WSUP
Water & Sanitation for the Urban Poor

TOPIC BRIEF

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Financial analysis for sanitation planning: lessons from Dhaka

Plans for sanitation improvements often stall at an early stage due to the challenge of costing different sanitation options, leaving low-income communities without improved sanitation. To address this need, and as part of ongoing work to build institutional capacity amongst WASH service providers in Dhaka (Bangladesh), WSUP, IWA and local partners have developed a financial tool which helps planners get a preliminary understanding of the affordability of different sanitation improvement strategies. This Topic Brief describes the development of the prototype tool, how it works, its practical application in two wards of Dhaka and the results it produced. Ways in which the tool could be improved are noted, and the Topic Brief ends with a discussion of the tool's potential wider applications.

1. The planning bottleneck

Solid, robust financial analysis is a key element in planning water supply and sanitation improvements. In order to carry out such an analysis a methodology is needed to rapidly cost and compare a range of technical options. This will provide decision-makers with evidence to mobilise investment, allocate resources and prepare long-term budgets which will in turn substantially improve the likelihood of increasing access to services over the long term.

However, conducting a financial analysis is challenging. Data is hard to find and accessible information is often of poor quality and unreliable. Frequently, the information is incomplete – perhaps not including all the elements of the proposed system or omitting, for instance, operation and/or capital maintenance costs. Rarely do managers have data to predict the cost of more than one solution, meaning that a range of costed options cannot be compared. This situation is common the world over, but it is particularly an issue in less-developed countries where the culture of record-keeping and data collection is less embedded, and where decisions are often taken on the grounds of expediency rather than forward planning. Indeed, this lack of information often manifests itself as inaction – in other words, because it is too difficult to estimate the cost of solving the problem, nothing is done. Not surprisingly, this blockage in the estimating process leads decision-makers to assume that the cost of the improvement will be prohibitively high and they too finally conclude that nothing can be done, leaving the costs unknown and the problem unsolved.

“Decision-makers seemed paralysed into inaction by the lack of resources”

In 2009 WSUP identified that this problem was one of the bottlenecks contributing to the low level of access to sanitation for many residents of Dhaka, the capital city of Bangladesh. Decision-makers there seemed paralysed into inaction by lack of resources to plan the infrastructure needed to serve the current population, let alone the ever-growing population in the future. In order to help solve this problem, WSUP worked closely with a range of stakeholders (the mandated WASH service providers, civic society representatives, academia and local engineering consultants) to design a financial analysis tool which could be used to estimate the full lifetime costs of different options for sanitation provision in two discrete areas of Dhaka. The tool developed is based on preliminary rather than detailed designs to provide an initial overview of the situation at a macro-planning level, with the specific purpose of furnishing the city's decision-makers with the financial information they need to mobilise investment for these areas. In addition, it provides them with a flexible financial analysis tool which they can use to assess the scale of investment required to serve other parts of the city as well.

This Topic Brief, which forms one of a series documenting WSUP's work, explains how the financial analysis tool was designed and how it was used to estimate the cost of achieving access for 100% of the population to sanitation services in two wards in Dhaka. The Brief also explores the lessons learned during the development of the tool, including its limitations and potential for development, as well as the substantial opportunities for replicating its use in further areas of the city and more generally in cities worldwide.

2. Sanitation in Dhaka

The huge number of people worldwide who remain without access to an improved sanitation facility – currently 2.6 billion (WHO/UNICEF (JMP) 2012) – is well documented elsewhere, along with details of the economic cost of this desperate situation. Bangladesh is often cited as one of the countries where the problem is most acute (see Box 1). A study in 2007 found that the annual economic cost of inadequate sanitation to Bangladesh is in the order of US$4.2 billion (WSP 2007), equivalent to 6.3% of Bangladesh's GDP in 2007 or – in more tangible terms – treble the national exports in that same year.

The situation in Dhaka is typical of urban sanitation provision in the rest of the country, and far from satisfactory. Best estimates suggest that only 20% of the city's 16 million residents are connected to the sewer network. The network is poorly maintained and less than half that figure is thought to be connected to the city's only wastewater treatment plant (WWTP) at Pagla; the plant functions below its potential capacity and therefore the treatment process is sub-optimal.

