

Developing a Sanitation Decision Support Tool

Politically and Socially Adapted for the Indian Context



Prepared by:

Katherine Delavan | Nandita Kotwal | Kammi Sheeler | Colin Wright

Johns Hopkins School of Advanced International Studies
International Development Program

Practicum 2015-2016

Client: Athena Infonomics

Advisor: Dr. Tanvi Nagpal

**ATHENA
INFONOMICS**
Data Science for Development


JOHNS HOPKINS
SCHOOL of ADVANCED
INTERNATIONAL STUDIES

This report represents the final product of a year-long practicum course undertaken by a team of four students in the International Development Program (IDEV) at the Johns Hopkins University School of Advanced International Studies (SAIS). IDEV offers this course in order to expand students' opportunities to work directly with public, private and non-governmental organizations, and to hone their skills through practice.

Athena Infonomics (<http://www.athenainfonomics.in>) is a fast growing policy research and development data analytics firm with a focus on strengthening the use of data and social science research to solve development and inclusive growth issues around the world. Athena Infonomics hosted this practicum team to assist in the creation of a decision-support tool to guide sanitation investments in the Indian context. Over the course of this collaboration, Athena Infonomics oversaw and supported the research efforts of the SAIS team, facilitated a two week field research experience in Chennai and Vellore, including 10 stakeholder meetings, and provided feedback on the development of this report.

Executive Summary

The increasing recognition of investment and capacity gaps in Indian Cities has culminated in the launch of the Swachh Bharat Mission (SBM) or the Clean India Mission in 2014, the Smart Cities Mission (SCM) and the Atal Mission for Rejuvenation and Urban Transformation (AMRUT). The SBM calls for eradication of open defecation by 2019. Each of these programmes has financing support for infrastructure creation across urban infrastructure areas in general and sanitation (sewerage and septage management) in particular.

Given that the AMRUT considers both sewerage (UGSS) and septage as potential options for cities, there is need for a clear mechanism for option assessment when cities are preparing their sanitation plans. Sanitation represents a sizeable share of the total estimated investment budget for cities and yet historical investments in UGSS systems have lacked a cogent and efficient investment approach. Thus, it is important to enhance the capacities of cities to make sanitation decisions in an informed and structured way, to ensure the proper decision given the context and maximize use of funds.

This project was conducted by a team from Johns Hopkins SAIS, in collaboration with Athena Infonomics. Its goal is to build capacity in the ULBs and provide technical support, by evaluating existing decision-making support tools and providing recommendations for the development of a new decision support tool which could help cities assess the viability of UGSS vs. Septage systems. This enhanced tool will contribute to more robust and realistic Service-Level Improvement Plans (SLIPs), which in turn will translate to improved State Annual Action Plans (SAAPs), hence enhancing the overall value for money of public expenditure on sanitation.

This report includes a review of existing Sanitation Decision Support Tools, with recommendations regarding ways in which such tools can be better adapted to the Indian context and made more comprehensive and useful for planners. We also provide a detailed analysis of the linkages and relationships among influencing variables, both technical and non-technical, as well as suggestions for developing a new Excel-based tool that systematically addresses all relevant factors in sanitation decision making, including technical, financial, political and social considerations.

Principal findings from the literature review and from stakeholder interviews in the Chennai and Vellore, India are summarized on the following pages.

Principal Observations & Recommendations

Land acquisition causes a major delays in implementation of sanitation systems

When public service providers have overlapping domains and varied interests, it can delay the process of land acquisition. Some of the most efficient sanitation projects have planned systems in collaboration with other service providers, taking opportunities to package system upgrades and keep overall costs low.

A political champion for sanitation is an essential factor for success of the project

Sanitation projects often have to overcome many institutional and social hurdles. To keep projects on track and the morale of working groups high, a strong leader is tantamount to success.

A decentralized system may serve as a viable option for certain areas not yet meriting centralized systems but which have graduated from septage

Many politicians expressed that they would push for 100% sewerage when it may not have been the most appropriate option. Because of public perceptions surrounding UGSS as the benchmark for a well-developed sanitation system, other options that are better suited may be ignored. There are variants that should be given proper consideration before choosing an all-or-nothing UGSS approach.

Awarding of smaller contracts for sanitation system construction may remove barriers to entry for qualified but smaller contractors

Implementing sanitation systems that are smaller than a city-wide UGSS system opens up opportunities to engage new private sector partners. There is limited capacity in India for the management of larger scale projects, so by compartmentalizing, one can ease the bottleneck that presents itself from the lack of available construction and management firms.

Public willingness to pay for UGSS services is key to eventual connection and covering of costs

A financing plan for long-term operations and maintenance costs is necessary to ensure the sustainability and use of any sanitation system. ULBs will need to conduct a thorough willingness-to-pay assessment in their service areas to determine appropriate requirements for user fees.

Movement towards PPPs may facilitate UGSS construction in less costly manner

Public-Private Partnerships provide opportunities for ULBs with limited resources to strategically share the upfront costs of a sanitation system with a private company, enabling more efficient development of new sanitation infrastructure and service delivery.

Any city-wide sanitation plan should include considerations for rapid population growth

At the rate at which India's cities are expanding, municipalities will be using resources far more efficiently if planning and building for future need. Sanitation systems are inherently hard to scale after being built, and risk of becoming obsolete if not incorporating future growth.



Contents

Executive Summary	0
Principal Observations & Recommendations	2
Contents	4
Introduction	5
Literature Review	6
<i>Factors for Tool Development</i>	6
<i>Architecture of Tools</i>	7
<i>Political Economy</i>	8
<i>Economic and Social Costs and Benefits</i>	10
<i>Context Adaptation</i>	12
Community Participation	13
Prioritization Frameworks	13
<i>Financing</i>	14
Considering Informal Settlements	15
Field Research	15
<i>Interviews</i>	17
<i>Variables and Decision Matrix</i>	19
Conclusion	20
Annotated Bibliography	20
Appendices	24
<i>Appendix 1: Analysis of Variables</i>	24
Technical Variables	24
Non-Technical Variables	27
Financial Variables	27
Political Economy Variables	28
<i>Appendix 2: Decision Tree Mockup</i>	30
<i>Appendix 3: Excel Tool Mock-ups</i>	31

Acknowledgements

We would like to thank our colleagues at Athena Infonomics for their support of this project and for hosting our team in Chennai and Vellore, especially Vijay Bhalaki, Deepa Karthykeyan, Praveen Ravi, Kowshik Ganesh, Adarsh Mathew and Pramila Annamalai.

A special thanks also to our Practicum Advisor, Dr. Tanvi Nagpal, without whom this experience would not have been possible.

Introduction

The purpose of this study is to assess different tools that have been developed internationally in supporting decision makers in the choice of municipal sanitation systems. This includes investigation into the types of sanitation systems generally covered, the architecture used in building the tools, the influence of local political economies, the economic and social costs and benefits and how the tools were ultimately adapted to the local context.

Sanitation is principally concerned with safeguarding health and the environment through the proper management, collection and disposal of human excreta and community liquid wastes. However, people generally value sanitation systems not for their health benefits, but for their positive benefits to privacy, convenience and sight/smell improvements. There are also macro-level improvements arising from efficient sanitation systems, including improved productivity and economic growth.

There are many different ways to model costs and benefits in making sanitation decisions, using simple Excel-based tools, financial modeling software, or purpose-built online decision making tools. Most tools only model technical variables, as data for qualitative variables such as cultural practices, household attitudes, or even political considerations is limited and difficult to accurately value.

Many political-economic factors will be either influencing or restrictive in the success of implementing the decision outcome of the tool, and should be considered in the process. It is politically important that the tool and the decisions that result from the tool be owned and strongly supported by the public authorities to emphasize commitment to sanitation decision-making, while leveraging background expertise of external actors. The most salient of these factors are existing incentives and rewards, transparency of the tool, and level of decentralization.

No single solution is widely applicable to every country and every context. In making a municipal sanitation decision, one should include community members in the discussion, as well as assess local willingness to pay. Each municipality will also have a particular set of preferences and values that will influence the weight that different variables should be given in making sanitation decisions. By revealing and modeling user preference structures, one can tailor the eventual sanitation decision to best reflect true costs and benefits in a given context. This includes considering those in informal settlements with limited voice, as sanitation has positive network externalities, and all will ultimately benefit from including every user in the decision process.

Literature Review

Existing DSS tools are designed to support a wide range of sanitation solutions, from basic containers requiring manual emptying to flush toilets connected to underground sewers. The most effective tools allow decision makers to tailor the inputs and potential outputs to local needs and preferences.

As examples, WASHCost is a tool developed by the International Water and Sanitation Centre (IRC) that guides the user through an easy to use graphical interface as they design a sanitation system for a single house, a small network, or a larger network of customers. The SANEX tool, originally created by Loetscher in 2000 and adapted by Fabrega in 2007,¹ used a Microsoft Access database and Excel outputs to produce a matrix assessing the feasibility of 14 distinct sanitation solutions, including both on-site and off-site options, based on 9 technical criteria.

