34		Rent-free		1.28%	0.11%	0.11%	0.01%	0.23%	0.00%
35		Other		0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
36	Compound House (rooms)	Owned		2.46%	2.97%	2.60%	0.01%	7.45%	0.00%
37		Rented	1.76%	5.07%	3.86%	5.00%	0.15%	13.69%	0.00%
38		Rent-free	1.84%	2.53%	2.57%	2.31%	0.07%	9.24%	0.00%
39		Other	0.01%	0.04%	0.07%	0.03%	0.00%	0.07%	0.00%
40	Huts/ Buildings (same compound)	Owned	1.16%	0.13%	0.44%	0.20%	0.01%	0.43%	0.00%
41		Rented	0.08%	0.19%	0.09%	0.08%	0.01%	0.39%	0.00%
42		Rent-free	0.13%	0.11%	0.16%	0.11%	0.00%	0.46%	0.00%
43		Other	0.03%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
44	Huts/ Buildings (different compound)	Owned	0.09%	0.01%	0.01%	0.00%	0.00%	0.03%	0.00%
45		Rented	0.00%	0.00%	0.00%	0.01%	0.00%	0.03%	0.00%
46		Rent-free	0.00%	0.01%	0.03%	0.00%	0.00%	0.03%	0.00%
47		Other	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
64	Other	Owned	0.08%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
65		Rented	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
66		Rent-free	0.03%	0.01%	0.00%	0.00%	0.00%	0.03%	0.00%
67		Other	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
68		Net	10.58%	22.42%	14.34%	13.29%	0.35%	38.99%	0.04%

1b Step 1b: Identifying types of toilets

1a Step 1a: Identifying types of houses

Sheet name as per attached penalties base model: "Toilet by HH type – urban"

Step 2: Understanding and defining housing segments

Once the raw data has been entered, the user should analyze it to determine whether the various house and toilet types can be consolidated into unique segments that can be used for analysis. **If there are too many categories of houses, and/ or toilets, it would make the model cumbersome** and take away from its usefulness as a decision-making tool. For example, as seen in Figure 17, there are multiple house types and toilet types in Ghana. Attempting to use the data in this raw form would have made the model difficult to understand, while not adding any additional value in terms of useful insights.

Further, in order to target the policy to specific groups, **it is important that the house and toilet segments used in the model are mutually exclusive of each other**, or else it will not be possible to isolate the impact of the policy on any particular segment(s). Therefore, **it is recommended that the number of segments be kept to a minimum by consolidating similar house and toilet types into the largest unique segment that is still relevant for analysis**. To do this, the user needs to identify differentiators on the basis of which the different house, occupancy, and toilet types can be segmented. The selection of these differentiators should be driven by the specifics of the policy lever and the availability of reliable data.

For example, as we saw in Chapter 3, the major differentiators of house type in Ghana are the number of households living in a house, and whether these households rent or own the house they are living in. As a result, the various house types were consolidated into two main categories: self-contained houses (consisting of separate houses, semi-detached houses, and flats/ apartments); and multi-occupancy houses (consisting of compound houses, huts/ buildings in the same compound, and huts/ buildings in different compounds). The occupancy types were also consolidated into two categories: rented (including rent-free) and owned. This led to four mutually exclusive segments:

- Rented – Multi-occupancy
- Owned – Multi-occupancy
- Rented – Self Contained
- Owned – Self Contained

Similarly, the different types of toilets need to be categorized into broader mutually exclusive segments as well. The basic aim is to be able to clearly identify which types of facilities are considered inadequate and would lead a house to be targeted by the policy, and which types are considered adequate. Therefore, at a minimum, for the model to work, two categories are required: adequate/ improved sanitation, and inadequate/ unimproved sanitation.

A good starting point for segmenting toilet types is the JMP classification which categorizes sanitation facilities as at least basic (improved and not shared), limited (improved but shared), unimproved, and open defecation (no facility). While this classification should work in most instances, it is possible that for certain geographies/ markets, the user may need to make modifications. For example, in Ghana, of the numerous toilet types entered into the table in Figure 17, only W.C.s and KVIPs are considered to be adequate as per the JMP classification. Further, even households with access to W.C.s or K.V.I.Ps would be classified as having inadequate sanitation facilities if these facilities are shared with other households. However, given the large number of multi-occupancy houses in Ghana, it was assumed that as long as a household shares an improved sanitation facility with less than four households (the average number of households living in multi-occupancy houses), it will be considered adequate. As a result, three segments were created:

- Improved toilets (consisting of W.C. and KVIP)

- Unimproved toilets (consisting of bucket/ pan latrines, pit latrines, public toilets, no facility, and others)
- Improved toilets shared with four or more households

Both unimproved toilets and improved toilets shared with four or more households were considered inadequate for the base model. Figure 18 shows the effect of consolidating the house and toilet types into mutually exclusive segments. When seen side-by-side with Figure 17, one can see that the data is much more manageable and easy to read once consolidated in this manner.

It should be noted that while the differentiators on the basis of which toilets are segmented remain the same across geographies/ markets (improved/ adequate vs. unimproved/ inadequate), the differentiators used for segmenting house types would most likely vary from geography to geography. For example, it is possible that in the geography/ market selected, there are no multi-occupancy houses; and/ or that the majority of houses are owner occupied, making differentiating by occupancy status irrelevant. The **decision regarding how to segment should depend on the basis used for targeting the policy**. For instance, if the policy aims to target wealthy house owners, and the size of a house is taken to be a proxy of wealth, then there could potentially be only two segments: large houses and small houses.

The base model allows the user to enter data for up to four housing segments and three toilet types without altering the structure of the model. Depending on the form the raw data is in, the user has two options of how to enter the data. If the data is already available for the broader housing segments and toilet categories, the user can directly input the data into the summary tables shown in Figure 18; the only condition is that the segments should be mutually exclusive. However, if the data is more granular, the user would first need to input the data into the larger input tables depicted in Figure 17, and add together related sub-segments to arrive at the final categories. For example, in the base model, cells containing data for separate houses, semi-detached houses, and flats/ apartments were added and the sum captured in the summary table under self-contained houses.

Further, the base model has two sheets where data on house segments can be inputted, one for urban areas and one for rural areas. If the user does not wish to differentiate between geographical areas, but has identified four or less housing segments, then data can be entered in one of the input sheets while leaving the second input sheet blank (with all the values set to zero). On the other hand, if the user does not wish to differentiate between geographical areas, but has identified more than four housing segments, **the second input sheet can be used to capture data for an additional four segments taking the total number of segments the model supports to eight**.

While having a larger number of segments could potentially increase the flexibility of the model, it also greatly increases the complexity. Therefore, it is recommended that the housing segments be kept to a minimum by consolidating similar house/ occupancy types into the largest unique segment that is still relevant for your analysis. For example, if data is available separately for apartments and standalone houses, but the analysis does not require you to differentiate between the two, they should be collapsed into the same segment.

Figure 18: Consolidating house and toilet segments

	B	C	D	E	F
3	2 # HOUSEHOLDS by type of house, occupancy, and sanitation facility				
4	House type	Occupancy status	Type of sanitation facility		
5			Improved	Shared with >= 4 HHs	Unimproved
6	*Self-contained*	*Owned*	102	31,577	252,614
7		*Rented (plus rent-free)*	787	69,707	265,721
8		*Misc.*		596	2,383
9	*Multi-occupancy*	*Owned*		107,242	696,476
10		*Rented (plus rent-free)*	195,418	487,950	1,532,366
11		*Misc.*	2,383	596	8,341
12	*Other*	*Owned*	4,766	2,383	25,619
13		*Rented (plus rent-free)*	9,533	9,533	57,791
14		*Misc.*	-	1,192	7,149

2 **Step 2:**
Consolidating house and toilet segments

Sheet name as per attached penalties base model: "Toilet by HH type – urban"

Step 3: Refining the sanitation coverage data

The raw data inputted in the base model, as described in the previous steps, was at the household level, i.e., the number of households living in a particular type of house with access to a particular toilet type. This is because in Ghana, as **in most countries, data on access to sanitation facilities is captured at a household level. However, the unit of inspection, and thereby policy enforcement, is a house**. As we have seen, in the case of Ghana, the number of households living in a house varies depending on whether the house is a self-contained house or a multi-occupancy house. Therefore, the **sanitation coverage data had to be further refined to arrive at the number of houses with a particular type of toilet**. This was done by assuming that on average one household lives in one house in the case of self-contained houses; but that there are four households to a house in multi-occupancy houses. Further, in the case of Ghana, the data showed that houses that share toilets with more than four households, on average share them with seven households.

Additionally, sanitation coverage is often calculated based on individuals who have access to sanitation facilities; therefore, the household sanitation access had to be converted into individual access by multiplying it with the average household size in urban and rural areas. As a result, the "Toilet by HH type - urban" and "Toilet by HH type – rural" sheets in the base model **distinguish between households, houses, and individuals** who have access to adequate sanitation facilities.

When adapting the model to a different geography/ market, the user needs to be cognizant of: a) the unit in which data on access to sanitation is available (house vs. household); and b) the unit of enforcement (this is most likely to be a house). If the selected geography does not have multi-occupancy houses, then the user may be able to assume that data for households is equal to that for houses. However, if there are multi-occupancy houses, the user first needs to segment houses into self-contained and multi-occupancy (as done in the base model), next the average number of households that live in multi-occupancy houses needs to be determined, and finally, the number of households living in multi-occupancy houses with access to toilets needs to be divided by the average number of households to arrive at the actual number of houses with toilets.