Clearly, this leaves the vast majority of residents unconnected to a sewer network. Instead, they either connect latrines directly to the open surface water drainage network, use some form of “on-site” sanitation solution (e.g. septic tanks or pit latrines), or they practice open defecation. Importantly, in all three cases the effluent and frequently the sludge from these activities ends up polluting surface water bodies. This unregulated disposal of human waste is a growing cause of concern for the city, as surface water sources are the only alternative to the drastically over-extracted and declining underground aquifers. With decades of environmental degradation already affecting water quality, further pollution of the Buriganga River and other water bodies around Dhaka will only increase the cost of treating and distributing water from these sources.

Box 1: Bangladesh: use of sanitation facilities in 2010 (percentage of urban population)

Improved: 57%, Shared: 26%, Other unimproved: 15%, Open defecation: 2%.

> "There is no organisation in Dhaka with responsibility for on-site sanitation"

2.1. Responsibility for WASH

The institutional framework in Dhaka for delivery of WASH-related services is complex, with responsibility split between two organisations: Dhaka Water and Sewerage Authority (DWASA) and the City Corporation of Dhaka (DCC).[1] DWASA is an autonomous public body, under the Ministry of Local Government Rural Development and Co-operatives (MLGRD&C), with the mandate to provide water supply and sewerage services to Dhaka's residents; meanwhile the DCC is responsible for solid waste disposal and health services. This leaves a gap as neither organisation considers that it has responsibility for on-site sanitation. In other words, there is no organisation in Dhaka with responsibility for on-site sanitation, i.e. for the disposal of excreta produced by people without a sewer connection – 80% of the population.

This challenge is huge, but it is clear that addressing it is in the long-term interests of the whole city. A solution needs to be found to overcome the barriers preventing the city's local service providers from providing adequate services for the majority and not just for a fortunate minority.

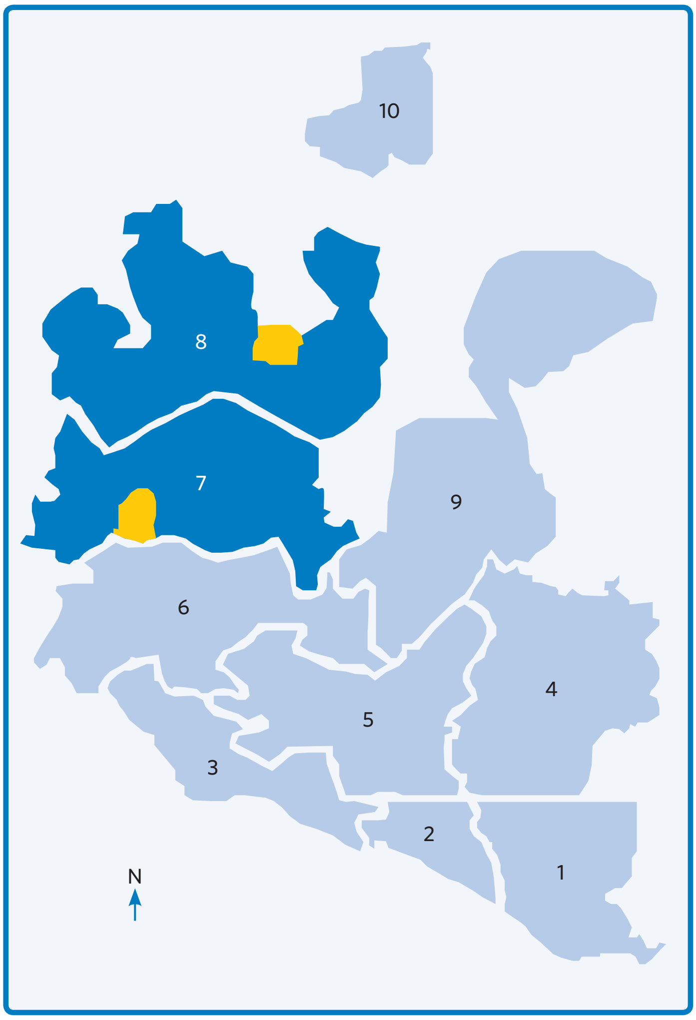
2.2. WSUP in Mirpur

WSUP has been working in Mirpur thana[2] of Dhaka since 2009. Over this period, and working in partnership with CARE, WSUP has developed a strong relationship with staff from DWASA and the DCC based in Mirpur. WSUP's involvement has focused on institutional capacity-building of these mandated service providers at senior management, zonal, and local or ward levels; at the same time, WSUP has implemented a large, school-based hand-washing campaign as well as a "demonstration project" in a low-income community.