Sample of Tools Reviewed

Tool Name	Author(s) and Date
WASHCost Life-Cycle Costing Tool for Sanitation	International Water and Sanitation Center (IRC)
Integrated Urban Sanitation Decision Support Tool	cSTEP
A Guide to Decisionmaking: Technology Options for Urban Sanitation in India	WSP and Govt of India Ministry of Urban Development, 2008
SANEX	Thomas Loetscher, 2002
Adapted from SANEX	Ir. David Castellano Fabrega, 2007
SafiSan	Water Services Trust Fund, Kenya

Factors for Tool Development

Sanitation is traditionally a technical decision based upon such variables as user density, capacity and coverage area. These factors can be seen as either *restrictive*, meaning that they can eliminate certain options from being viable, or *influencing*, meaning that they affect the particular design characteristics of the chosen option.²

The most critical restrictive variables to consider are the availability of water and the population density. In India, the government sets a baseline of 135 lpcd (liters of water per capita per day) as the minimum acceptable water provision for people using flush systems. If the municipality has limited access to water or is

¹ D. Fabrega, "Decision Support Tool for the Appropriate Selection of Sanitation Systems"

² The Sourcebook Project Team, *Philippines Sanitation Sourcebook and Decision Aid*, (2007)

unable to provide each person with this minimum acceptable standard, any plans for sewerage systems should be accompanied by plans to augment the water supply. This will ensure adequate individual water supply, and that the sewer system will have sufficient water to function correctly. If there are no accompanying plans to build water supply, then the municipality should consider mainly non-flush septic systems. If there is sufficient water, then one should assess the density of users in a catchment area, as sewer systems only function effectively when operating at a certain capacity based upon system design.

Influencing variables affect both the design and the methodology of system implementation based upon both technical and socioeconomic considerations. Some of the technical influencing considerations are the content of wastewater, volume of wastewater, space available, etc. The socioeconomic considerations include local attitudes and motivations, consumer knowledge of sanitation options and respective benefits, as well as willingness to pay. Most DSSs only weigh the costs and benefits of technical variables, as there is limited data available for modeling qualitative variables.

Architecture of Tools

Decision support systems are broadly designed in four phases (see Figure 1 below):³

- Analysis and interpretation of the problem
- Development of a model to quantify metrics for comparison
- Development and evaluation of alternatives for selection and design
- Validating and verifying DSS logic

For each of these phases, the tool can be based upon a variety of digital systems. Some decision support tools rely on Microsoft Excel as an inexpensive method of data capture and analysis. Safisan uses Excel spreadsheets to gather data for sanitation decisions, and emphasizes the use of basic Community Score Cards (CSC) to gain feedback about sanitation service provision. Augmented with Visual Basic macros, Excel can also be a simple solution for creating preference matrices and evaluating feasibility. Others utilize software such as Valuecharts, normally used by financial analysts for valuing stocks, to attach costs to variables in order to rapidly iterate and evaluate different system designs. There are also a host of web-based decision support software platforms that collect system and preference data and perform value analyses as a package solution. As examples, 1000minds, D-Sight, analytica, and expert choice all offer different methods of capturing technical data using an online platform. Then, by systematically presenting users with pairs of options (e.g. More system outages and more coverage area, OR less outages and less coverage), the platforms can model revealed preferences and allow users to assess different design configurations.

³ M. A. Hamouda, W. B. Anderson and P. M. Huck, *Decision support systems in water and wastewater treatment process selection and design: a review*, (2009)

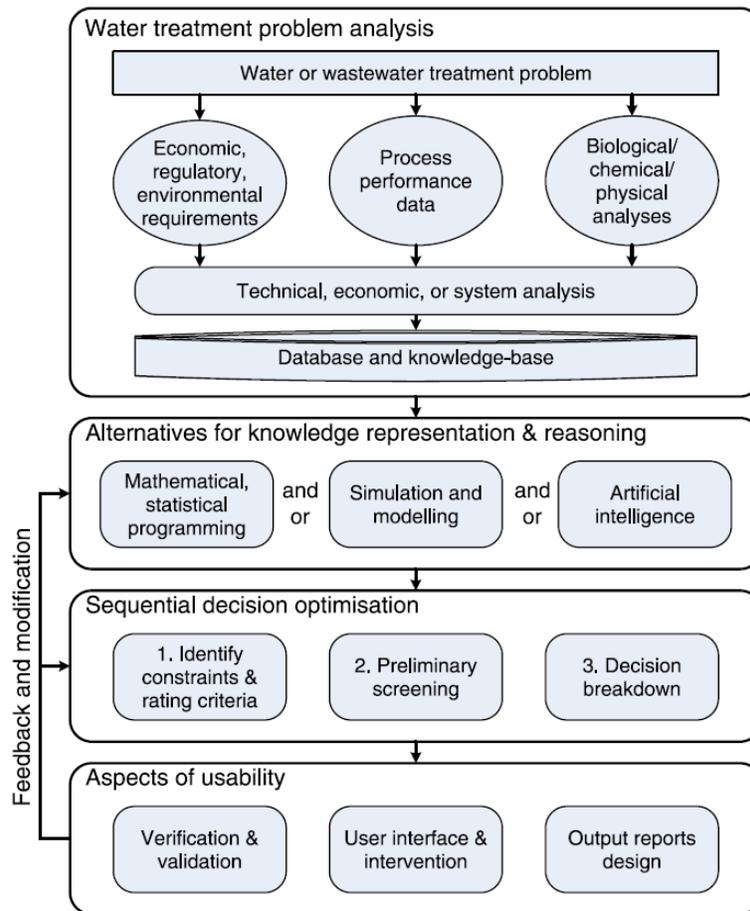


Figure 1: Stages of developing a sanitation Decision Support System

(M. A. Hamouda, W. B. Anderson and P. M. Huck, "Decision support systems in water and wastewater treatment process selection and design: a review" (2009))

Political Economy

The political economy includes the social, political, and economic processes and actors that determine and influence the extent and impact of sanitation investment and service provision. The political economy of sanitation can be best examined through supply and demand side perspectives, and influences if not restricts factors depending on the context. *On the supply side, governments' sanitation expenditures are determined largely by political, rather than technical or economic constraints, and institutional frameworks determine how efforts at increasing sanitation investment and impact should be approached. On the demand side, behavioral and cultural elements affect demand for or usage of sanitation systems.* The following explains how the tool and its implementation may be influenced by these variables, and how the political economy may be leveraged as support for sanitation investment decisions.

Important to note is the importance of maintaining government **ownership of sanitation decisions** when external actors play a strong role in the decision-making. The World Bank's Water and Sanitation Program (WSP) found that it is

most effective to ensure government ownership and the optics of control and commitment in the sanitation efforts, lest external influence (from aid agencies, donors, NGOs, private sector) be seen as interference or subversion (Garbarino & Holland, 2011). It is prudent for government decisions to not be seen as donor driven, giving a “back seat role” to external actors but utilizing their research and expertise to work towards better sanitation. The use of the sanitation decision tool puts the decision process and generated outcome decidedly in the hands of local policy makers.

The **cultural and historical influence on sanitation** can be changed with effort. On the supply side, the **use of incentives and rewards** for policymakers and government officials in promoting and investing in sanitation can create desire to improve and champion sanitation. Political returns for sanitation investment in Maharashtra have become increasingly apparent and have proven effective - officials committed to sanitation have risen to more senior positions, rewards are given to officers who advocate for and exhibit dedication and results in sanitation, and village-level leaders supporting sanitation are granted greater access to senior decision makers. This has pushed sanitation to the front of the agenda in a resource competitive environment. The impact on the decision support tool is that support for certain types of investments may either be incentivized or disincentivized. This choice must be looked at in the context of political will and incentives to understand if the choice is indeed politically viable or if it will be introduced amidst restrictive political opposition and thus likely fail to be implemented. The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) is one example of a recent sanitation program incentivizing and emphasizing sanitation activities.

On the demand side at the consumer level, the focus in Maharashtra has been giving rewards to communities through subsidies and other recognition tactics. Requirements have shifted from emphasis on household inputs and infrastructure itself (ex: construction of x number of toilets) instead to collective outcome and end results (ex: an end to village-wide or community-wide open defecation). Both of these supply and demand side emphases allow for encouragement of effective sanitation champions in government and civil society organizations. These factors will affect decision making and the tool’s suggested investment option by making clear whether at the consumer and city level the option will be well received or confront push-back. Additionally, the incorporation of concrete infrastructural goals may help encourage tangible results and coverage.

Increase accountability of policymakers towards citizens. Through the supply side, legislation and regulation reduce undesirable political economic influence. Through the demand side, mobilizing and empowering poor consumers and communities can increase access to and strengthen equitable outcomes. Widespread communication strategies can lessen suspicion and resistance towards government efforts. The government can engage private actors and NGOs in these efforts, keeping in mind the importance of government ownership. This feeds into the need for a tool which will use standardized inputs and a visual line of “thought,” which will increase transparency. The resulting investment decision will also create a goal towards which progress can be monitored. The

tool must allow the decision-maker to support the tool's investment decision in a clear, cogent manner to others - evidence must be digestible to policy-makers as well as technocrats. This will provide subjective support for the decision and dispel suspicion of ulterior motives.