Figure 19: Refining the sanitation coverage data

	B	H	I	J
2		3 # HOUSES by type of house, occupancy, and sanitation facility		
3	House type	Type of sanitation facility		
4		Improved	Shared	Unimproved
5	*Self-contained*	240,102	31,577	252,614
6		284,787	69,707	265,721
7		1,787	596	2,383
8	*Multi-occupancy*	38,901	15,320	204,846
9		57,476	69,707	450,696
10		701	85	2,453
11	*Other*			
12				
13				

3 Step 3: Refining sanitation coverage data

Sheet name as per attached penalties base model: "Toilet by HH type – urban"

Step 4: Defining the enforcement mechanism

From the viewpoint of enforcing the policy, the government needs to be able to identify which households/ houses actually fall into the segments discussed above. In order to do this, a policy enforcement mechanism is required. The next step in adapting the model is, therefore, to clearly define the features of this enforcement mechanism. As defined in this document, an enforcement mechanism consists of the following parts:

- **The enforcement process:** This refers to the details of how the policy will be executed on the ground, including:
    - The frequency with which houses will be inspected
    - The time required to inspect a house
    - The parameters on the basis of which a house owner will be considered to be in default
    - The number of warnings a house owner is given to rectify the situation
    - The time between a warning and the subsequent follow up inspection
    - The procedure for prosecuting and sentencing defaulters
    - The nature and extent of the penalty imposed
- **The organizational structure:** This refers to the people and infrastructure required to follow the process as determined above. This includes:
    - The number of enforcement personnel involved in: inspecting houses; providing administrative support; and prosecuting and sentencing defaulters
    - The average number of households or houses that an enforcement personnel is expected to cover (e.g., 1,000 households per field inspector vs. 5,000 households per prosecutor)
    - The average hours worked by this personnel, and the percentage of this time spent on enforcement of the policy
    - The physical infrastructure (e.g., field offices), and or equipment (e.g., two-wheelers) required by the enforcement personnel to carry out their tasks
- **The cost of enforcement:** This flows directly from the process identified and the organizational structure proposed. For example, the human resource cost will depend upon the percentage of time enforcement personnel spend on this task, which in turn depends upon the number of inspections defined in the enforcement process

In the case of Ghana, the enforcement mechanism already existed, and was modified to suit the needs of the base model. However, as the model is intended to show how the status quo can be changed in geographies/ markets where such market rules do not exist, it is not necessary that the selected geography/ market have an existing enforcement mechanism. In cases where the policy and enforcement mechanism don't exist, the user needs to hypothesize what this could look like.

While the enforcement mechanism can be hypothetical, it is recommended that the user design it based on an understanding of existing government mechanisms, especially those in place for local governance. Most countries have some mechanism for providing extension services for the government's social schemes; for example, health ministries in most countries employ frontline public health workers who promote immunization campaigns, or maternal and child health programs. Similarly, there are agricultural extension workers, or education officers who work in defined territories to roll out government schemes.

Practically, it is likely that if a government does introduce a new policy, they will enforce it through an existing mechanism, rather than invest in setting up a specialized one. Therefore, building the hypothesized enforcement mechanism atop an understanding of these existing mechanisms would make it more grounded. Further, this would allow a more realistic estimate of potential costs, as the salaries of government officials are often publically available. Ensuring the enforcement mechanism is as realistic as possible, would also lead to more productive discussions with policy makers in the future.

Step 5: Identifying key constraints

Though the market rule will apply to the entire housing segment(s) targeted, **there will be some house owners within any selected segment who face genuine constraints that prevent them from building toilets; for example, the inability to afford toilets**. Penalizing house owners who don't have the resources to build a toilet would only exacerbate inequalities, while not resulting in any new toilets being built. Therefore, the enforcement mechanism needs to be able to identify and exclude such house owners from the process. Policy makers, funders, and/ or implementers may have alternate channels (such as loans or subsidies) through which these house owners are supported in purchasing a toilet, but this is considered to be out of the scope for the penalties model.

In addition to lack of affordability, there could be other constraints specific to a geography/ market that prevent a house owner from building a toilet despite the desire to do so. The base model considered lack of space as one such constraint, however, there may be different constraints in different areas. For example, in some areas, the water table may be too high, making the construction of toilets technically difficult. **Whatever the constraint, the user needs to identify the most pressing (and genuine) ones and ensure the enforcement process excludes house owners who face these constraints**.

The base model allows users to include two constraints without altering the model's structure. While there may be more than two constraints in a given geography/ market, we believe that only a marginal improvement in the predictive power of the model would be gained by adding more than two constraints.

Step 6: Setting values for key assumptions

Once the enforcement mechanism has been detailed, and the key constraints identified, they need to be entered into the model so that the outputs can be calculated using these parameters. **Not all the data required may be available from secondary research, and the user would need to make certain assumptions to fill the gaps**. Even when there is an existing enforcement mechanism, it may need to be modified on the basis of certain assumptions (as was the case with the base model). The user needs to clearly identify these assumptions to ensure that there is no ambiguity. The assumptions required are likely to include the following:

- The ratio of enforcement personnel to population/ area
- The time taken by enforcement personnel to inspect one house
- The percentage of time (and by extension, the share of salary) spent by enforcement personnel on sanitation enforcement
- The percentage of house owners who face the identified constraints
- The percentage of house owners who default after receiving a formal warning

The user may choose to have a default value for some of these assumptions, but allow for it to be varied in order to see the impact on outputs. For example, in the base model, the percentage of house owners facing various constraints is a key variable that the user can change.

Step 7: Entering the data into the input sheets

Data related to the enforcement process should be entered into the "Enforcement inputs" sheet in the base model. The sheet has blocks for each type of personnel involved in the enforcement process. In each block, the user needs to enter:

- The number of enforcement personnel of a particular type that will be needed
- The average monthly salary for that type of enforcement personnel
- The total hours worked in a month by that type of enforcement personnel
- The percentage of the total working hours that are required for enforcement of the policy

The sheet allows data to be entered separately for urban and rural areas, as one of the basic assumptions (as defined in subsection 3.3.1) is that the enforcement mechanisms for urban and rural areas are distinct. However, if the user does not wish to distinguish between urban and rural areas, they can choose to fill data in only one column and rename it as required. The surplus column should be left as is and blanked out (shaded in dark grey) to avoid any confusion.

In addition to the enforcement personnel, the "Enforcement inputs" sheet also has blocks for each of the stages in the enforcement process. In these blocks, the user can list different scenarios for the percentage of house owners that face each of the key constraints identified (e.g., affordability and space). The user can also list scenarios for the expected default rates at each stage of inspection, and set the time taken between each inspection.

Step 8: Entering other general inputs

There are certain general inputs that are required for calculating change in coverage rates, and converting data on the number of households with access to sanitation to data on the number of houses (or individuals) with access (see subsection 3.3.1). This includes demographic data such as population, and average household size. This data is entered in the "General inputs" sheet of the base model. This sheet is also where assumptions regarding how many households can share a toilet, and therefore the number of toilets that need to be built in a house, are entered. It is not necessary the user will need to fill in information against all the heads in the "General inputs" sheet, if data on a particular head is not needed, the user can leave that cell blank. In addition, the user can list any additional assumptions they have made in this sheet.

Box 1 provides a list of potential data sources for the different kinds of input data listed above.

Box 1: Potential sources for input data

Potential data sources

Type of data	Potential sources
Housing data	• Government census studies • Government national sample surveys which capture housing standards (e.g., living standard surveys, health surveys, population surveys etc.) • Reports by government ministries/ departments and/ or reports prepared for parliamentary committees • Reports by international organizations (e.g., UN Habitat), and/ or local NGOs working in the housing space • Industry association reports
Sanitation coverage data	• Government census studies • Government national sample surveys which capture health related data (e.g., health surveys) • Reports by government ministries/ departments and/ or reports prepared for parliamentary committees • Sanitation coverage data from UNICEF/ WHO Joint Monitoring Program • World Bank development indicators database • Program evaluation reports by funders (e.g., USAID, DFID, UNICEF, BMGF etc.), and implementers (e.g., WSP, Water for People, WaterAid, WaterSHED, PSI etc.) working in the sanitation space
Demographic data	• Government census studies • Government national sample surveys • Databases of international organizations, e.g., World Bank indicator database, CIA Factbook etc.
Enforcement related data	• Government ministries/ departments in charge of public health (for enforcement mechanism, personnel, and costs) • Government budget documents (for enforcement personnel and costs) • Studies by international organizations working in public health e.g., WHO, UNICEF • Studies by local NGOs • Newspaper articles/ reports

Note: *Ideally, the housing data, sanitation coverage data, and demographic data should be sourced from the same report/ database. In the model, data on type of sanitation facility has to be captured by housing type and using data from different sources can make it difficult to match facility to house type. Similarly in an ideal scenario, data on enforcement personnel, their roles and responsibilities, and their salaries should be obtained from the same source.*

STAGE 2: ADAPTING THE CALCULATION SHEETS

The calculation sheets are at the heart of the model, containing the formulae that pull together all the inputs and assumptions and convert them into outputs on the basis of the underlying logic. These sheets are linked to the input sheets, the output sheets and the user dashboard. They extract data from the input sheets, and have links out to the output sheets and dashboard. In addition, they pick up user-entered values set in the dashboard in order to determine which segment(s) to apply the policy to, and which house owners within the segment(s) to include or exclude. While this last relationship will be discussed in more detail in 'Stage 3: Adapting the output sheets', it is important to remember that values entered in the dashboard need to be imported into the calculation sheets in order for them to function. The user will need to work on adapting the calculation sheets and user dashboard simultaneously, and therefore, it is recommended that the user read through the steps in 'Stage 4: Updating the user dashboard' in addition to the steps in this Stage before starting to adapt the calculation sheets.