The institutional component concentrated on three areas: facilitating enhanced coordination between DWASA and the DCC; establishing a Low-income Community Division (within DWASA) with specific responsibility for improving access to WASH facilities in the slum communities; and improving the capacity for financial planning of sanitation improvements – which is the focus of this Topic Brief.

[1] In December 2011 this was further complicated when the DCC was divided into two administrative areas – Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC).

[2] Thana is the term used in Bangladesh for a sub-district or administrative division.



The Mirpur area is located on the north-western boundary of the DCC (see map in Figure 1) and is made up of two administrative zones (Zones 7 and 8) which comprise 15 wards. In total, Mirpur covers an area of 23 km^2.

Like the rest of Dhaka, Mirpur suffers from annual flooding which damages roads, houses and other infrastructure. Dhaka sits in two floodplains (of the Ganges and Brahmaputra rivers), experiences high rainfall (>2,000 mm / year) and has a high water table. These unfavourable natural characteristics are exacerbated by the unplanned development of the city's infrastructure, particularly the poor design and management of the surface water drainage network. This lack of planning is also evident in the sanitation sector and plays an equal, or possibly greater, part in the failure of the city to provide adequate sanitation services.

Figure 1. Map of Dhaka City Corporation's zones (Mirpur Zones 7 and 8 are highlighted, with Wards 2 and 11 shown in yellow). Source: Mikhael 2012a.

"The two models leave a planning gap"

3. Sanitation planning in Dhaka

Investment in the urban sanitation sector in Bangladesh, as well as other developing countries, generally falls into one of two models: short-term and small-scale, targeting less than 10,000 low-income beneficiaries, or long-term and large-scale and focused on city-wide master planning. The latter will typically include provision of "large infrastructure" – conventional sewerage and waste water treatment plants – which tends to benefit the (perhaps) millions of already-connected middle- and high-income consumers, without reaching the often larger number of unconnected residents who live in the low-income areas.

Evidence of this is easy to find in Dhaka where there is currently an abundance of ongoing small-scale NGO-led slum development projects, whilst at the same time a World Bank-supported city-wide water and sanitation master plan is being implemented by DWASA with technical assistance from a consortium of international consultants: see Box 2.

Box 2: NGO involvement in WASH provision, versus the World Bank-supported Dhaka Sewerage Master Plan project

NGO involvement in WASH provision: Over the last twenty years the NGO sector – including but not limited to CARE, UNICEF, Plan, WaterAid Bangladesh and its partners Dushtha Shasthya Kendra (DSK) and Population Services and Training Center (PSTC) – has worked intensively to promote the improvement of water and sanitation services for Dhaka's slum-dwellers. WaterAid, DSK and PSTC pioneered the social intermediation model (SIM) which has created a workable link between DWASA and the slum communities. In the specific context of pit-emptying, UN Habitat and other NGOs have supported development and use of the vacutug, produced in Mirpur. However, the NGO sector cannot physically cover the whole city, and neither DWASA nor the DCC has established a formal arrangement that would enable these approaches to be scaled up. As a result many slums remain extremely poorly served.

World Bank-supported Dhaka Sewerage Master Plan project: In 2011 the World Bank agreed to support a technical assistance initiative to improve water supply and sanitation services in Dhaka. International consultants are leading the programme which includes the development of a detailed and comprehensive Sewerage Master Plan for the wastewater management and sanitation system of Dhaka city, with the primary goal to reduce significantly – and, in the long-term, to eliminate – the pollution arising from unhygienic disposal of wastewater, of all industrial, commercial and domestic origin, up to the planning horizon 2035 (DWASA 2011.)