Institutional complexity of the sanitation sector is a huge obstacle to sanitation investment, cohesive implementation and pro-poor policies. **Institutional change** on the supply side, such as regulatory reform, can clarify roles and lead to more effective control of sanitation decision making. In particular, well-managed **decentralization** has been key in the success of sanitation investment. Decentralization keeps politicians and bureaucrats more accountable, and a decentralized budget authority allows pressure on decision makers directly from civil society and local government to allocate a budget to sanitation. Chiefly important in devolution is well-defined and delineated responsibility, especially between local bodies. The WSP recommends a clearly designated body for sanitation to decrease complexity of sector planning, increase accountability, and institutionalize knowledge. In Maharashtra, decentralization has allowed for the creation of such government entities dedicated to sanitation, which has promoted the institutionalization of sanitation practice and knowledge in the state. The tool's main usage at the state level is appropriate for making an investment decision and then designating an appropriate authoritative body at the municipal level to implement it. The planning and implementation of the investment decision will be placed under appropriate technical bodies.

It should be noted that decentralization must be paired with awareness and strong demand among budget holders and citizens. A decentralized authority, as long as it is accountable and open to feedback as well as communicative with the successive levels of government, may allow stakeholders to debate and contest sanitation investment that affects them. During field research in Chennai, the necessity of interconnectedness between government levels became apparent - interviews found that decentralization can, in fact, have a neutralizing and isolating effect on decentralized authorities. Unless representatives retain influence and connection with subsequent levels of government or carry particular political weight, decentralization can leave ward and city representatives without enough influence or clout to procure resources from the city or state level.

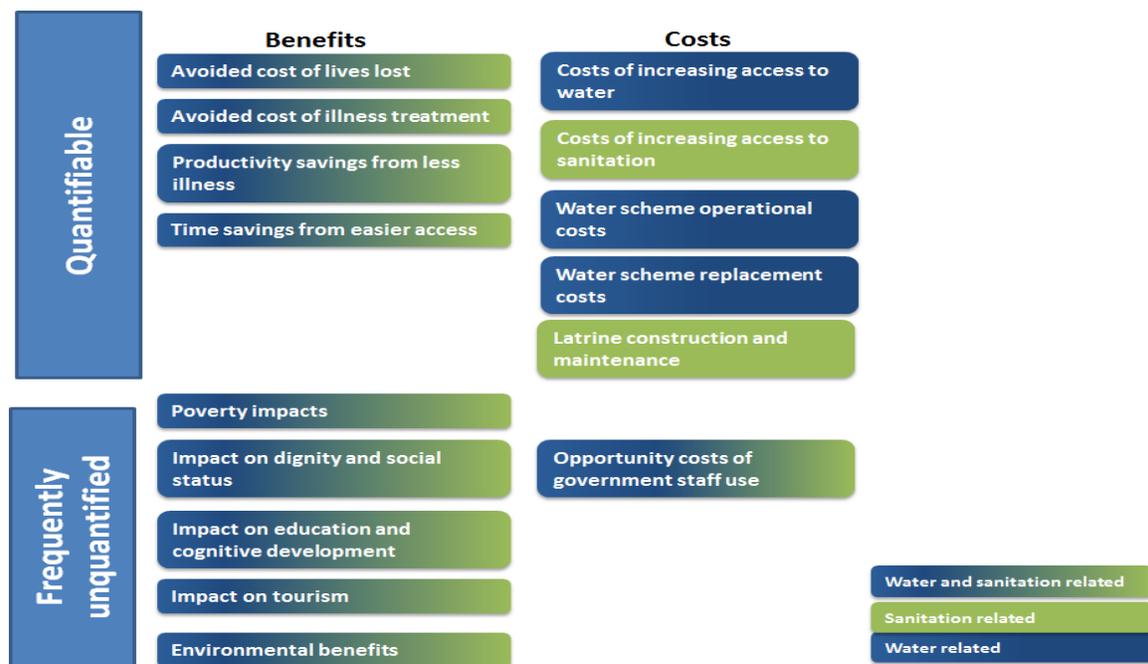
The above described political economy sectors are not traditionally considered in decision-making tools despite the fact that they are definitely influencing, if not restrictive, factors that should be considered in the decision making process. The implementation and utilization of the sanitation system investment - and therefore the success - will be influenced by these factors.

Economic and Social Costs and Benefits

The economics of sanitation is an effective approach in stimulating stakeholder participation and investment in sanitation markets. The rationale behind investing in sanitation systems for both consumers and producers is simple; not only is sanitation an integral part of the Millennium Development Goals (and the new

Sustainable Development Goals) established by the United Nations, but investment in sanitation systems has important social benefits for society.

For assessing the economic costs, it is important to look at every step in the sanitation value chain, and address specific issues at each of these levels of sanitation. Tremolet (2012) outlines some of the steps which can be taken to improve sanitation service delivery with the already existing data. These steps include- a greater investment in sanitation, fostering demand for sanitation and correctly estimating the value of various sanitation by-products. In developing countries, there is a distortion in demand and supply of sanitation services because of problems of market failure such as asymmetric information, abuse of monopoly by providers and external effects.



Source: Tremolet, 2010

A cost-benefit analysis will give us a measure to evaluate the need to invest in sanitation projects. One of the biggest challenges in assessing the need to invest in this sector is that some of these costs and benefits are more amorphous or difficult to measure, or are deemed unquantifiable. These “softer” costs and benefits are thus often excluded in calculations, hence neglecting some of the benefits and positive externalities as well as failing to catch the negative externalities and costs that affect sanitation markets. Tremolet (see figure above) points out some of these additional and usually unquantified benefits of a good sanitation system which are mostly associated with societal benefits such as good health, monetary gain through tourism, impact on education and cognitive development. Perhaps, one of the most visible impacts of being open-defecation free is that it facilitates an environment for tourism and has a positive impact on the dignity of a community. Moreover, ‘access-time impacts’ are also being considered in order to evaluate the real cost of inadequate access to sanitation. School absence time, work absence time, time taken to access shared

community toilets or open grounds as compared to using a private toilet are being considered and quantified into economic units (WSP, 2011). A study conducted by the WSP in 2011⁴ tries to quantify some of these factors in the context of India. The authors estimate that in 2006, the economic impacts of inadequate sanitation were equivalent to 6.4% of India's gross domestic product (GDP). The composition of the costs consisted of access time (20%), costs related to water (7.8%), tourism costs (0.5%) and health costs (71.7%). These costs imply that lack of investment in improved sanitation has a large negative impact on the growth of a country.

A critical challenge to investing in sanitation systems seems to be of ownership—who owns and finances sanitation infrastructure is an ambiguous question. Many consider sanitation as a 'private good', and yet there are many externalities attached to sanitation systems which make it a 'public good,' making the question of financing difficult. Underground systems in particular entail high costs for connections of households to the main trunk line, a cost that disproportionately affects the poor who often cannot make these investments. However, literature suggests that public perception is biased towards underground sanitation systems, and having on-site sanitation is only seen as a temporary solution or a lesser option. This means that local governments expect to eventually receive funds from the central/state government or donors to "graduate" to UGSS, and thus they will refrain from investing in on-site sanitation. Moreover, in many countries, the topic of sanitation is a 'taboo' subject. Due to this, it is difficult to create demand for sanitation services or to find public officials willing to champion this cause. The findings suggested that public funding in sanitation financing and hardware subsidies had increased effects on access to household sanitation. The report also suggests that public funding for "software" (sanitation marketing and outreach programs) has an important role in information dissemination and demand creation for improved sanitation as well as bringing about change in sanitation behaviour.

Understanding three critical questions - 'why invest?', 'who invests?' and 'how much to invest?' are an integral part of any decision support tool for sanitation. Quantifying economic and social costs and benefits and analyzing these questions will provide a strong economic and social argument for investing in either on-site or sewerage sanitation systems.

Context Adaptation

The Indian context presents a unique set of challenges and opportunities to the development of a sanitation decision support tool. Official reports revealed that 595 million people, nearly half of the total population of India, still practice open defecation in 2014. Although 100% UGSS coverage of India's cities is a stated political goal, most of India's households still rely on on-site sanitation solutions. On the high end, UGSS coverage in urban areas is estimated at around 60-70% of households in cities such as New Delhi and Chennai. To meet the challenge of providing improved sanitation services to India's rapidly urbanizing population of

⁴ A.Tyagi (et al), Water and Sanitation Program (WSP), "Flagship Report: Economic Impacts of Inadequate Sanitation in India", 2011

1.2 billion people, stakeholders have experimented with a range of different approaches.

The Government of India in collaboration with the World Bank's Water and Sanitation Program (WSP) produced a guide to urban sanitation decision making in India.⁵ This document focused on household decision-making and recognized that the majority of urban homes are likely to require on-site sanitation systems for the foreseeable future.

cSTEP produced one version of an optimized functional framework for a decision making tool based on the Indian context.⁶ This approach analyzes ward-level baseline data, defines the system context, and produces ward and city-level breakdowns of cost and other indicators.

Community Participation

Community engagement has also been used as a means of improving sanitation coverage and use in India. A partnership between the community, municipal corporation and local NGOs in Tiruchirappalli led to an innovative program of community-managed toilets in informal settlements.⁷ An assessment of this program's results found significant improvements in the quality of sanitation coverage in slums where CMT's operated, and overall these toilets were managed much more effectively than those under the administration of local government actors.

Initiatives to involve the community in sanitation improvement efforts are also useful in spreading awareness about the value of safe sanitary practices and increasing demand for improved facilities. This is especially valuable in India, where local cultural norms often support unhygienic sanitation practices such as open defecation.