The "Enforcement schedule urban" and "Enforcement schedule rural" are the sheets in which calculations are made regarding how many house owners are targeted, how many comply, and how many are penalized (see subsection 3.3.3). The two enforcement schedules are identical in their construct, differing only in that the inputs and assumptions utilized for the urban schedule are taken from the "Toilet by HH type – urban" sheet (and the urban column in the "General inputs" sheet), while the inputs and assumptions utilized in the rural schedule are taken from the "Toilet by HH type – rural" sheet (and the rural column in the "General inputs" sheet). As the construct of these schedules is identical, the explanation on how to adapt these sheets will be based on just the "Enforcement schedule – urban" sheet, and the user can modify the rural enforcement schedule by following the same steps.

Step 9: Measuring the aggregate impact of the policy

The urban enforcement schedule consists of two tables. The first is an aggregate table, and it is this table that pulls data from the input sheets and calculates the overall impact of the policy in terms of houses/ house owners affected and toilets constructed. This aggregate table is depicted in Figure 20. As seen in this figure, the table contains rows for:

a. The total number of houses in urban areas (by housing segment)

b. The share that houses in each housing segment constitute of the total number of urban houses

c. The total number of urban houses that can be inspected in a month

d. The total number of urban house owners that are forewarned (first warning)

e. The percentage of forewarned house owners that can afford a toilet (first constraint)

f. The percentage of forewarned house owners that can afford a toilet and have the space to build one (second constraint)

g. The percentage of house owners who are issued an improvement notice (second warning); this is the percentage of the house owners in point "f" that default after receiving the first warning

h. The percentage of house owners who are penalized; this is the percentage of house owners in point "g" that default after receiving the second warning

Figure 20: Enforcement schedule: Table 1 – aggregate impact

	Head	Total	Owned self-contained	Rented self-contained	Owned multi-occupancy	Rented multi-occupancy	Misc.
Overall impact of policy	# houses	1,989,460	524,293	620,215	259,068	577,879	8,006
	Share of total number of houses		26.5%	31.3%	13.1%	29.2%	
	Total number of houses that can be inspected per month	275,453	72,885	86,220	36,014	80,334	
	% of house owners that are forewarned		0%	0%	85%	90%	
	% of forewarned house owners who can afford a toilet		0%	0%	50%	75%	
	% of forewarned house owners who can afford toilets and have space to build them		0%	0%	75%	50%	
	% of house owners who are issued an improvement		0%	0%	75%	75%	
	% of house owners penalized		0%	0%	25%	25%	
	# house owners forewarned (total)	740,569	-	-	220,166	520,403	
	# house owners forewarned		-	-	220,166	520,403	
	# forewarned house owners who can afford a toilet		-	-	110,083	390,302	
	# forewarned house owners who can afford toilets and have space to build them		-	-	82,562	195,151	
	# house owners penalized		-	-	15,480	36,591	
	# house owners who comply with the policy	225,642	-	-	67,082	158,560	
	% total complaint house owners	100.00%	-	-	29.73%	70.27%	
	# toilets built	225,642	-	-	67,082	158,560	
	% total toilets built	100.00%	-	-	29.73%	70.27%	

Values imported from the 'Toilet by HH type-urban' sheet

Values imported from the 'Dashboard' sheet

Values computed using formula in this sheet

9 Step 9: Calculating the aggregate impact

Legend

	Hard coded data: The values in these cells is from data captured in the input sheets from verified secondary sources
	User entered inputs: The values in these are directly ported from the values of key variables set by the user in the dashboard
	Calculations: The values in these cells have been calculated based on formulae present in these cells

Sheet name as per attached penalties base model: "Enforcement schedule urban"

The columns in the aggregate table represent each of the four housing segments that were identified in Ghana while developing the base model. While adapting this model to a new market, the **user will need to update these columns in line with the housing segments identified for the new market as per the instruction in Step 1**. In line with the input sheets, this table allows for data on four housing segments to be captured. If the user has identified fewer than four segments for the new market, the remaining columns can be left blank.

It can also be seen from Figure 20 that different cells in the aggregate table are colored differently. This color-coding is based on the type (and source) of data in a particular cell. The **cells shaded in light grey** derive their values directly from the hardcoded data in the "Toilet by HH type – urban" sheet. This is **verified data from secondary sources and cannot change** for a given geography/ market. For example, the value of 1,989,460 in cell "D4" is the actual total number of urban houses in Ghana as per data taken from the GLSS6 report. Similarly, cells "E4" to "H12" contain details of the actual number of houses in each of the four housing segments identified in Ghana. Similarly, the values in "Row 7" (percentage of house owners that are forewarned) are based on the actual percentage of houses in each housing segment that do not have access to sanitation as per the hardcoded data from GLSS6. These cells have formulae to extract the values directly from the input sheets, therefore once the user updates the input sheets, the figures in these rows will update automatically.

The cells in "Row 8" to "Row 11" are shaded in yellow (and demarcated with a green border), signifying that these contain user-entered values. These rows represent the key variables and/ or constraints that were discussed in Step 5. The values in "Row 8" and "Row 9" determine which house owners will be excluded from the policy even if the house segment they belong to is selected for policy application. Further, "Row 10" contains values that determine the percentage of house owners who default after the first warning, and "Row 11" values that determine the number that default after the second warning. The values in these cells are not entered in enforcement schedule directly, but in the user dashboard. The cells in the enforcement schedule have formulae to import the values entered in the user dashboard based on the housing segment(s) selected for policy application. Once the user sets the values of these key variables/ constraints in the user dashboard, the cells in the enforcement schedule will update automatically.

The unshaded (white) cells found in "Row 13" to "Row 20" signify computed values. These cells are linked to the actual calculations which will be explained later. These cells detail the absolute number of house owners forewarned, those issued an improvement notice, those forewarned who can afford a toilet, those forewarned who can afford a toilet and have the space to build it, those house owners who are penalized, those that comply, and the total number of toilets built as a result of enforcement of the policy.

In Figure 20, the **cells "E8" to "E20" and "F8" to "F20" are blank**, i.e., they have a value of zero. On the other hand, the **cells "G7" to "G20" and "H7" to "H20" are populated**. This is because, when the screenshot was taken, the policy was applied to only multi-occupancy houses (both owned and rented), and therefore the impact of the policy was calculated only for these housing segments. The column for a particular housing segment becomes **"active"** automatically if the segment is selected for policy application by the user in the dashboard. If a column is "active", it means that the formulae used to calculate the impact of the policy are applied in that particular column. On the other hand, if a housing segment is not selected in the dashboard, the column will be **"deactivated"**, meaning the formulae will not be applied, and the values will be set to zero.

The dashboard, as discussed in detail later, has switches for each housing segment that can be toggled on and off. Changes made in the Dashboard these switches impacts the "Row 8" to "Row 11" of the enforcement schedule. When a switch is toggled on in the user dashboard, the "IF function" pulls values from the relevant cells in the input sheet (the percentage of houses that don't have adequate sanitation) and user dashboard (user-entered value for key variables and constraints); else the value is set to zero.

Box 2: Note regarding housing segments

Note on the "Misc." housing segment in Figure 20

In Figure 20, it can be seen that there is a "Misc." housing segment as well (cell "I4"). This "Misc." category refers to those houses that don't fall into any of the other four identified segments. The raw data from Ghana does not mention what these houses are and as the number of such houses constitutes a negligible share of total urban houses (0.004%), they are not considered in any of the calculations. The formulae in "Row 5" and "Row 6", therefore, subtract these houses from the total number of houses when calculating the percentage of houses in each segment, or the number of houses to be inspected in each segment. When the model is adapted for another market, there may not be a "Misc." category. In such cases, "I4" should be set to zero; this will ensure the total number of houses is considered in the calculations in "Row 5" and "Row 6 without the need for modifying any of the formulae.

Step 10: Applying the mathematical calculations to the relevant housing segment(s)

The first step in applying the policy in the base model is to select which housing segment to target. In the base model, we applied the policy to urban multi-occupancy houses (owned and rented). However, even though the policy hasn't been applied to self-contained houses, it can be seen from Figure 20, that in columns "E" and "F" the values for number of houses ("Row 4") and total number of houses that can be inspected in a month ("Row 6") are still populated rather than being set to zero. This is deliberately done, and is a result of two of the basic assumptions referred to in subsection 3.3.2 :

- **No matter which segment is selected, all houses in the geographic area(s) targeted (urban only, rural only, or urban and rural) will be inspected at least once; and**
- **Within their geographic areas, field inspectors are deployed in a way that ensures full utilization**

The thinking behind the first assumption is that all houses in a geographic area will have to be inspected at least once in order to determine which housing segment they fall into, and what type of sanitation facility they possess. Therefore, the total number of houses to be covered in the first inspection ("Row 4") remains constant no matter what combination of housing segments is selected.

However, the number of houses inspected for a second time (all houses that were found to lack adequate sanitation facilities and forewarned), those inspected for a third time (all houses whose owners were forewarned and found to have the resources and space to build a toilet), and those inspected for a fourth time (those who were issued an improvement notice) are dependent on the housing segment(s) selected for policy application. Therefore, in the current example, we see that the percentage (and therefore the absolute number) of house owners forewarned is zero for self-contained houses ("E7" and "H7"). As these house owners did not get forewarned, the values of "Row 8" to "Row 20" automatically get set to zero.

The number of houses inspected in a month ("Row 6") is used to spread the impact of the policy over time. Cell "D6" refers to the total number of urban houses that can be inspected per month based on: a) the number of urban field inspectors; b) the total time spent by them on sanitation in a month; and c) the time taken to inspect one house. The total number of houses that can be inspected is distributed across the different housing segments (cells "E6" to "H6") based on the percentage of houses in that segment to the total number of urban houses (these percentages are entered in "Row 5"). The values in cells "E6" to "H6" denote the maximum number of houses that can be inspected in each housing segment per month.