Both models are well intentioned and each has significant benefits. NGOs are well placed to engage with stakeholders at the local or tertiary level ensuring that all consumers in a defined community are included, while the larger-scale projects provide primary-level infrastructure with the potential to connect many more households to the city infrastructure over a wider area. However, it is clear that the two models are at opposite ends of the planning spectrum, and leave a "planning gap" with large areas of the city remaining unplanned and, more importantly, unserved.

3.1. The ward as unit of planning

Recognising that both these approaches were failing to reach all the city's residents, WSUP concluded that a medium-scale investment – developed in the context of both practical initiatives on the ground and links with city-wide processes – would be most appropriate and help to "close the gap". WSUP's definition of such an investment is loosely defined as one that addresses a population of 100,000 to 200,000 within a clearly-defined administrative area of a city: this might be a zone, district or ward equivalent, depending on the city context. In Dhaka it was clear that the DWASA zones and their respective drainage catchment areas would be an appropriate unit of planning, but populations in these are large – in excess of one million – and the demographic data was found to be unreliable. Therefore, the smaller administrative areas known as *wards*[3] were selected. Ward populations generally range from 40,000 to 200,000 and two were identified where demographic data was complete. In addition, the WSUP intervention observed that there are distinct benefits of using a ward as the unit of planning, which can be summarised as:

- The investment required is of a magnitude that potential investors could afford to fund (millions of dollars, not the tens or hundreds of millions required for a whole city).
- The ward is a government administrative structure and therefore one within which the government can operate and engage.
- The investment required is a manageable size that stakeholders in Dhaka can control and coordinate.
- The scale is large enough for the whole sanitation value chain to be addressed with potential for economies of scale in collection and treatment.

[3] There are five zones in each of the reorganised DCC areas – DNCC and DSCC – and each zone comprises between 5 and 15 wards, the ward being the smallest government administrative structure. In total there are 92 wards, each with an elected male councillor. In addition, for every three wards, one female councillor is also elected, i.e. there are 31 women councillors.

> "The tool was designed in a collaborative manner with a range of stakeholders"

- The scale is small enough for appropriate technical options to be considered using a combination of both networked and non-networked systems.
- The planning is inclusive; it addresses the needs of all the residents in the ward area, not just the households who are already connected to the city's existing infrastructure, and not just the low-income households.
- All stakeholders within the ward can be actively involved in the planning process. This provides a defined, project-focused forum in which zone-level officials from DCC and DWASA can work together.

The following sections of the Topic Brief look more closely at how and where a ward-level model for sanitation-planning financial analysis was developed, and explores the lessons learned during the process and the potential for its further development and use.

4. Designing the tool

4.1. A collaborative approach

The tool was designed in a collaborative manner with a range of stakeholders from different fields, all with a keen interest in and knowledge of the sanitation sector in Bangladesh. The stakeholders involved are listed in Box 3 and include those from national and local government, local service providers, academia, local and international consultants, donors and NGOs. Two participatory workshops and a number of follow-up meetings were used to engage stakeholders, agree important principles, resolve problems and disseminate the findings. This process ensured that decision-makers involved in WASH service provision in Dhaka were fully informed and able to contribute to the development of the tool.

Box 3: Stakeholders actively involved in designing the financial planning tool in Dhaka

- National Government: Local Government Division (LGD) of the Ministry of Local Government and Rural Development (MLGRD)
- Local government: Dhaka City Corporation (DCC)
- Local service provider: Dhaka Water and Sewerage Authority (DWASA)
- Academia: Bangladesh University of Engineering and Technology (BUET), Mirpur Agricultural Workshop and Training School (MAWTS)
- Donors and international organisations: World Bank and its Water and Sanitation Program (WSP)
- NGOs: Dushtha Shasthya Kendra (DSK), Population Services and Training Center (PSTC)
- International Water Association (IWA)
- International consultants: (Grontmij/Carl Bro)
- WSUP/CARE as facilitators

Source: Mikhael 2012a.