Prioritization Frameworks

Even within the country or region, different municipalities have different sets of priorities for sanitation projects. There are no single solutions for infrastructure investment, rather, decisions should be made with a multidisciplinary approach to create robust solutions.⁸ As mentioned in the *Architecture of Tools* section, one way to effectively tailor the project to a specific municipality is to model preferences. This can either be subconsciously revealed (through making a set of binary choices) or estimated by simply hierarchically organizing or attaching weights to influencing variables based on local needs and values.

⁵ WSP and the Government of India, "A Guide to Decisionmaking: Technology Options for Urban Sanitation in India" 2008

⁶ cSTEP, "Integrated Urban Sanitation Decision Support Tool Review of Support Resources in Sanitation," 2014.

⁷ WaterAid, India, "Tiruchirappalli Shows the Way: Community-Municipal Corporation-NGO Partnership for City-wide Pro-poor Slums' Infrastructure Improvement," 2008

⁸ L. Andres, D. Biller, M. Dappe. A Methodological Framework for Prioritizing Infrastructure Investment. (2015)

Financing

Financing for sanitation infrastructure, maintenance and operations generally comes from a combination of local government funds, outside grants and user fees. In India, Urban Local Bodies (ULBs) depend on higher levels of government to fund the bulk of their local expenditures. The federal government allocates resources to state governments, which in turn provide funding to the governing bodies of municipal corporations, municipalities and town panchayats within their state. Over the last thirty years, successive administrations have prioritized investing in sanitation to improve health and cleanliness throughout India. In the 1980s, the government of India initiated the Central Rural Sanitation Program (CRSP) to build new toilet facilities throughout the country, focusing on rural areas. Although the program technically increased access to improved sanitation options, it was not successful in raising usage statistics or preventing open defecation. In many areas, the newly-built toilet structures were used for alternative purposes, such as storage. The CRSP was reimagined and expanded in 1999 under a new name: the Total Sanitation Campaign (TSC). The TSC sought to incorporate more demand-driven programming, extending financial support for new latrines to individual low-income households and incentivizing local governments to end open defecation.

The latest version of India's national sanitation strategy is the Clean India Mission (Swachh Bharat Abhiyan), launched in 2014 by Prime Minister Modi. Swachh Bharat is designed to improve overall cleanliness, encompassing sectors beyond sanitation management, but the primary goal is still to make India an open-defecation-free (ODF) country by 2019. As part of this campaign, the federal government has made funds available for grants to ULBs wanting to improve their local sanitation services. Through programs such as the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), states submit Annual Action Plans (SAAPs) to the federal government that include Service Level Improvement Plans (SLIPs) for all designated AMRUT cities in the state.

As noted previously, the GOI's primary approach to solving its sanitation problems to date has been to subsidize the construction of new toilet facilities. This has increased access to improved sanitation options, but largely failed to increase usage and change behavior. One of the main reasons for this has been the lack of planning and investment in operations and maintenance requirements for facilities. Newly constructed toilets quickly fall into disrepair and become unhygienic and unappealing to users if they are not properly maintained. Therefore, sanitation projects must include a viable plan to cover the long-term O&M costs of providing clean, functional facilities.

In Alandur, a suburb of Chennai in Tamil Nadu, the city successfully implemented a public-private partnership to provide household sewerage connections. The success of this project relied on contributions from consumers to the new system's upfront capital costs. Specifically, the city needed to secure deposits from at least 10,000 households. Prior to the project the municipal authorities conducted a willingness to pay assessment which looked at citizens' willingness and ability to contribute to these costs. They also created different pricing mechanisms for domestic, industrial and commercial sewerage connections. Other cities may be

able to replicate this approach to ensure a sustainable project through fostering buy-in from consumers and contracting services to private sector partners.

Considering Informal Settlements

Incorporating informal settlements into a city sanitation plan requires a further adaptation of costs, benefits and assumptions. In many informal settlements, public toilets are unsatisfactory as the ratio of toilets to users is too low, and the facilities are inconveniently located.⁹ The management and maintenance of the facilities is improperly handled, and users ultimately become dissatisfied with facilities or unwilling to use them due to safety concerns.

In a typical example, a housing project may have 1,000-5,000 households, with an average of 6 members in each household. Wastewater in these areas is domestic in nature, but biological material may be 25% higher than normal households because these residents often run their small businesses out of the same location. They may also keep livestock. Since wastewater is often carried through open storm drainage, sanitation is inherently married to solid waste disposal for prevention of clogging. Some would cite foul odors and clogged drainage as impetus to develop municipal sanitation, but often those who have septic systems simply place responsibility on those without such systems. Since sanitation relies on positive network externalities, any city wide sanitation plan would be incomplete if not considering how to best address the needs of those who have the least access to public sanitation service.

Field Research

During a visit to Chennai and Vellore, we spoke with leaders of municipalities and local institutions. We have outlined some of the key takeaways below:

Land acquisition is often a major hold up in implementation of sanitation systems

When public service providers have overlapping domains, it can delay the process of land acquisition. Some of the most efficient sanitation projects have planned systems in collaboration with other service providers, taking opportunities to package system upgrades and keeping overall costs low.

A political champion for sanitation is an essential factor for success of the project

Sanitation projects often have to overcome many institutional and social hurdles. To keep projects on track and the morale of working groups high, a strong leader is tantamount to success.

⁹ The Sourcebook Project Team, *Philippines Sanitation Sourcebook and Decision Aid*, (2007)

A decentralized system may serve as a viable option for certain areas not yet meriting centralized systems but which have graduated from septage

Many politicians expressed that they would push for 100% sewerage when it may not have been the most appropriate option. Because of public perceptions surrounding UGSS as the benchmark for a well-developed sanitation system, other options which are better tailored may be ignored. There are variants that should be given proper consideration before choosing an all-or-nothing UGSS approach.

Awarding of smaller contracts for sanitation system construction may remove barriers to entry for qualified but smaller contractors

Implementing sanitation systems that are smaller than a city-wide UGSS system opens up opportunities to engage new private sector partners. There is limited capacity in India for the management of larger scale projects, so by compartmentalizing, one can ease the bottleneck that presents itself from the lack of available construction and management firms.

Public willingness to pay for UGSS services is key to eventual connection and covering of costs

A financing plan for long-term operations and maintenance costs is necessary to ensure the sustainability and use of any sanitation system. ULB's will need to conduct a thorough willingness-to-pay assessment in their service areas to determine appropriate requirements for user fees.

Movement towards PPPs may facilitate UGSS construction in less costly manner

Public-Private Partnerships provide opportunities for ULB's with limited resources to strategically share the upfront costs of a sanitation system with a private company, enabling more efficient development of new sanitation infrastructure and service delivery.

Any city-wide sanitation plan should include considerations for rapid population growth

With the rate at which India's cities are expanding, municipalities will be using resources far more efficiently if planning and building for future need. Sanitation systems are inherently hard to scale after being built, and risk becoming obsolete if not incorporating future growth.

Interviews

The main objective of our field trip was to assess the situation on the ground in order to truly tailor our research and framework to the Tamil Nadu context. With the assistance of Athena Infonomics, we set up interviews with stakeholders spanning different viewpoints and positions on developing a city-wide sanitation strategy. In order to contextualize the situation in Tamil Nadu, we spoke with the various stakeholders (see table below) to understand and consider some of their concerns as well as the current decision-making process at both the planning and implementation levels of the project.

Name	Title
	Vellore Municipal Commissioner
Dr. S Vasanth Divahkar	Vellore Chief Health Officer- Vellore Municipal Corporation
T. Balasubramanium	Corporation Engineer- Vellore Municipal Corporation
Mr. Raj Cherubal	Chennai City Connect (Recently appointed Chief Resilience Officer, Chennai Corporation)
Mr. M Vaitheeswaran	Sanitation Expert- Directorate of Municipal Administration, Chennai
Satyarupa Shekhar	City Action Group
Dr. Ashwin Mahalingam	Indian Institute of Technology, Chennai
Mr. S Krishnan	Principal Secretary, Planning & Development and CEO of Tamil Nadu Infrastructure Board
Ravikumar Joseph	Water and Sanitation Specialist, WSP
Somnath Sen	Indian Institute of Health Settlements

Apart from the content of these meetings, the field trip helped us understand the work culture surrounding these decisions. Although many of the local authorities had been willing to meet with the teams, it proved to be difficult to set up actual interviews.