As long as the cumulative number of houses to be inspected (including the first, second, third, and fourth inspections) is greater than or equal to the total number of houses that can be inspected per month (cell "D6"), the maximum number that can be inspected will be inspected. This is due to the second assumption, i.e., all field inspectors will be deployed in a manner that ensures full utilization of their capacity. Once the total number of houses to be inspected falls below the value set in cell "D6", the number of houses in each segment will reduce proportionately to ensure the total number of houses inspected is still distributed across housing segments as per the percentages in "Row 5".

Figure 21: Applying the mathematical calculations

	Head		Total	E	F	G	H	I	J	K
22									1 Year	
23								5 month	6 month	7 month
24	Total number of houses inspected			275,453	275,453	275,453	275,453	275,453	275,453	275,453
25	Stage 1: Identify & register	First inspection		275,453	275,453	172,502	172,502	182,025	182,025	182,049
26	Stage 2: Forewarn	Second inspection				102,951	102,951	64,473	64,473	68,032
27	*Owned self-contained*		-			-	-	-	-	-
28	*Rented self-contained*		-			-	-	-	-	-
29	*Owned multi-occupancy*		*220,166*			*30,607*	*30,607*	*19,167*	*19,167*	*20,225*
30	*Rented multi-occupancy*		*520,403*			*72,344*	*72,344*	*45,305*	*45,305*	*47,807*
31	# forewarned who can afford a toilet					69,561	69,561	43,563	43,563	45,968
36	# forewarned house owners who can afford toilets and have space to build them					38,606	38,606	24,177	24,177	25,512
41	Stage 3: Issue improvement notice	Third inspection						28,955	28,955	18,133
46	Stage 4: Penalize	Fourth inspection								7,239
51	# house owners who comply with the policy							9,652	9,652	27,760
56	# toilets built							9,652	9,652	27,760
63	Cumulative number of houses inspected each year									
64	Cumulative number of house owners forewarned each year									
65	Cumulative number of toilets built each year									
66	Total number of house owners penalized each year									

Breakdown within each row of the enforcement table

Impact over time

Totals that flow into Table 1 of Enforcement Schedule

The number of new houses inspected per month reduces as the second, third and fourth inspections start

2 month lag between first and second inspection

2 month lag between second and third inspection

2 month lag between third and fourth inspection

Sheet name as per attached penalties base model: "Enforcement schedule urban"

Step 11: Determining the enforcement mechanics

The rows in the table shown in Figure 21 are the basis of the figures in the aggregate table in Figure 20, with separate rows in Figure 21 for each stage of the enforcement process, plus rows that calculate which houses/ house owners are excluded from the policy, and rows showing how many house owners are penalized and how many toilets are built. The columns of this table represent time with each column representing a month.

The base model was built on the basis of a simplified version of the enforcement mechanism used in Ghana. This process has four inspection stages (see rows bordered in red in Figure 21):

- **The first inspection** is used to identify houses without toilets and register them; the number of houses that undergo a first inspection every month is captured in "Row 25" of Figure 21. The total number of houses undergoing first inspection will always be equal to the total number of urban houses (less the number of houses in the "Misc." category). At this time the houses without toilets are given two months to start building a toilet, else they will receive a formal warning
- **The second inspection** is used to officially forewarn house owners who haven't started building a toilet within two months of being identified and registered. As stated earlier, the number of house owners forewarned is based on the actual number of houses that do not have a toilet as per the GLSS6 data. These house owners are once again given two months to start building a toilet before they are issued a formal notice. The number of houses inspected a second time (and forewarned) is captured in "Row 26" of Figure 21
- **The third inspection** is used to issue a formal improvement notice to the house owners who haven't started building a toilet within two months from being forewarned. The number of house owners inspected a third time (and issued an improvement notice) is captured in "Row 41" of Figure 21. It is important to note that not all forewarned house owners that don't build toilets are issued notices. At this stage, the house owners who face genuine constraints are excluded from the enforcement process. The base model considered affordability and lack of space as the two key constraints faced by house owners in Ghana. The number of house owners inspected in a month who can afford toilets is captured in "Row 31", while the number who can afford toilets and have the space to build one is captured in "Row 36". The number of house owners issued an improvement notice is based on the user entered value for the percentage of house owners in the Dashboard who default after being forewarned
- **The fourth inspection** is used to issue court summons to those house owners who haven't started building a toilet within two months of receiving an improvement notice. This is the final stage of the enforcement process, and it is assumed that all those who receive court summons will be penalized and pay the penalty amount. The number of house owners that are penalized is calculated based on the user entered value for the percentage of house owners in the Dashboard who default after receiving an improvement notice. The number of penalized house owners is captured in "Row 46"

In Figure 21, it can be seen that **in the four inspection rows the data entered is staggered** (see the green shaded cells). While the identification and registration starts at Month 1 (cell "E24"), the forewarning of houses kicks off only in Month 3 (cell "G26"), issuing of improvement notices takes place in Month 5 (cell "I41"), and house owners are penalized starting Month 7 (cell "K46"). This is due to the specific nature of the enforcement process defined for Ghana, wherein house owners are given two months between each round of inspection to start building a toilet. As a result, after each inspection, the house owners who are found in default of the policy need to be re-inspected in two months' time.

This is an important point to note as **the number of field inspectors (EHOs), and the total number of houses they can inspect in a month is limited**. Therefore, while for the first two months the number of houses inspected for the first time will be equal to the total number of houses that can be inspected, from Month 3 ("Column G") onwards, the number of new houses inspected for the first time will reduce as the field inspectors will need to revisit houses that were inspected once and found to have inadequate sanitation facilities (see mud yellow arrow in Figure 21). Similarly, from Month 5 ("Column G") onwards, the number of new houses inspected will further reduce as some houses will have to be inspected for a third time, and the process will again repeat in Month 7 ("Column K") when certain houses need to be inspected for a fourth time.

Each row of the enforcement table in Figure 21 is being calculated for each individual housing sub-segment. To be able to see each individual calculation, a user will have to open the Grouped Rows by clicking the '+' button on the left side of the Rows indicator. In Figure 21, we have displayed the calculation rows for Stage 2 by ungrouping the rows between "Row 26" and "Row 31". Each such hidden row is for calculation of the total for each sub-segment. For example, the bright yellow box in Figure 21 indicates the number of households in each sub-segment that were forewarned. The sum of each row, i.e. cell "D27" to "D31" is linked to the enforcement aggregate table in Figure 20. So for example, "Cell D29" in Figure 21 is linked to "Cell G13" in Figure 20, indicating the total forewarned houses in the owned multi-occupancy segment.

Due to our assumption of full utilization of field inspectors, the total number of houses inspected (across first, second, third, and fourth inspections) will always remain equal to the total number of houses that can be inspected in a month (cell "D6" in Figure 20); that is until the number of houses to be inspected across all inspection stages falls below the value in cell "D6". In the example taken here, this happens in Month 10 (not seen in the figure), when the last of the urban houses are inspected for the first time. The total number of houses inspected in a month can be seen in "Row 24", which totals up all the houses inspected across the four inspection stages.

A formula has been built into "Row 24" in order to ensure that the number of houses inspected does not exceed the total number that can be inspected in a month (cell "D6" in Figure 20), or the total number of urban houses targeted(cell "D4" minus cell "I4" in Figure 20). The formula selects the minimum value from either: a) the total number of houses that can be inspected in a month less the number of houses that are inspected for the second, third, and fourth times (i.e., "Row 25" minus the sum of "Row 26", "Row 41", and "Row 46"); or b) the total number of houses to be inspected ("D4" minus "I4" in Figure 20) less the cumulative sum of all houses inspected for the first time.

The staggered inspection schedule, and the reduction in the number of new houses that can be inspected over time, determine the overall time taken to enforce the policy. As seen in the preceding paragraphs, the number of new houses that can be inspected in a month is constrained by the number of houses that need to be inspected for a second, third, and fourth time. This means that the higher the default rate after each inspection, the longer it will take to enforce the policy as there will be more houses that need to be inspected multiple times. Similarly, while the number of houses to be inspected the first time remains constant, the number of houses that need to be inspected a second time depends on the number of housing segments the policy is applied to. In the current example, the policy is applied only to multi-occupancy houses (owned and rented). However, if the policy was to be extended to include both segments of self-contained houses as well, it would take longer for the field inspectors to forewarn all deficient houses. Conversely, if only one housing segment is selected, the time taken to enforce the policy would reduce. As the third and fourth inspections build upon the number of houses covered in the second inspection, the choice of housing segments has a cascading effect.

The formula built into "Row 25" has been constructed in a way that ensures the values will update automatically based on the number of housing segments selected for policy application in the user dashboard. Further, while Figure 21 shows the enforcement only over seven months, the actual table in

the base model has been built to accommodate a ten year horizon. However, the user can easily extend this by dragging the cells for as many additional months/ years as needed.

This discussion shows that the **time lags in the policy enforcement are extremely important in determining the time taken to enforce the policy**. This is why the time taken between inspection stages has been called out as a key parameter that needs to be defined while designing the enforcement process (see Step 4). The choice of time lags will need to be reflected in the table in Figure 21. In the example, the inspection rows ("Row 25", "Row 26", "Row 41", and "Row 46") have been staggered in two month intervals due to the policy allowing for two months between inspection stages. Depending on the time period chosen when adapting this model to a new geography/ market, the user will need to **manually shift the starting cell** in each of the four inspection rows. Further, the rows giving force to the key constraints ("Row 26" and "Row 41") need to be shifted as well so that they start in the same column as that for which data is entered in "Row 25".