4.2. Where was it developed?

DWASA and DCC collaborated with WSUP/CARE to choose two wards which could be used as "test areas" to design the prototype tool. The benefit of this approach was that the tool could then be built with real data and the output would be useful both for mobilising investment and for stakeholders carrying out more detailed analysis. Further, the output would also lay the groundwork for preparation of implementation plans.

Two wards were selected: Ward 2 and Ward 11 in Zones 8 and 7 respectively. These were considered to be representative of the conditions in many of the 92 wards, and were chosen based on their:

- Population size and socio-economic diversity with presence of slum communities
- Access to water and sanitation services and distance from the sewerage network
- Dominant housing and structure types, general road layout
- Topography and physical characteristics

The WSUP team and consultants carried out a number of field visits to the relevant wards to assess the existing conditions. Data was collected from transect walks through the wards, and informal interviews with the target population. A household survey was used to gain a more accurate understanding of the two wards and assess the socio-economic status of the wards' residents, classifying them into two areas – low-income (LIC) and non-low-income (non-LIC) communities. This enabled the project to estimate the average monthly household expenditure and, from that, make an estimate of what each cohort could realistically afford to pay for sanitation services each month.

Table 1 summarises the information obtained from the survey work and the characteristics of a typical Dhaka ward, Ward 2. A parallel set of data was collated for Ward 11. For clarity, the remainder of the Topic Brief focuses only on Ward 2 and uses this area to illustrate the nature of the intervention, but it should be noted that an identical process was also followed in Ward 11.

Table 1
Summary of characteristics of Ward 2 obtained from survey work. Source: Mikhael 2012a.

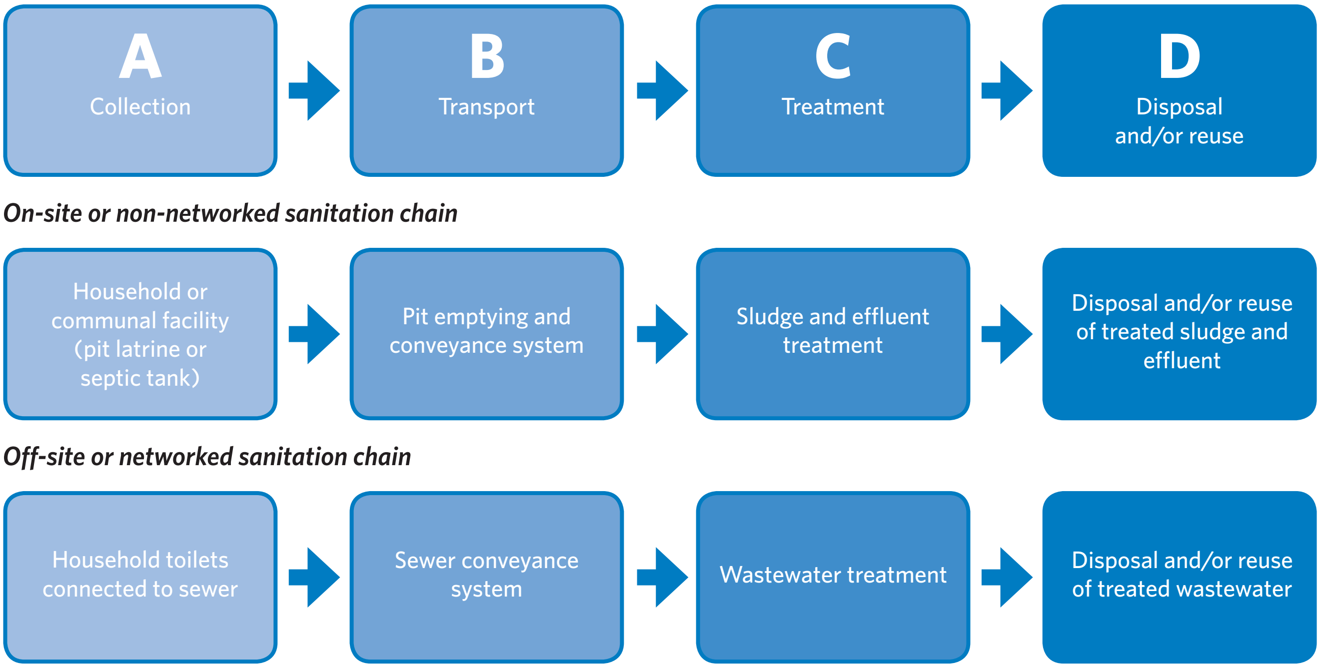
Characteristic	Finding
Population	175,000
Households	30,400
Sanitation	Sewerage network does not extend to Ward 2. 80% of households reported using latrines, with remainder using open defecation or buckets. About 65% of households who reported using latrines shared their toilets.
Water supply	DWASA's water network extends to Ward 2. Only 75% of households reported being connected to the network.
Low-income areas	Large slums in the north and eastern periphery, with some smaller slums in the interior. All slums are low-lying with significant flooding during the rainy season.
Ownership/tenancy	50% of households reported renting through a formal or informal agreement.
Mobility	25% of families reported having moved to their current address within the past 3 years.
Road infrastructure	Predominantly planned, with large paved roads on the perimeter (4 to 6 lanes), and narrow paved/unpaved roads (3 to 6 metres) in the interior.
Buildings	Majority one-storey buildings/compounds, some multi-storey construction ongoing, large slums on the periphery and some in the interior.
Topography	Variable with no general sloping direction and relatively shallow gradients.
Typology	Significant commercial institutions on the western periphery; industrial institutions and garment factories on Ceramic Road dividing the northern and southern parts of the ward; and residential area in the interior of the ward (with several small commercial enterprises).