Land acquisition and right-of-way was a recurring theme in many of the interviews. Much of sanitation infrastructure involves being physically located in the same location as other utilities and infrastructure which are owned and operated by

separate departments and bodies within the government, making the coordination involving land rights and potential remuneration often complicated and lengthy, causing delays with contracts. Mr. Raj Cherubal of Chennai City Connect, an initiative which facilitates stakeholder collaboration in urban planning, suggested that for efficiency purposes, it was better to contract one private agency for all sanitation services in order to combat right of way issues. This would solve issues of coordinating with multiple private contractors (water, electricity, transport) for building and operating sanitation infrastructure and any maintenance work associated with it. Moreover, better inter-agency coordination between different utilities at the local, state and national level would significantly reduce the length of a sanitation project. This view was reaffirmed by the Municipal Commissioner of Vellore Corporation who mentioned that one of the biggest challenges to service delivery for her corporation were time-delays in land acquisition from local, state and national authorities. In terms of sewerage, *ownership* is a large issue and there needs to be communication on sewerage repair and building to citizens, who are often uninformed about the reason for large construction projects in their neighborhoods during utility investment. While talking to the Sanitation Expert from the Directorate of Municipal Administration we realized that the general consensus at the municipal level was that there were delays in 100% UGSS because of financing issues, though all parties firmly felt that UGSS was the ultimate goal and all zones in the city would eventually get underground sewerage. However, at the higher level of government, the authorities are more welcoming to the idea of on-site sanitation in peri-urban areas as opposed to 100% UGSS. Mr. S Krishnan, Principal Secretary, Planning & Development, Tamil Nadu and CEO of Tamil Nadu Infrastructure Development Board recognized that given the limited amount of funding, 100% UGSS was not a feasible solution.

The option of a decentralized system may be especially useful in the Indian context for the rapidly expanding peri-urban areas. These areas crop up quickly and often septage is the first step, but a centralized system may not necessarily be viable as a next step. A decentralized system therefore may be a more natural fit when population density has reached a certain point.

Our interview with the Dr. Ashwin Mahalingam of the India Institute of Technology in Chennai regarding the Alandur PPP and his role in the project proved to be very insightful, as this project for bringing UGSS to the Alandur municipality has been hailed as one of the most successful implementations of UGSS in India. Our conversations both with Mr. Mahalingam as well as the Principal Secretary of Planning & Development/CEO of the Tamil Nadu Infrastructure Board definitely placed PPPs on the radar or potential approaches to implementing the decided-upon sanitation investment, the idiosyncrasy of the Alandur PPP provided interesting insight. The PPP seems to be a perfect confluence of variables, including community leader support rallying the citizens, strong ties between the community groups and a tenured mayor who controlled their respect and was a sanitation champion, a large investment fund, and a capable and willing private partner. While most seemed to agree that the Alandur PPP would be difficult to replicate, it does provide confirmation of the individual elements that help to facilitate decision making and investment surrounding sanitation.

Variables and Decision Matrix

This section outlines the key variables that must be considered when determining the most appropriate sanitation infrastructure investments for a given context. Drawing on existing tools and literature, as well as field research conducted in Chennai, our team has prepared a framework for a decision support system that addresses some of the shortcomings of currently available frameworks. Specifically, it guides policymakers in answering the question: What is the most technically and financially appropriate model that is also supported by ecosystem enablers in a city?

In Appendix 1 we provide a list of the questions regarding technical and non-technical variables that are factored in to our proposed tool. Technical variables are divided into restrictive and influencing categories. Non-technical variables that affect the feasibility and suitability of sanitation systems in certain contexts include health factors, regulatory requirements, social norms and preferences, and economic considerations such as funding and impact on the local economy. Finally, the role of political economy in making sanitation investment decisions is discussed. We have sought to simplify the process for decision makers by providing a guiding yes/no question for each variable. The answers to each question will help determine which approach to sanitation coverage is most suitable.

As an example of how this data could be captured and processed, our team consolidated the variables into a draft Excel-based tool (see Appendix 3). The primary stakeholders driving sanitation decisions can answer a series of questions about both technical and non-technical variables. Answers to technical questions should be weighted so as to contribute points toward each of the available sanitation options. We have designed the tool to cover three options: (1) Expand underground sewerage network, (2) Establish a decentralized treatment system, (3) Keep/adopt an on-site sanitation system (septage). The tool should be built out so that the responses selected by the user adds points to the three options according to how they are affected by the specific variable. Cumulative responses will result in a coding of each option by a numerical value and a color scheme of green (option is feasible under stated conditions), yellow (option is feasible under stated conditions only if certain low-scoring variables are addressed) and red (option is not feasible under stated conditions). Some responses may rule out a particular option entirely, in which case the negative result will be clearly noted by coding the option as red.

Our tool also includes sections covering non-technical variables that may influence sanitation decisions. The user may respond to the questions regarding non-technical factors in order to get an idea of how the local political economy or user preferences might support or undermine investments in the available options. These sections provide additional guidance and encourage policymakers to consider the issue holistically, but carry less weight than the technical variables in determining which system to use. This tool is designed to be adaptable to the needs of decision makers in any context and transparent in how determinations are made about the feasibility of a given option.

Conclusion

The market for sanitation investments is not currently lacking in tools intended to advise the decision-making process. The options range from basic guides designed for rural household heads to complex frameworks targeting high-level policymakers managing heavily populated urban centers. However, two main structural deficiencies should be addressed to improve upon sanitation tools. First, few of these tools have incorporated a feedback mechanism to evaluate their use and impact. Information on how a tool was used in practice by households or policy makers, along with any observed shortcomings, barriers to use, or particularly effective components, has not been systematically sought or reported. This oversight has resulted in the creation of many similar tools whose use remain undocumented, undermining the process of refinement and improvement that would enable a tool to become more efficient over time. A new DSS tool should allow for the input of results of decisions made using the tool to determine if the outcomes are in fact desirable and should be replicated or improved upon.

Second, when designing a framework for making sanitation decisions, both technical and non-technical aspects must be considered. Our field research demonstrated that apart from engineering and topographical variables, the local political economy and external costs and benefits should be factored in to an effective sanitation DSS tool. These elements are particularly relevant in India, where local politics and bureaucracy directly influence the amount of funding, capacity and political will available to undertake new infrastructure investments. It is vital that the tool can be adapted to the local context. A top-down approach to sanitation strategies is not the best approach for creating demand and supply of sanitation services, especially in India where latrine usage remains low even when they are made readily available. Conducting willingness to pay analyses and post-implementation evaluation surveys would provide evidence for assessing needs and identifying the most appropriate system of sanitation service delivery. Through conscientious, holistic planning, Urban Local Bodies in India can better determine the best near-term options to improve sanitation services for their citizens and advance India toward its goal of ending open defecation.

Annotated Bibliography

Title	Author(s)	Year	Location	Summary
A compatibility-based procedure designed to generate potential sanitation system alternatives	Max Maurer*, Ahmed Bufardi, Elizabeth Tilley, Christian Zurbrügg, Bernhard Truffer	2012	N/A - general tool	A compatibility assessment procedure is proposed to determine the set of technically feasible or potential sanitation system alternatives. This is based on a clear definition of such an alternative containing sub-processes that include a user interface, storage, conveyance treatment and reuse/disposal. A newly developed compatibility matrix is applied to identify

				incompatibilities between the options of the sub-processes.
A decision support system for selecting sanitation systems in developing countries	Thomas Loetscher*, Jurg Keller	2002	N/A - general tool, some reference to pilot cases in Indonesia	Detailed description of a specific tool and how it was designed and implemented - case studies are brief and implementation was too recent for this particular article to provide impact assessments, but I'll look for more recent data on this tool
A Decision Support System for the Design and Evaluation of Sustainable Wastewater Solutions	Brent C. Chamberlain, Giuseppe Carenini, Gunilla Öberg, David Poole, and Hamed Taheri	2012	World	Describes a decision support tool for sanitation system based upon two computer models. The first analyzes local constraints for system design, the second aids decision making through qualitative prioritization.
A Guide to Decisionmaking: Technology Options for Urban Sanitation in India	Water and Sanitation Program & Government of India Ministry of Urban Development	2008	India	Describes the different approaches (UGGS/sewerage or septic) that are desirable due to given contextual factors, while also acknowledging the problems that may arise when this decision is implemented in a city context. Includes both recognition of the different issues facing poorer sections of the community as well as describes potential decisions in this context as well. Includes guidance on implementation, financial issues, and technical details. Pays special attention to addressing sanitation decisions in poor sections of the city in order to create an overall functional sanitation system
A Methodological Framework for Prioritizing Infrastructure Investment	Andres, Luis Alberto; Biller, Dan; Herrera Dappe, Matias;	2015	The World Bank	Examines options for making investment decisions to address sanitation infrastructure gaps in the context of limited public budgets, while using a multidisciplinary approach. Advocates the use of non-traditional variables just as strongly as more traditional variables such as physical and financial constraints in order to integrate softer and harder to measure variables that may impact the decision making process or the outcome of the investment's efficiency just as strongly as traditional constraints. Emphasizes the importance of political negotiations and influences on the outcome of the decisions.
A Review of Decision-Making Support Tools in the Water, Sanitation, and Hygiene Sector	Meena Palaniappan, Micah Lang, Peter H. Gleick	2008	N/A - general tool	Assessment of 120 existing support resources, including books, manuals, and websites. Also an evaluation of the 18 support resources that most closely resembled decision-making tools. Finds that existing support resources fail to adequately serve WASH practitioners. Most common items missing from these tools were: an effective user interface; consideration of social implications; regional specificity; information on costs and financing; hygiene approaches; project replicability; and evaluation and monitoring.
Alandur Sewerage Project- A success story of public-private partnership arrangements	Dr. Mukesh Mathur	2002	Alandur Municipality, India	This PPP project was carried out in Alandur. The most important aspect was that a part of the capital costs for the sewerage system were a contribution from the citizens. The project would only work under the stipulation of the municipality securing deposits from at least 10,000 households. Prior to the project they did a 'willingness to pay' survey which looked at citizen's commitment to contribute to O&M costs. They also had different pricing mechanisms for domestic, industrial and commercial sewerage connections.
Cities, sewers and poverty: India's politics of sanitation	Susan E. Chaplin	1999	India	This paper discusses the political circumstances which help explain why the insanitary living conditions of such a large section of India's urban population have been ignored, and contrasts these with the circumstances which explain successful sanitary reform in Britain in the second half of the 19th century.
Cost-based decision support tools for water and sanitation	Catarina Fonseca, Amélie Dubé and Jeske Verhoeven	2011		Explores some of the DSTs (decision support tools) that have been developed for low income settings ; cautions against adopting these tools that require disaggregated info/data inputs because these are often not available.