Note, while the existing formula used in the current starting cell needs to be shifted to a new cell, the formula itself does not need to change. For example, if the time period between the identification stage and the second inspection is increased to three months from the current two months, the data in "Row 25" would need to start from cell "H25" rather than cell "G25". To do this, the user needs to copy the exact text of the formula in "G25" and paste it in "H25". The user should then delete the value in "G25" while dragging the formula in "G25" across how many ever months they desire to extend the model to. It is important that the formula be copied as-is into the new cell and then dragged across the remaining months; simply deleting the value in "G25" and leaving the remaining values would yield incorrect results. Similarly, if the time period were reduced to one month, the exact text of the formula would need to be pasted into cell "F25" and then dragged across the remaining cells in the row. Again, simply dragging the formula in "G25" to "F25" would lead to incorrect results.

The number of house owners who comply with the policy and the number of toilets built is not necessarily the same. While it is assumed that there is one house owner to a house, **there may be more than one toilet that needs to be built per house to ensure adequate access to sanitation for all households living in a house**. This is true in Ghana due to the presence of multi-occupancy houses. On average four households live in a multi-occupancy house, and as such it is assumed that it is adequate if up to four households share an improved toilet (see subsection 3.3.1-A). However, in multi-occupancy houses where an improved toilet is shared with more than four households, there are on average seven households living in the house. Therefore, such houses require two toilets for sanitation facilities to be considered as adequate; that is one additional toilet over and above the toilet that already exists. On the other hand, self-contained houses, and multi-occupancy houses with unimproved sanitation, only require one toilet to be built in the house.

Given this situation, in order to accurately calculate the number of toilets built, we broke down each sub-segment into two broad categories: the number living in houses with improved but shared sanitation ("Row 61"), and the number living in houses with unimproved sanitation ("Row 62") in Figure 22.

This division is done through formulae that multiply the total number of complaint house owners with the percentage of total compliant house owners from a particular housing segment and the percentage of houses in that particular segment that have unimproved or improved but shared toilets (as per data in the "Toilet by HH type – urban" sheet). Similarly, for each housing sub-segment, from "Row 57" to "Row 60", we have calculated total toilets built by multiplying households who comply with toilets built per that household. For multi-occupancy segments, in "Row 59" and "Row 60", the calculation is more elaborate. It is essentially calculated as households who comply with the policy multiplied by the proportion of houses in that sub-segment without adequate sanitation (shared or not shared) multiplied by the number of toilets to be built for that segment (shared or not shared).

Figure 22: Calculation of number of toilets built

		Head	Total	1 month	2 month	3 month	4 month	5 month	6 month	7 month
				1Year						
	Impact over time	Total number of houses inspected		275,453	275,453	275,453	275,453	275,453	275,453	275,453
		Stage 1: Identify & register		**275,453**	**275,453**	**172,502**	**172,502**	**182,025**	**182,025**	**182,049**
		Stage 2: Forewarn				**102,951**	**102,951**	**64,473**	**64,473**	**68,032**
		# forewarned who can afford a toilet				**69,561**	**69,561**	**43,563**	**43,563**	**45,968**
		# forewarned house owners who can afford toilets and have space to build them				**38,606**	**38,606**	**24,177**	**24,177**	**25,512**
		Stage 3: Issue improvement notice						**28,955**	**28,955**	**18,133**
		Stage 4: Penalize								**7,239**
		# house owners who comply with the policy						**9,652**	**9,652**	**27,760**
		# toilets built						**9,652**	**9,652**	**27,760**
		Owned self-contained	-					-	-	-
		Rented self-contained	-					-	-	-
		Owned multi-occupancy	67,082					2,869	2,869	8,253
		Rented multi-occupancy	158,560					6,782	6,782	19,507
		# compliant owners in houses with improved sanitation	25,907					1,108	1,108	3,187
		# compliant owners in houses with unimproved sanitation	199,735					8,543	8,543	24,573
		Cumulative number of houses inspected each year								
		Cumulative number of house owners forewarned each year								
		Cumulative number of toilets built each year								
		Total number of house owners penalized each year								

Sheet name as per attached penalties base model: "Enforcement schedule urban"

This division is relevant in any geography/ market where there are different numbers of households living in different types of houses. However, even if there is no such distinction, the user can simply set the number of additional toilets required in the "General inputs" sheet to the same value for both types of houses and the right number of toilets built will be calculated. Conversely, the user can choose to delete the rows in the "General inputs" sheet that relate to the number of toilets required in multi-occupancy houses. However, this would mean making a change to the structure of the model, and related changes across nearly every sheet in the model; hence, this is not recommended.

The final section of the 'impact over time' table provides yearly totals for the number of houses inspected, the number of house owners forewarned, the number of toilets built, and the number of house owners penalized. These totals will update automatically. The user may not wish to distinguish between urban and rural areas. In such cases, the user can choose to update any one of the enforcement schedules and leave the second one blank. Alternately, if the user has decided not to differentiate between urban and rural, but to still use one of the two input sheets to enter more than four housing segments (up to eight are possible), then both enforcement schedules will need to be updated. The process of adapting the urban enforcement schedule described in this section can be used to update the second enforcement schedule as well.

Users should note that this table has been designed to run for a maximum of 120 months or 10 years. In case, they wish to adapt it for a longer possible duration, they will need to extend the formulas towards the right.

Step 12: Determining the duration of the policy

The second table in the urban enforcement schedule, in addition to spreading the enforcement of the policy over time, also calculates the duration for which the policy runs (see cells bordered in red in Figure 21). The base model has been set up to run for the duration which the user defines in the Dashboard. However, if all the houses that need to be inspected get inspected before the duration as defined by the user, then the policy runs for only as many months which are required. For example, a user defines the duration of the policy in the Dashboard to be 60 months. However, in Figure 21, if the total number of target market houses which need to be inspected get fully inspected in 18 months, then the duration of the policy will be the lesser duration, i.e., 18 months.

The duration is important to know for two reasons; first, it allows users to compare the impact achieved over a period of time with that achieved by other initiatives and determine which is more effective; and second, knowing how long it will take to enforce the policy allows users to determine the cost to the government for implementing the policy. The table in the urban enforcement schedule, depicted in Figure 21, spreads the enforcement of the policy over time using inputs and assumptions from the "Enforcement inputs" sheet.

Figure 23 explains how the calculation of the duration of the policy is set up in the base model. The figure collates the user-defined duration from the Dashboard in cell "L5" and the duration of the policy from "L4". The duration of the policy is counted as the number of months for which houses get inspected. The calculation in cell "L6" takes the lesser of the two durations. For example, in case the user-defined duration is 60 months, but the inspection of all houses for the selected sub-segments gets completed in 18 months, then the cell in "L6" will take the lesser duration, i.e., 18 months to be the duration of the policy.

Figure 23: Determining the duration of the policy

	K	L
2		
3		Calculation of duration
4	Actual Duration	16 months
5	User-defined Duration	20 months
6	Min	16 months

Sheet name as per attached penalties base model: "Enforcement schedule urban"

STAGE 3: ADAPTING THE OUTPUT SHEETS

Step 13: Modifying the segment-wise output sheets

The main output of the model is the change in sanitation coverage as expressed by the number of toilets built, the number of households that gain access to toilets, and the number of individuals that gain access to toilets (see subsection 3.3.3). While these outputs are calculated in the enforcement schedules, each schedule only shows the outputs for a particular geographical area (urban or rural). It is not possible for the user to see the total impact of the policy on a housing segment across all geographies from a single enforcement schedule. The segment-wise output sheets found in the base model address this issue by consolidating the outputs for a particular housing segment from across both geographic areas in one sheet. There are four such sheets, one for each of the housing segments identified in Ghana. Figure 24 depicts the segment-wise output sheet for the "Rented – Multi Occupancy" housing segment. The structure of the remaining three sheets is identical to the one depicted here.

The outputs mentioned above can be found in the section with the red border in Figure 24 along with the number of houses inspected in this housing segment, the number of house owners penalized, and the income to the government from the fines paid by defaulting house owners ("Row 19" to "Row 24"). As seen from the yellow bordered section in the figure, the data has been disaggregated by geography with separate columns for urban ("Column D") and rural ("Column E") geographies; as well as a national column ("Column F") that sums up the other two columns.

The data for number of toilets built in urban areas "D20" and rural areas "E20" is imported directly from the urban and rural enforcement schedules respectively. The number of households that gain access to sanitation ("Row 21") is calculated by multiplying the number of toilets built ("Row 20") by the average number of households living in urban or rural houses (as entered in the "General inputs sheet"). Similarly, the number of individuals that gain access to sanitation ("Row 22") is calculated by multiplying the number of households in "Row 21" by the mean household size in urban and rural areas (as entered in the "General inputs" sheet).

In addition to the impact of the policy, the segment-wise outputs also provide a snapshot of the baseline sanitation coverage in terms of households ("Row 5" to "Row 8") and houses ("Row 10" to "Row 17") with different types of sanitation facilities (improved, improved but shared with more than four households, and unimproved). **These are the cells with the green border** in Figure 24. The data for these rows is taken from the "Toilet by HH type – urban" and "Toilet by HH type – rural" sheets. The baseline figures have been included to provide context for the impact figures, allowing the user to see the pre and post policy status in one place.