4.3. Sanitation systems and technologies considered

The tool was designed with the flexibility to allow consideration and comparison of both off-site sanitation, often known as networked sanitation (i.e. using sewers), and on-site sanitation, often known as non-networked sanitation (e.g. using pit latrines and septic tanks). Within both of these broad definitions are the many components that make up a sanitation system, sometimes known as the sanitation value chain. Figure 2 shows the four main components of the sanitation chain (collection, transport, treatment and disposal) for both off-site and on-site sanitation[4] and the general terms used to describe the technologies that make up each component.

[4] For more information on sanitation systems and technologies, and the various options available, see Tilley et al. 2008.

Figure 2. The sanitation value chain.



The purpose of the tool is to gain a rapid assessment of the cost of achieving 100% access to sanitation in a Ward whilst a) considering the most suitable sanitation technologies and b) considering the context in which the technologies would be constructed and used. WSUP and its consultants selected a range of technologies appropriate for the context, identified how these would be linked to complete the sanitation value chain and generated five robust sanitation systems for analysis; these are shown in Figure 3.

The tool focuses on the transport[5] and treatment components. In general, it is assumed that the collection component would be provided by the user and therefore all costs would be borne by the households.[6] However, the costs of providing and operating disposal and/or reuse components were not included and this remains an area which would further strengthen the tool.

4.3.1. Transport component

It was determined that two types of sewer transport system could be used: conventional sewers and simplified sewers.[7] In addition, it was identified that simplified sewers and conventional sewers could be used in series. In this option, the neighbourhood lanes would be laid with small diameter simplified sewers discharging into larger diameter conventional collector sewers and subsequently to conventional trunk sewers for downstream transport to the treatment works.

[5] Based on a rapid assessment of the topography in both wards it was concluded that the sewer networks would operate by gravity. Consequently, no pumping would be required and this is not included in the financial analysis. More detailed analysis of local topography is required to verify this assumption.

[6] In System 1 (see Figure 3) the capital cost of the substructure of the collection component was included in the analysis since it was recognised that the collection component – a large communal septic tank – would be unaffordable for households in the target area. For a discussion on when communal public toilets are an appropriate option, see WSUP Topic Brief 1, February 2011.

Mechanical emptying of sludge from a suitable collection point was also considered an appropriate technical option, so the project considered the use of both vacutugs[8] and larger capacity vacuum tankers. It was recognised that vacutugs are well suited to the generally more congested low-income areas.

4.3.2. Treatment component

After investigation, two alternatives – semi-centralised waste stabilisation ponds (WSP) and decentralised anaerobic baffled reactors (ABR)[9] –were identified as appropriate treatment processes for the context. Other treatment options considered but rejected were settling ponds with up-flow anaerobic sludge blanket reactors (UASB) and settling ponds with trickling filters; these were considered too costly and complex for the context and so were not included in any of the systems.