Decision support systems in water and wastewater treatment process selection and design: a review	M. A. Hamouda, W. B. Anderson and P. M. Huck	2009	N/A - Review of Tools	This paper explores a systematic approach to developing decision support systems, which includes the analysis of the treatment problem(s), knowledge acquisition and representation, and the identification and evaluation of criteria controlling the selection of optimal treatment systems. The objective of this article is to review approaches and methods used in decision support systems developed to aid in the selection, sequencing of unit processes and design of drinking water, domestic wastewater, and industrial wastewater treatment systems.
Decision Support Tool for the Appropriate Selection of Sanitation Systems	David Castellano Fabrega	2007	Tool tested in Cape Town, South Africa	Research of existing decision support tools intending to facilitate the selection of suitable sanitation systems is presented. In order to assess the appropriateness of the five decision tools identified they were confronted with six evaluative criteria (user-friendliness, transparency, flexibility, versatility, interactivity and level of detail). From this research, the authors create their own DSS tool involving: A Microsoft Access database is organized through a Visual Basic application in order to simplify and clarify the user interface as well as to protect the data entry in the system. On the other hand the database includes the features of a range of sanitation systems as well as their principal characteristics. In the model, based on an Excel screening tool, these characteristics are used as limitations for the later suitability assessment against the specific conditions of the selected settlement.
Development of a Decision Support Tool for On-site Wastewater Treatment Systems in Jamaican Communities	Andrew M. Snauffer	2007	Jamaica	Analyzed the technical inputs in onsite sanitation decision making at the national and parish levels. A lot of focus on the environmental impact of decisionmaking; groundwater vulnerability; describes a variety of weighting tools and sequences to make decisions; assessed groundwater rechargeability on various levels
Development of a multi-function software decision support tool for the promotion of the safe reuse of treated urban wastewater	Dolores Hidalgo, Rubén Irusta, Lidia Martinez, Despo Fatta, Achilleas Papadopoulos	2007	N/A- general tool	Presents a multi-criteria, multi-user software tool that guides authorities to the most efficient solutions for reusing treated wastewater for agricultural purposes.
Economic Impacts of Inadequate Sanitation in India	Water and Sanitation Program	2011	WSP India	This paper measures the impacts of improved sanitation through economic costs and benefits. The Water and Sanitation Program at the World Bank has undertaken an economics of sanitation initiative (ESI) at a multi-country level, and this paper provides evidence to decision-makers to invest in sanitation infrastructure and services.
Financing Household On-Site Sanitation for the Poor	WSP Sanitation Global Practice Team	2011	N/A	Financing hard infrastructure for sanitation for impoverished households in developing countries is costly and unviable for these cash-strapped regions. This paper argues in favor of on-site sanitation systems instead of sewerage for poor households in countries like India.
Indicators for the sustainability assessment of wastewater treatment systems	Annelies J. Balkema, Heinz A. Preisig, Ralf Otterpohl, Fred J.D. Lambert	2002	N/A	Overview of sustainability assessment methods and currently used indicators. Proposes a general assessment methodology and a complete set of sustainability indicators, yielding insight into the trade-offs made when selecting sustainable wastewater treatment systems.
Integrated Urban Sanitation Decision Support Tool Review of Support Resources in Sanitation	cSTEP	2014	India	Describes an "ideal" functional framework for a decision making tool. Has an India tool case breakdown that has ward-based results (very useful); includes different steps : 1. Ward analysis- demographics, physical characteristics, institutional/economic characteristics, social/cultural characteristics; 2. system context- define the system; 3. ward/city level indicators - breaks down costs, time taken for operations

Introductory Guide to Sanitation Marketing	WSP Toolkit- Jacqueline Devine and Craig Kullmann	2011	N/A- general tool	This is a toolkit published by the WSP on Sanitation Marketing, a process where social and commercial marketing practices are used to bring about social and behavioural change. This is a very useful report because it not only covers all aspects of sanitation marketing strategies, but also includes a very comprehensive summary of case studies. This would be a good report to review for the DSS toolkit
Monitoring Systems for Incentive Programs: Learning from Large-scale Rural sanitation Initiatives in India	Water and Sanitation Program & Total Sanitation Campaign	2010	India	This paper elaborates that a community wide achievement of sanitation outcomes is essential for public health benefits. The paper outlines the importance of incentives to local governments for sustainable collective sanitation outcomes such as awards for achieving Open Defecation Free (ODF) status.
National Urban Sanitation Policy	Government of India Ministry of Urban Development	2008	India	The policy document states the vision, goal and frameworks for a national urban sanitation policy. It defines sanitation concepts for cities and outlines the different awards available at the city level for totally sanitized cities. In addition, the policy categorizes cities into red, black, blue and green codes depending on the rating mechanism developed for sanitation levels of cities.
Philippines Sanitation Sourcebook and Decision Aid	The Sourcebook Project Team	2007	Philippines	The Sanitation Sourcebook aims to stimulate effective demand for sanitation services by presenting tools for strategic decision-making using more affordable sanitation options. Aims to create informed investment decisions by local governments to ensure more sustainable outcomes. Environment-friendly and affordable decentralized solutions.
Public Funding for Sanitation: The many faces of sanitation subsidies	Barbara Evans, Carolien van der Voorden and Andy Peal	2009	Water Supply and Sanitation Collaborative Council, WSP	The paper explores different public funding mechanisms for sanitation, the current debates surrounding subsidies and sanitation funding, types of sanitation subsidies and ways of improving the policies surrounding subsidies. This is a good resource for looking at the effectiveness of sanitation subsidies. There are also some short case studies of sanitation subsidies applied in countries in Africa and Asia which present both cases-subsidies which have worked and which have not worked.
Sanitation 21: A Planning Framework for Improving City-wide Sanitation Services	Jonathan Parkinson, Christoph Lüthi and Dirk Walther	2014	India	The document sets out key principles and process guidelines to help city stakeholders develop appropriate and affordable solutions to sanitation problems, taking into account technology issues, management arrangements, institutional challenges and demands for improvement from different stakeholders. The framework is structured around the following five stages: STAGE 1: Build institutional commitment and partnership for planning STAGE 2: Understand the existing context and define priorities STAGE 3: Develop systems for sanitation improvement STAGE 4: Develop models for service delivery STAGE 5: Prepare for implementation
Sanitation Marketing in Cambodia	Jan Willem Rosenboom, Cordell Jacks, Kov Phyrum, Michael Roberts and Tamara Baker	2011	Cambodia	The project aims at assessing the sanitation marketing pilot which aims at making sanitation affordable and making desirable latrines available through market channels on both supply and demand sides.
Sanitation Markets: Using economics to improve the delivery of services along the sanitation value chain	Sophie Tremolet	2012	N/A- general tool	The "sanitation economics" approach used in this paper uses economic principles, approaches and tools and considers each aspect in the sanitation value chain as a separate 'sanitation market'. This paper also argues that there needs to be additional investment in sanitation as it has positive economic gains.
Septage Management in India	Centre for Science and Environment	2011	India	Access to improved sanitation in urban India has risen but the management of onsite sanitation systems such as septic tanks remains a neglected component of urban sanitation and wastewater management. Septage, which is a fluid mixture of untreated and partially treated

				sewage solids, liquids and sludge of human or domestic origin, flows out of septic tanks and enters waterways or is generally disposed into nearest water body or low lying areas. This leads to serious health and environmental implications. This necessitates a well-defined regulation, guidelines, and management strategy for septage in the country. The septage management approach, discussed in this report, is an effort for assuring that septage is managed in a responsible, safe, and consistent manner across the states
Strategic Planning for Municipal Sanitation: A Guide	GHK, WEDC, WSP-SA	2000	N/A - general tool	This guide discusses municipal sanitation generally, but in its C3 Decision section it provides four support tools. These tackle i) methods for choosing sanitation system, ii) how to qualitatively order the systems by most appropriate, iii) costing the appropriate options, and iv) estimating consumer willingness to pay.
Tamil Nadu Urban Sanitation Policy (draft)	Commissionerate of Municipal Administration, Govt of Tamil Nadu, Municipal Administration and Water Supply Department	2012	India, Tamil Nadu	Presents a vision for Tamil Nadu's urban sanitation policy, outlining key policy issues and goals. Key Policy issues include: lack of awareness, social and occupational aspects of sanitation, fragmented institutional roles and responsibilities, lack of an integrated city-wide approach, limited technology choices, reaching the poor and unserved, lack of demand responsiveness.
The Political Economy of Sanitation: How can we increase investment and improve service for the poor?	Sabine Garbarino & Jeremy Holland - WSP Sanitation Global Practice Team	2011	Brazil, India, Indonesia, Senegal	The report presents a brief assessment of lessons learned from the retrospective political analysis of four case studies. It highlights how a better understanding of the risks and opportunities associated with institutions and stakeholder interests in the sanitation sector can be used to better support more pro-poor sanitation investment. In a sector whose default mode can be very technical, donor and lender involvement can facilitate practical operational guidance for political economy analysis of more pro-poor service delivery.
Tiruchirappalli Shows the Way: Community-Municipal Corporation-NGO Partnership for City-wide Pro-poor Slums' Infrastructure Improvement	WaterAid, India	2008	Tiruchirappalli, India	Study of a pro-poor sanitation upgrade in the slums of Tiruchirappalli over the course of 6 years. Finds that community managed sanitation is far more effective than municipality led, but recognizes the need for the government to play a role in the sanitation development.