Figure 24: Sample segment-wise output sheet

		Urban	Rural	National
Existing Sanitation coverage - Households	Total # households living in rented multi-occupancy houses	2,215,735	691,199	2,906,934
	# households with improved sanitation	195,418	29,832	225,250
	# households with improved but shared sanitation (> 4 HHs)	487,950	40,869	528,820
	# households with unimproved sanitation	1,532,366	620,498	2,152,865
Existing Sanitation coverage - Houses	Total # rented multi-occupancy houses	577,879	197,466	775,345
	# houses with improved sanitation	57,476	8,774	66,250
	# houses with improved but shared sanitation (> 4 HHs)	69,707	6,192	75,899
	# houses with unimproved sanitation	450,696	182,500	633,195
	% of total houses that are rented multi-occupancy houses	29%	16%	24%
	Total # rented multi-occupancy houses without adequate sanitation		188,692	709,095
	% of houses without adequate sanitation that have shared toilets (> 4HHs)		3.3%	10.7%
	% of houses without adequate sanitation that have unimproved toilets		96.7%	89.3%
Impact of policy	# rented multi-occupancy houses inspected by EHOs (A)	577,879	197,466	775,345
	# toilets built (B)	158,560		
	# households living in rented multi-occupancy houses that gain access to toilets (C)	539,105		
	# individuals living in rented multi-occupancy houses who gain access to toilets (D)	1,940,778		
	# house owners penalized as a result of the policy (E)	36,591	-	36,591
	Income from penalties (USD) (F)	4,866,582	-	4,866,582

Geographic disaggregation of data

Baseline data:
Imported from the "Toilet by HH type urban" and "Toilet by HH type rural" sheets

Outputs:
Imported from the enforcement schedules and/ or calculated based on formulae in this sheet

"B" directly imported from the enforcement schedules (urban and rural)

"C" = "B" x Avg. number of households living in rented multi-occupancy houses

"D" = "C" x Mean urban household size

Sheet name as per attached penalties base model: "Rented – Multi Occupancy"

It can be seen from the example in Figure 24, that both the baseline data and the impact data are organized by houses with improved, improved but shared with more than four, and unimproved sanitation. This is specific to the context in Ghana. **When adapting the model to a new geography/ market, these categories will have to be updated in line with the choices made regarding how toilet types are defined and inputted in the model (refer to Step 1-Step 3)**.

For example, it is possible that the user only wants categories for improved and unimproved sanitation. In this case, the user can either leave the extra rows in place but blank them out (shading them dark grey), or the user can delete these extra rows. It should be noted, that if the user decides to delete the rows, similar changes would have to be made across all the sheets, including the input and calculation sheets.

Choices regarding how housing segments are defined and inputted have an even more fundamental impact as they directly affect the structure of the model and the number of output sheets required. If the user decides to have less than four housing segments, then the surplus sheets can either be left as is and hidden, or deleted. As these four sheets are linked to the enforcement schedule, the user will have to make sure to remove references to the deleted sheet that may exist in formulae in the enforcement schedule. Alternatively, **the user may not wish to differentiate between urban and rural areas (or any other geographic unit). In such cases, the segment-wise output sheets are not needed** per-se as the impact data can be seen in the aggregate table of the enforcement schedule. The user can still choose to retain these sheets in order to see the baseline sanitation coverage and inputs for a particular housing segment in one place. If however, the user decides these sheets are not required, we suggest hiding them rather than deleting them as deleting the sheets may impact formulae in the rest of the model.

Finally, if users decide not to differentiate between geographical units, they can **choose to use the surplus enforcement schedule to capture data for up to four additional housing segments. If this is the case, it is recommended that these segment-wise output sheets not be used.** This is for the following reasons:

- First, the user would need to create additional segment-wise sheets for the extra housing segments created;
- Secondly, the formulae to pull data from the enforcement schedules into the segment-wise output sheets would need to be completely overhauled; and
- Finally, the additional value of these sheets will be limited as the same data would be available in the enforcement schedules.

The user can instead use the enforcement schedules (or the "Toilet by HH type" input sheets) to calculate the baseline sanitation coverage (using the same formulae as found in the current segment-wise output sheets) and link this to the relevant cells in the user dashboard.

Step 14: Determining the enforcement costs

The other key output of the penalties model is the cost of enforcing the market rule. This is important as it allows the government to ascertain whether the impact arising from the market rule justifies the expense incurred. The cost of enforcement, as shown in Figure 25, is a sum of the cost of all the manpower engaged in enforcing the policy. As was the case in the segment-wise output sheets, there are separate columns showing the cost of enforcing the policy in urban areas ("Column C"), and in rural areas ("Column D"). The cells in these columns contain formulae that calculate the costs for each type of enforcement personnel by multiplying the number of personnel under each head, with the time they spend on enforcement, and their monthly salaries. It does this by pulling the relevant data from the "Enforcement inputs" sheet.

These costs are calculated on a monthly basis and totaled to arrive at the total monthly enforcement costs ("Row 11"). Further, the time taken to enforce the policy is also imported into this sheet from the enforcement schedules ("Row 12"). This is the calculation for the duration scheduled as explained in the previous Step 12. Therefore, the values in "Row 12" of Figure 25 will update automatically depending on how many housing segments are selected and how long it takes to enforce the policy.

Again, as with previous sheets, if the user decides not to differentiate between geographic units (urban and rural) then the user can leave the extra geographical column ("Column D") as is and blank it out. However, if the user has used one of the geographical input sheets and the related enforcement schedule to capture data on additional housing segments, then "Column D" would need to capture the costs of enforcing the policy on these additional segments. This is an important point to note, while one of the "Toilet by HH type" sheets and its corresponding enforcement schedule can be used to capture additional housing segments rather than geographical variance, the assumption that there are two distinct enforcement mechanisms will have to be maintained. Without this assumption, we will not be able to calculate the costs separately in "Column C" and "Column D" of Figure 25 and add their totals in the user dashboard.

Figure 25: Enforcement cost output sheet

	A	B	C	D
2		**Enforcement Costs**		
3		Personnel	Urban	Rural
4		Supervisor costs (zonal head)/ month	9,956	-
5		Field staff costs (EHOs)/ month	152,968	-
6		Additional cost of reallocating field staff	20%	20%
7		Total field staff costs/ month	183,561	-
8		Prosecutor costs/ month	110,619	-
9		Case officer costs/ month	132,743	-
10		Administrative costs/ month	21,239	-
11		Total cost/ month	458,119	-
12		Total number of months	16	-
13		Cost for entire enforcement period	7,329,903	-

Sheet name as per attached penalties base model: "Enforcement costs"

STAGE 4: UPDATING THE USER DASHBOARD

Step 15: Modifying the summary outputs table

The user dashboard provides only the most relevant information in a way that is easy to read and understand, and allows users to update the value of the key variables in order to see the impact this has on the outputs. In line with this, the user dashboard in the attached base mode has two tables; the blue table (Figure 26) displays the outputs of the model, while the green table (Figure 27) is the control panel where the user can adjust the values of the key variables.

As can be seen from Figure 26, the user dashboard only focuses on select outputs at an aggregate level (rows with a red border); these are:

- The number of houses that gain access to toilets
- The number of individuals that gain access to toilets
- The increase in improved sanitation coverage rates
- The duration taken to enforce the policy
- The net economic cost of the policy (i.e., the difference between the cost of the policy and the income generated through penalties paid by defaulters)

These values are imported from the enforcement schedules and update automatically if changes are made in those sheets. If, upon seeing the outputs in the dashboard, the user wants to delve into greater details of what is happening, they can go to the relevant output sheet, or the enforcement schedules.

As in previous sheets, the outputs in the user dashboard are disaggregated by urban and rural areas (see cells indicated by the yellow arrow). If users do not wish to differentiate between geographic areas, they should retain "Column C" in Figure 26 while deleting the formulae from "Column D" and "Column E", blanking them out.

Additionally, if the user has used the second enforcement schedule (i.e., the rural enforcement schedule in the base model) to enter data for more than four segments, the formulae in "Column C" will have to be modified in order to import data from the second enforcement schedule as well.

Figure 26: User dashboard: Summary outputs table

		Head	Urban	Rural	National
19	Change in sanitation coverage	# toilets built due to the policy	225,642	-	225,642
20		# individuals who gain access to toilets due to the policy	2,761,860	-	2,761,860
21		Net increase in coverage rate of improved sanitation	17.3%	0.0%	9.6%
22		Existing number of individuals with access to toilets	3,135,750	633,666	3,769,416
23		Existing coverage rate of people wit improved sanitation		4.9%	13.1%
24		New coverage rate of people with ir sanitation		4.9%	22.7%
25		Duration taken to enforce the policy (months)	16 months	-	
27	Cost to the government	# house owners penalized for not building toilets	52,071	-	52,071
28		Income from penalties (USD)	6,925,479	-	6,925,479
29		Cost of enforcement (USD)	7,329,903	-	7,329,903
30		Net economic impact of the policy (USD)	(404,424)	-	(404,424)
31		Cost per toilet	1.79	-	1.79

Outputs:
Imported from Enforcement schedules (urban and rural) and updated accordingly

Sheet name as per attached penalties base model: "Dashboard"

Step 16: Modifying the control panel

The green table seen in Figure 27 is the control panel section of the user dashboard. This is where the user can adjust the key variables that drive changes in the model's outputs. The four rows from "Row 8" to "Row 12" denote the four housing segments identified while constructing the base model. The columns are divided into three distinct blocks that represent different choices the user can make regarding: which segment(s) to apply the policy to; the constraints faced by house owners in each segment; and the expected default rate after each warning. These are described in greater detail below:

- **Block 1 – geographic coverage ("Column D" and "Column E"):** In this block (cells with the blue border), the user can decide whether to apply the policy to a particular housing segment, and whether this should be done in urban areas only, rural areas only, or in both urban and rural areas. **To apply the policy to urban houses of a particular housing segment, the user needs to set the value of the corresponding cell in "Column D" to "1**" from the drop-down menu in the cell. Conversely, to exclude urban houses of a particular housing segment, the value should be set to "0". The same applies to rural areas; the user can choose to apply the policy to rural houses of a particular segment (or not) by adjusting the values in "Column E". For example, in Figure 27, all values are set to "0", except for in cells "D10" and "D11"; this means that in this scenario, the policy only applies to urban owned multi-occupancy houses and urban rented multi-occupancy houses
- **Block 2 – constraints ("Column F" to "Column I"):** This block (cells with the yellow border) allows the user to set the values for the two most pressing constraints faced by house owners in a particular housing segment. **The values set here will determine how many house owners from a housing segment are excluded from the policy, even when it is applied to that segment.** For the base model, the two constraints chosen were affordability ("Column F" and Column G"), and lack of space ("Column H" and "Column I"). For each of these constraints, values can be set separately for each housing segment and for urban or rural areas. The way the sheet is constructed, the cells for the constraints are blanked out (shaded in dark grey) unless the policy is applied to a particular segment and geographic area at which point the corresponding cell gets activated (shaded yellow). In Figure 27, only "F10", "F11", "H10", and "H11" are highlighted in yellow while all the other constraint cells are greyed out. This is because only "D10" and "D11" were set to "1" in the preceding block. The values set here are linked to the enforcement schedules and directly impact how many house owners are excluded from the enforcement process between the forewarn and improvement notice stages of the process
- **Block 3 – default rate ("Column J" to "Column M"):** In this block, the **user can set values for the percentage of house owners who are expected to not comply with the policy**. There are two stages at which the default rate can be set: the first is after the forewarn stage to determine how many house owners would be issued an improvement notice; and the second is after the improvement notice has been issued to determine how many house owners would be penalized. There are many factors that can influence the actual compliance with the policy, making it hard to predict an actual figure with any accuracy. Therefore the model allows the user to set values based on their experience of the target geography/ market. As with Block 2, the cells in Block 3 are also greyed out, unless the policy is applied to the corresponding housing segment. Hence, in Figure 27, only "J10", "J11", "L10", and "L11" are highlighted in yellow while all the other cells are greyed out. This is because only "D8" and "D9" were set to "1". Cells in this block are once again directly linked to the enforcement schedules

In addition to the blocks described above, the control panel also allows the user to set the penalty amount (cell "D13"), the percentage of time field inspectors spend on enforcement (cell "D14") and the duration of the policy (cell "D15"). Both these parameters have a direct bearing on the net cost of the policy to the government. The first directly influences the income generated through fines in the selected geography/ market; while the second affects the time taken to enforce the policy. By varying these values, the users can get useful information regarding the amount of resource time required to implement the policy, the likely impact this would have on enforcement costs, and the optimum penalty amount. Any changes made in the three blocks, or the cost parameters, described above will result in real-time changes in the output table (Figure 26).

Adapting the control panel to suit the context of a new geography/ market should be done carefully as it has cascading effects throughout the model. As mentioned in subsection 4.2, the base model can be adapted to support three variations:

i. **In the first variant, the user maintains some form of geographic differentiation** (e.g., urban vs. rural; or hilly areas vs. plains; or coastal areas vs. interiors), but has less than four housing segments. This variant requires the least adjustment to the base model. The user can leave the control panel as is but set the values in "Column D" and "Column E" to zero for the rows that are not required. Additionally, the user can grey out these rows completely to avoid confusion. Note, it is recommended that the user not delete the extra rows as this would lead to errors in the formulae used in the enforcement schedules and the enforcement cost sheet, and therefore in the output table in the user dashboard. If the user does decide to delete the extra rows, changes will have to be made to the formulae in the enforcement schedules in the enforcement cost sheet

ii. **In the second variant, the user decides not to differentiate between geographical areas, and identifies only up to four housing segments.** This variant doesn't require much alteration to the base model either. The user needs to maintain all values in "Column E" as zero and keep the model as is. Again the user can choose to grey out the cells to avoid confusion. In this scenario, the user can also choose to delete all the columns for the second geographic area ("Column E", "Column G", "Column I", "Column K", and "Column M")

iii. **In the third variant,** the user decides not to differentiate between geographical areas, and **uses the second sanitation coverage input sheet (and related enforcement schedule) to enter data for more than four housing segments.** This variant requires the user to make significant alterations to the control panel, as well as to the output table and other sheets:

   a. **First, the user will need to add additional rows** after "Row 11", one for each additional housing segment identified;

   b. **Second, the user would need to replicate the drop-down menus**, and input cells found in "Row 8" to "Row 11". Third, the user would need to delete all the columns for the second geographic area (Columns "D", "F", "H", "J", and "L");

   c. **Finally, the user would need to go to the enforcement schedules and update the formulae in the aggregate table**, as well as all the formulae in the "Enforcement costs" sheet. In the aggregate table of the enforcement schedules, and in the enforcement cost sheet, "IF" functions have been used to determine when to import data, or apply a formula. These formulae check to see what value has been set for cells in Block 1 of the user dashboard, and import data/ apply formulae for those housing segments for which the value has been set to "1". These formulae are built considering four segments, however, if additional rows are added to the control panel in the user dashboard, then the formulae will need to be modified to account for these changes

Figure 27: User dashboard: Control panel

	A	B	C	D	E	F	G	H	I	J	K	L	M
5			Parameter	Geographic coverage		Constraints				Default rate (non-compliance with policy)			
6				To apply policy select 1 from drop-down		Select % without toilets who can afford them		Select % that can afford toilets and have space		Select % who default after 1st warning		Select % who default after 2nd warning	
7			House and occupancy type	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
8		Policy parameters	Owned self-contained houses	0	0								
9			Rented self-contained houses	0	0								
10			Owned multi-occupancy houses	1	0	50%		75%		75%		25%	
11			Rented multi-occupancy houses	1	0	75%		50%		75%		25%	
12			Enforcement cost-benefit data	Urban	Rural								
13			Input desired penalty amount (USD)	133									
14			Input % of time spent by field staff on sanitat	25%									
15			Time duration of the policy	20 months									

Sheet name as per attached penalties base model: "Dashboard"

5.0 CHECKING FOR ERRORS

The previous chapter discussed how the base model could be modified for use in different geographies/ markets. While in some instances, adapting the model may be fairly straightforward, in other cases it may require changes to the structure of the model and the formulae used. In the latter instance, there are chances that the changes made may not reflect throughout the model, or that the formulae in some sheets are not updated accurately. Even if the changes made don't actually require changes to the structure and formulae, it is possible for errors to be made in the way the data is entered in the input sheets and how these sheets are linked to each other. If either case occurs, the model would generate faulty outputs, and or there may be errors that prevent it from generating any outputs at all. Some of the common pitfalls that occur when adapting an existing model are mentioned in Box 3.

There are a series of checks the user should run in order to ensure the model is error-free. The main checks that should be carried out are described below:

i. **Hygiene checks:** These are basic quality checks that should be done sheet-wise as the user finishes updating a sheet, and again at the end once all updates have been made. The hygiene checks include:

   a. Going through each sheet and making sure none of the cells contain error messages such as "#REF!"; if such an error does exist, it means that there is an incorrectly linked formula, and/ or one of the cells the formula refers to has been renamed or deleted

   b. Ensuring hardcoded data has been entered and cleaned correctly and there are no errors such as the wrong unit being used for a number (extra zeroes, or too few zeroes), misplaced decimal points, incorrect formatting of cells (e.g., format type set to number instead of percentage when entering percentages)

   c. Ensuring that links in and links out from a sheet are connected to the correct cells. For example, ensuring that links out to the urban enforcement schedule are from the urban sanitation coverage inputs sheet and not the rural sanitation coverage sheet

   d. Ensuring that only the data that is to be displayed is being displayed in cases where conditional ("IF") functions have been used. For example, if the policy has not been applied to any rural houses, there should be no data in the rural column of the user dashboard, the rural column of the enforcement costs sheet, and the rural enforcement schedules. If there is data in these cells, it means that there is an error in the formula used. Similarly, if the policy is not applied to a particular housing segment, the columns for those segments in the enforcement schedule should be blank. This last case is something that should especially be checked for in cases where the user adds more than four segments to the model

ii. **Stress tests:** Stress tests involve deliberately introducing extreme values into the model and doing a sense check to see if the resultant outputs are valid. This involves using values that are either known to be unrealistic, or are outside a defined range set by the model and seeing if the logical relationships still hold. For example, if default rates are set at 100% after both the forewarn stage and the improvement notice stage, and there is still a net increase/ decrease in sanitation coverage, it indicates that one of the formulae governing the logical relationship has broken down. Similarly, if very high and very low values are set for the key variables but there is no discernable change in the net sanitation coverage, it implies that either a formula is not correctly implied, or the key variable selected is inappropriate. It is recommended that this test

be done for all key variables, but one at a time; i.e., at any time one of the key variables should be varied while holding the values of the others constant

iii. **Testing for overweight variables:** This is a subset of the stress test. While testing the key variables individually, the user should also see whether any of the variables has a disproportionate effect on the outputs. If this is the case, it could be due to incorrect hardcoded data, or an assumption that gives undue/ insufficient importance to one of the key variables. However, it should be noted that sometimes extreme values may result due to the context in the chosen geography/ market. For example, in the base model, applying the policy to only urban rented multi-occupancy houses and setting the affordability constraint at 75%, the space constraint at 50%, first default rate at 75%, and the second default rate at 25%, we achieve a net increase in urban sanitation coverage of 12.2% in just 16 months. On the surface, this seems a drastic increase in coverage in a very short time. However, if we analyze why this is happening we realize it is because of our assumption that up to four households in multi-occupancy houses can share one improved toilet without it being considered inadequate. Given a mean household size of 3.6 in urban areas, this means that for every toilet built, ~14 individuals gain access to a toilet. Therefore the model generates a disproportionately high impact if the policy is applied to multi-occupancy houses. However, given the specific context in Ghana, it is unreasonable to expect there to be placed for one toilet per household in a multi-occupancy house, therefore our assumption is a valid one. If this is accepted, it actually adds to the value of the model as a decision-making tool as it clearly identifies multi-occupancy houses as a high priority segment

iv. **Scenario tests:** This test flips the model on its head. Starting with a desired output, the user tests to see the combination of key variables that are required to achieve this pre-defined output. For example, if a minimum 10% increase in sanitation coverage is desired within 24 months, what combination of values for the key variables would achieve this? The user then needs to do a sense check to ascertain whether this combination of variables is realistic or not. Note, for this test to work, the user should have a general idea of what is realistically achievable in a given context

v. **Field tests:** The final test is an external test, as opposed to the earlier four tests which are all internal to the model. Field testing means validating the model (and its predicted outputs) with experts who have in-depth experience in the sanitation sector in the selected geography/ market. Reactions from these experts can help refine assumptions and correct any logical flaws there may be in the model