Appendices

Appendix 1: Analysis of Variables

Technical Variables

1. Availability of Water Supply

IS water available (minimum of 135 lpcd)?

YES: Continue to Question 2.

NO: Are there plans to augment the city's water supply?

YES: What is the time frame for these plans?

Within 2 years: Wet systems/UGSS feasible, Continue to Question 2

2-5 years: Wet systems/UGSS planning can begin, with implementation contingent on successful completion of water augmentation

More than 5 years: Wet systems/UGSS are not feasible in the near-term, delay planning of UGSS and rely on current sanitation system/septage approach until water supply is augmented

NO: The city should take steps to plan future augmentation of local water supply if UGSS is desired in the long term.

2. Space Limitations

IS land readily available to which the city owns rights?

YES: Are available plots of land contiguous or separate?

CONTIGUOUS: May use natural treatment systems (wetlands, ponds, lagoons, leaching fields, reed beds) and large-space disposal systems (soil infiltration, irrigation, central, high-capacity STP)

SEPARATE: Decentralized system of disposal and treatment recommended. Consider smaller-capacity STPs located throughout city

NO: Can the city augment its supply available land?

YES: Take steps to acquire/repurpose land, then move forward with options of centralized vs decentralized.

NO: Construction of new STPs (either large central or smaller decentralized plants) is not feasible under current conditions. Recommend city takes measures to acquire land needed to move forward with STPs/UGSS expansion

3. Flood Risk

IS available land prone to flooding?

YES: Consider sites outside of risk area if possible, otherwise evaluate options and take measures to mitigate flood risk at selected site

NO: Continue to Question 4

4. Difficult Vehicular Access

Decentralized systems relying on trucking of sludge may be disqualified

IS designated treatment site(s) accessible by vehicle?

YES: Septage and decentralized treatment systems requiring transport of waste by vehicle may be included as part of overall sanitation system

NO: Decentralized systems relying on trucking may be excluded, or alternate treatment sites that are accessible by vehicle must be selected.

5. Irregular roads

IS Road layout regular and gridded?

YES: Centralized UGSS is feasible, continue to next question

NO: Cost of implementing centralized sewerage network will be higher and take longer. Some localized, condominium sewer networks may need to be included in more difficult areas and attached to trunk infrastructure.

6. Terrain/Topography

IS proposed site of sewerage network sloped (___grade)?

YES: Some natural slope to the terrain supports gravity-fed sewerage systems. If the area is very hilly, a pressurized sewerage system may be more cost-effective.

NO: Gravity-fed sewerage systems may be less effective. Consider options to build some slope into the trunk infrastructure to support gravity-fed systems, though this will raise costs of construction. Consider switch to pressurized sewerage system for easier implementation and lower costs.

IS bedrock depth greater than 7.5 feet (typically?)

YES: gravity system is an option, though with increasing depth of pipe installation costs increase.

NO: pressurized system possible; in warmer areas pressurized system piping can be placed at a shallower depth, especially if cold temperatures do not occur and pipes do not need to be protected from frost level

7. Poor soil permeability

Leaching systems may be excluded. (Leach pits & Pit Latrines)

IS Soil Permeable?

YES: Leach pits and pit latrines may be included as part of the system

NO: May exclude Leach Pits and Pit Latrines

8. Depth of Groundwater Table

IS The Groundwater Table Depth Less than 2 meters?

YES: Risk of Contamination is HIGH

NO: Risk of Contamination is LOW

IS The Groundwater Table Depth Less than 5 meters?

YES: Risk of Contamination is HIGH

NO: Risk of Contamination is LOW

9. Volume of wastewater (Density of Population)

IS Population Density Greater than 16,000/km² (160/hectare)?

YES: High Density

NO: Low Density

10. Content of wastewater

Would sewers take in wastewater from sources other than households (i.e. hospitals, chemical plants, slaughterhouses, etc??)

YES: Ensure pre-treatment at source for non-households

NO: Pre-treatment at source is not a requirement

11. City Population Growth Rate

Is current system UGSS (centralized or decentralized)?

YES: Years before capacity inadequate: ___ Options for expansion:

- additional segments for STP to increase capacity
- Larger trunk lines to absorb increased volume
- Consider additional decentralized cluster
- Consider servicing expanded and uncovered area with septage

NO: Current system is septage. Years before capacity inadequate: ___

Options for expansion:

- If population growth is outward, consider further septage

- *If population growth concentrated in previously covered area (higher density for existing system), consider decentralized and centralized if population growth is large*

Non-Technical Variables

1. Community Affordability

Can the community afford the cost of a conventional sewage system?

YES: Centralized, decentralized, and septage are all viable options; decision can be made following determination of other constraints

NO: Consider investment in a septage or decentralized system

2. Distance from Trunk Lines

Is the community (that needs improved sanitation) remote from existing sewer networks?

YES: Septage or decentralized system

NO: Centralized, decentralized, or septage possible pending other constraints

3. Water Reuse

Are localized water reuse opportunities available in the area?

YES: Decentralized or septage options viable

NO: Centralized option more suitable, allows for transfer and treatment of waste over longer distances

Financial Variables

1. ULB Budgeting

Has the ULB estimated the cost of building and maintaining an underground sewerage system?

YES: What is the best way to finance the UGSS?

- ULB funds
- User fees
- State grants
- Federal grants
- Public-Private Partnerships
- Multilateral/ Aid donors

NO: Maintain or expand coverage through on-site septic systems and re-visit UGSS options when the necessary financing becomes available.

2. Willingness to Pay

Has the ULB completed a willingness to pay survey/assessment?

YES: Consider the revenue from user fees to cover the cost of O&M and upfront capital investments

NO: Undertake a willingness to pay survey

3. Holistic Budgeting

Does the current funding mechanism include the cost of sanitation marketing and community awareness programs?

YES: Ensure that the current budget promotes hygiene and sanitation behaviour

NO: Include a 'software' budget for sanitation awareness in the community

Additional non-technical variables to consider:

Health Variables

1. Risk of water pollution
2. Risk of food pollution
3. Other Undesirable Effects

Regulatory Variables

1. Compliance with environmental standards and regulation
2. Compliance with engineering standards of design and construction

Social Variables

1. Informal Settlements and low-income housing
2. Social norms
3. Hygiene practices
4. Community participation
5. Education

Political Economy Variables

1. Decision Making Process

Is the decision-making process for sanitation investments seen as government-driven, as opposed to externally promoted (NGOs, private sector, IOs)?

YES: Continue to Question 2

NO: Mild Difficulty - Recommendation: increase government visibility and role in the decision, campaign for awareness about the investment decision and government support for it; speak with community leaders about the importance of the decision as well as community buy-in.

2. Supply Side Incentives

Do supply side incentives for policymakers and government officials exist?

YES: Identify a local sanitation champion and leverage for investment cause; engage this person directly and establish a connection

NO: medium difficulty - more aggressive action needed: engagement of either politicians at city and ward level and/or communication with community groups to educate on the importance of the sanitation investment decision to both the health and quality of life of the users.

3. Sanitation Incentives

Do programs or rewards exist to incentivize a community to achieve sanitation goals?

YES: Engage community and emphasize the importance of the sanitation investment in achieving these goals and citizen role in working with local governments to obtain them. Encourage citizen buy-in to work towards a shared goal.

***NO:** Mild Difficulty - meet with local community leaders to speak about the importance of the goals of the sanitation investment, regardless of whether there is an official incentive*

4. Perceptions

If the decision is to implement septic system, is an UGGS system seen by local officials and/or the public as superior to a septic system?

***YES:** High Difficulty - meet with local community leaders and collaborate. This will require significant campaigning to spread understanding about why a septic tank system is preferable and more economical than the traditionally-preferred UGSS.*

***NO:** Continue to Question 5*

5. Transparency

Is there transparency in implementation processes, such as in bidding procedures and planning mechanisms?

***YES:** Impose frequent meetings and updates, with established milestones and timelines*

***NO:** Expect delays and significantly increased costs;*

6. Communication

Is communication between community and local governing bodies frequent?

***YES:** Use channels for widespread communication strategies to lessen suspicion and potential resistance towards government efforts; teach of importance of sanitation decision; establish frequent connection between governing body representative and community groups.*

***NO:** The government can engage private actors and NGOs in these efforts, keeping in mind the importance of government ownership, to accomplish the above suggestion.*

7. Institutional Knowledge

Is there a designated sanitation system body at the decentralized level, with technical experts and institutionalized knowledge?