Box 3: Common pitfalls in adapting an existing model

Common Pitfalls

Some of the common mistakes made while updating an existing model include:

- **Incomplete adaptation:** The different sheets in the base model contain multiple linkages to each other and changes to any one will require changes in all linked sheets. For example, if the user changes the number of housing segments in the input sheets, he/ she would need to make similar changes in the calculation, output, and dashboard sheets
- **Overwriting formulae:** To enable the interlinkage of sheets, a number of cells have formulae that import data from source cells. When updating these linked cells, changes need to be made in the source cells. If data is hardcoded into a linked cell, it may lead to erroneous outputs
- **Linking wrong cells:** When working with multiple housing segments, toilet types and geographic units, it is possible that errors can be made in linking data. For example, linking the number of rural EHOs to the urban enforcement schedule
- **Deleting linked cells:** Another challenge of working with linked cells is that if the user deletes any such cell, all linked cells would be affected and it may be difficult to trace back the error
- **Working with named cells:** Some of the cells in the input and calculation sheets have been named and the formulae that link to these cells utilize the name of these cells. This may result in some challenges when updating the model. For example, if the name of any of these cells is changed, the formulae that link to these cells will break. Similarly, dragging formulae that contain names of cells would copy the exact value in the original cells rather than replicate the formulae

6.0 USING THE MODEL AS A DECISION MAKING TOOL

Once the user has finished adapting the model and checking for errors, the model can be used to generate outputs which can facilitate decision-making on sanitation policymaking. The model outputs can aid decision-making through 3 key benefits:

- Users can use the model to aid **prioritization** of different target markets and policies. They can compare the impact of applying the policy to different target markets under their purview. For example, users of the base model can compare the impact of applying the policy to different housing segments in Ghana (such as self-occupied vs. multi-occupancy). They can also compare the impact of applying the policy in their target market, to the impact of applying other policies (for which similar models may exist).
- Users can gather inputs to **plan implementation** from a financial and operational perspective, which can be used for advocacy and budgeting purposes. This model can generate estimates of the total investment required for paying salaries of the enforcement staff, as well the time and enforcement staff capacity required for implementing the policy.
- Finally, users can use the model to **strengthen the confidence of decision-makers** on the policy by identifying the critical factors that drive the outputs of this model, which may warrant further investigation. For example, both the default rates and the percentage of households who can afford toilets are critical drivers of the model. Users can choose to conduct further research on these factors to get more robust estimates. This develops greater confidence in the potential efficacy of the policy and enables buy-in from different stakeholders.

7.0 LIMITATIONS OF THE MODEL

The model described in this guide can be a powerful tool for policymakers to support their decision-making on sanitation-related market rules. However, the model has limitations since it is based on an economic modeling approach; more specifically, this model is limited by its reliance on publically available data and select expert interviews.

Economic modeling has certain inherent limitations as an analytical tool and these are reflected in this model:

- **Economic models are an abstraction of reality, and cannot include all the logical relationships** that influence the model outputs since the precise mathematical equation for such relationships may not be known. Below, we highlight the most pertinent missing logical relationship for this model:

    - **Relationship between penalty amount and default rate:** The penalty amount and the default rates of the policy should be correlated, since a higher penalty amount will typically lead to a lower default rate in most contexts. However, we could not model this relationship due to unavailability of data to explain the mathematical relationship between the two variables. Future users can define the relationship between penalty amount and default rate by entering appropriate values depending upon their experience in the field and knowledge of the local market context. For example, if users increase the penalty amount, they should decrease the default rate to an appropriate degree to reflect the correlation between the two factors.

- **Economic models hold certain systemic or macroeconomic factors constant over time** as they are hard to predict or model. However, if contextual factors do change, the data in the model may need to be updated to reflect this. Below, we highlight the most pertinent contextual factors which are assumed to be constant in the base model:

    - **Variety of toilets available:** The base model assumes that the kinds of toilets available in Ghana will not change for the duration of the policy. However, a change in the type of toilets available may impact the price of available toilets, leading to a change in affordability levels and default rates
    - **Supply of toilets:** The base model assumes that the supply of toilets in Ghana will not change in the short-run, and will be sufficient to fulfill the increase in demand for toilets. A dramatic reduction in supply of toilets may lead to house owners not being able to comply with the policy due to a lack of purchasing options
    - **Political and economic environment:** If there is an economic crisis in the country, the ability of households to afford toilets may be drastically affected (thus reducing affordability), and/ or the ability of entrepreneurs to access capital to run their businesses may be severely limited (thus reducing the supply of toilets in the market)

In all of the above cases, stakeholders need to exercise their judgment when entering values for variables to ensure they are as close to a reflection of reality. At the same time, they need to complement the outputs produced by the model with their understanding of the ground-level realities of the markets they hope to influence. Doing this ensures that the model produces more robust outputs that are useful for guiding decision-making in most 'normal' conditions.

This model is further limited due to the fact that it was built using publically available data and select interviews with experts. Economic models require a minimum base-level of data and the estimates generated are only as good as the quality of underlying data. As such, the data used to construct the model lacks granularity, which can manifest as an issue in multiple ways:

- **The quality of outputs can significantly reduce due to errors in estimating the most sensitive variables** as data for many such variables is not available publically at a sufficiently granular level. Any errors in such variables get amplified as the model outputs are highly sensitive to them. Below, we highlight the most pertinent of these variables for this model:

    - Percentage of households who can afford toilets
    - Percentage of households who can afford toilets and have space to build them
    - Percentage of households who default after first warning
    - Percentage of households who default after second warning

    Users of the model should sufficiently validate the accuracy of the above variables.

- **The quality of outputs can reduce due to exclusions.** The enforcement costs primarily consider the salaries of officials apportioned to the extent they are involved in the process. Costs such as transport or official per diems for traveling on official work may be applicable and will increase enforcement costs. However, while the rates are available, we were unable to determine their applicability for the different types of officials, nature of tasks, distance traveled, among others. We chose to exclude the cost instead of introducing a significant error.

- **The quality of outputs can reduce due to small sample size of datasets**. The model requires data on sanitation coverage. This model uses data from a sample survey of 18,000 households to identify the types of sanitation facilities. However, the sample sizes of a few sub-segments are significantly smaller (less than 30 households). Such a small sample size increases the likelihood of data errors for that particular segment, which will get reflected in the outputs of the model.

- **The model does not incorporate all the intricacies of a typical policy process** since it is based on sample market rules. The different processes of the market rule were modeled based on publically available data and select expert interviews. For example, the enforcement procedure reflects the process followed in Ghana and the same is assumed possible in any other geography. Further, these processes encapsulate the major stages of the policy and do not detail the sub-stages or intermediate minor stages, which are unavailable in the public domain and not captured in the models.

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ANNEX 2: REFERENCES

The penalties base model was constructed using secondary data on Ghana. The key references used in the base model are listed below:

Antwi-Agyei, P., Monney, I., & Dwumfour-Asare, B. (2017). *Findings from Fieldwork: Analysis of factors influencing implementation of municipal regulation requiring landlords to provide acceptable sanitation for tenants (Ghana).* Kumasi: Water & Sanitation for the Urban Poor.

Edgar, K., & Asante, F. (2015). *Compound Sanitation Enforcement: D&I Engagement Ga West & Kumasi, Ghana.* Water & Sanitaiton for the Urban Poor.

Ga West Municipal Assembly. (2014). Ga West Municipal Assembly, Amasaman: Sanitation Bye-Law. Ga West Municipal Assembly.

Ghana Statistical Service. (2014). *Ghana Living Standards Survey Round 6.* Accra: Government of Ghana.

Hymans, S. H. (2008). Forecasting and Econometric Models. *The Consise Encyclopedia of Economics*.

Mazeau, A. P., Wellington, N., Drabble, S., Asante, F., & Awantungo, D. (2014). Bringing toilets back to Kumasi's compound houses: landlord and tenant behaviours and motivators. *37th WEDC International Conference: Sustainable Water and Sanitaiton Services for All in a Fast Changing World.* Hanoi: WEDC.

Ministry of Finance, Government of Ghana. (2017). *The Budget Statement and Economic Policy of the Government of Ghana.* Accra: Ministry of Finance.

Pedi, D., & Jenkins, M. W. (2013). Enabling Environment: What Roles and Functions Are Needed in the New Sanitation Market?". *UNICEF Sanitaiton Marketing Learning Series*.

PSI. (n.d.). *PSI India: Strengthening Markets for Sanitation: Case Study.* PSI.

Schaub-Jones, D. (2009). *To let or toilet? Is that the question? The hidden challenges of selling sanitation.* London: Building Partnerships for Development in Water and Sanitation.

Shaibu, I., & Awunyo-Vitor, D. (2014, August 20). Households' Awareness and Perception of Sanitation Bye-Laws in Ghana: Evidence from Kumasi Metropolis. *Research Journal of Environmental and Earth Sciences*(6), 402-407.

Shalab. (n.d.). Introduction to Econometrics. In Shalab, *Econometrics.* IIT Kanpur.

USAID. (2018). *Scaling Market-based Sanitation: Desk review on Market-Based Rural Sanitation Development Programs.* Washington, D.C.: USAID.

Water & Sanitation for the Urban Poor. (2016). A Toilet in Every Compound: What we've learned so far from Kumasi and Accra, Ghana. USAID.

WHO/ UNICEF. (2015). *Progress on sanitation and drinking water – 2015 update and MDG assessment.* WHO Press.

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