***YES:** Continue to Question 8*

***NO:** if possible, create an ad hoc planning board; if no local expertise available draft private sector consultants*

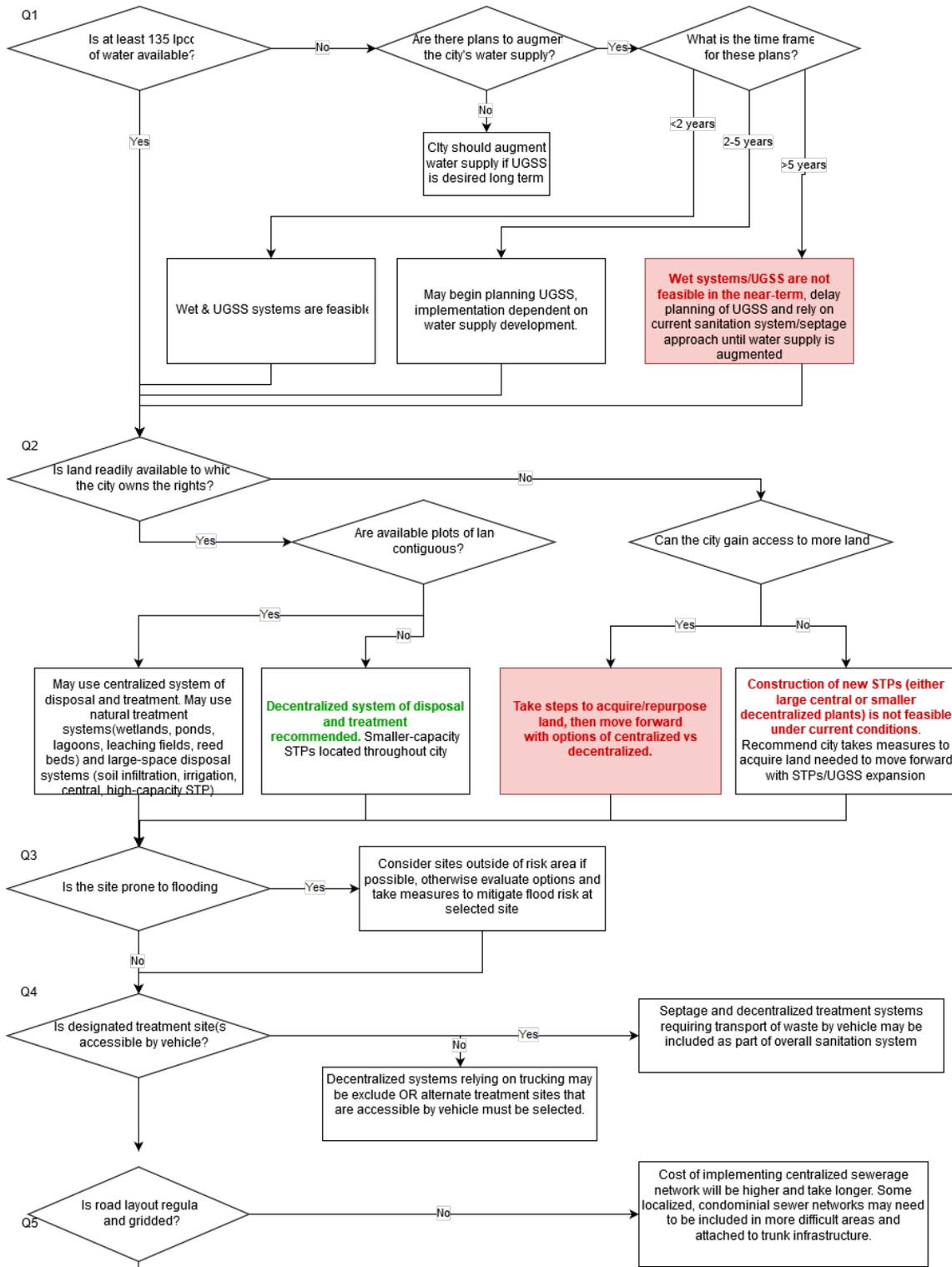
8. Established Roles

Are there clearly defined roles and powers assigned to different bodies to control the implementation process?

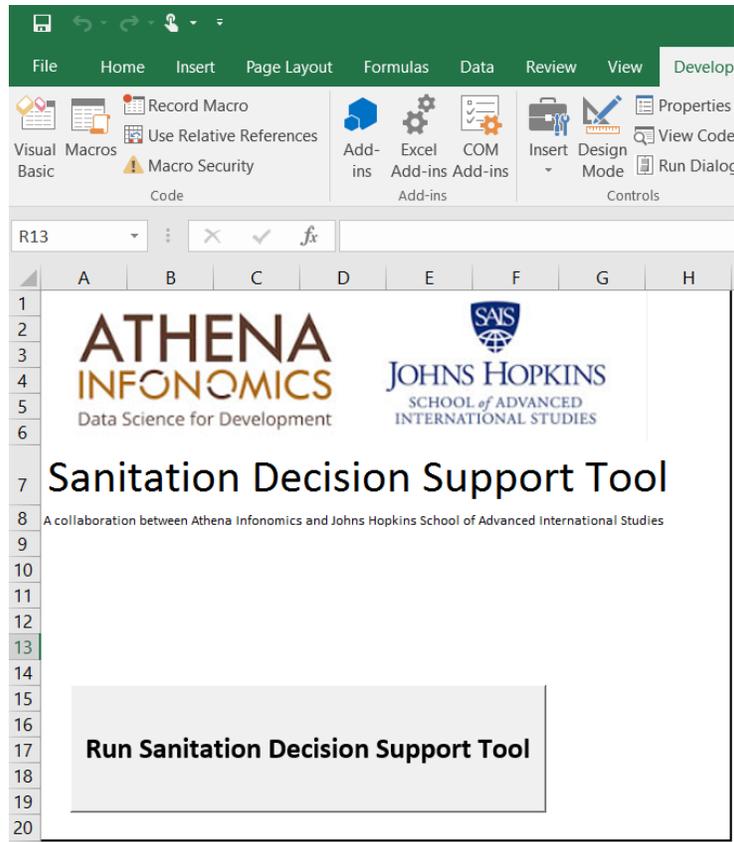
***YES:** Continue*

***NO:** Meeting with involved municipal and local bodies will need to be held. Documentation of EXPLICITLY defined roles to promote cohesion and sequencing of implementation of the sanitation decisions. Clearly delineated roles between local bodies are critical.*

Appendix 2: Decision Tree Mockup



Appendix 3: Excel Tool Mock-ups



Sanitation Decision Support Tool
✕

Technical
Financial
Political
Social

Question 1
How much water is currently available? >135 lpcd <135 lpcd

Question 2
What is the average population density? >160/ha <160/ha

Question 3
Is land readily available to which the city owns rights? Yes No

Question 4
Is the area prone to flooding? Yes No

Question 5
Is the area covered by a regular gridded road system? Yes No

Question 6
Is the soil highly permeable? Yes No

Question 7
Is water piped from a central system? Yes No

Question 8
Dependent on Question 7 Yes No

Question 9
Would sewers take in wastewater from sources other than households (i.e. hospitals, chemical plants, slaughterhouses, etc)? Yes No

Recommendations:

System Status:

Legend

Optimal Some Reservations Many Reservations

Collection	Transport	Treatment
Dry System	Central Sewer	Central WWTP
Flush System	Trucking	Natural



ATHENA
INFONOMICS
Data Science for Development



JOHNS HOPKINS
SCHOOL of ADVANCED
INTERNATIONAL STUDIES

Return to Home

Continue to System Selection

Sanitation Decision Support Tool
✕

Technical
Financial
Political
Social

Question 1
How much water is currently available? >135 lpcd <135 lpcd

Question 2
What is the average population density? >160/ha <160/ha

Question 3
Is land readily available to which the city owns rights? Yes No

Question 4
Is the area prone to flooding? Yes No

Question 5
Is the area covered by a regular gridded road system? Yes No

Question 6
Is the soil highly permeable? Yes No

Question 7
Is water piped from a central system? Yes No

Question 8
Dependent on Question 7 Yes No

Question 9
Would sewers take in wastewater from sources other than households (i.e. hospitals, chemical plants, slaughterhouses, etc)? Yes No

Recommendations:

Technical Considerations

Sewers need a critical density to function properly, consider latrines and septic systems.

Flooding doesn't preclude sewerage or septic systems, but evaluate depth of water table and consider areas less prone to flooding.

Trucking sludge may become more expensive. Sewers also tend to follow road lines, without a grid they too will be more expensive.

Financial Considerations

Evaluate the best way to finance the UGSS.

Undertake a willingness to pay survey to determine if user fees could cover operation and maintenance costs.

Political Considerations

Without the government controlling the decision, project difficulty will increase mildly.

System Status:

Legend

Optimal Some Reservations Many Reservations

Collection	Transport	Treatment
Dry System	Central Sewer	Central WWTP
Flush System	Trucking	Natural



ATHENA
INFONOMICS
Data Science for Development



JOHNS HOPKINS
SCHOOL of ADVANCED
INTERNATIONAL STUDIES

Return to Home

Continue to System Selection