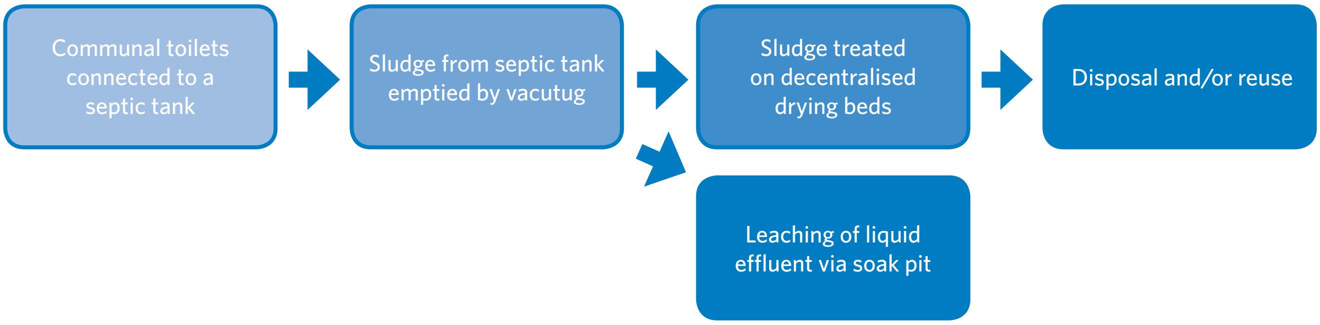
[7] For more information on the advantages and disadvantages of conventional and simplified sewers see Mara et al. 2000 and Tilley et al. 2008.

[8] For more information on vacutugs and vacuum tankers see Tilley et al. 2008 and UN-Habitat (undated).

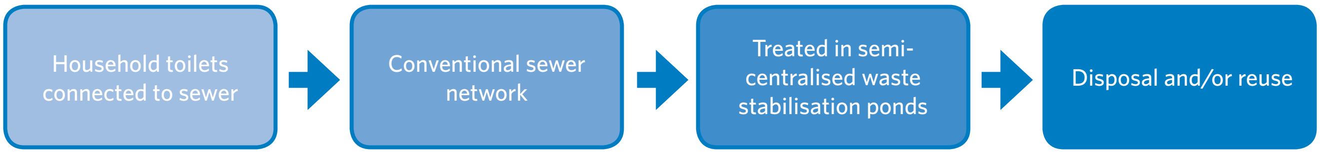
[9] For more information on waste stabilisation ponds and ABRs (which are also known as decentralised wastewater treatment systems (DEWATS)) see Tilley et al. 2008.

Figure 3. System combinations.

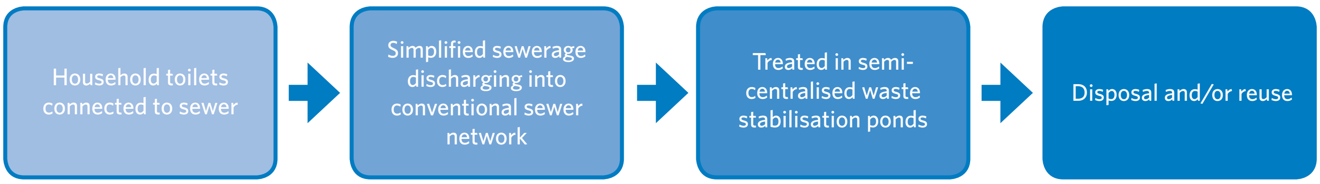
System 1: Communal toilet facility connected to a septic tank; sludge emptying and transport by vacutug with sludge treatment by drying beds for disposal/reuse; and leaching of partially treated via soak pit.



System 2: Conventional sewers followed by treatment in waste stabilisation ponds at a semi-centralised treatment plant



System 3: Simplified sewers discharging into conventional sewers followed by treatment in waste stabilisation ponds at a semi-centralised treatment plant



System 4: Simplified sewers connected to an ABR with sludge emptying by vacuum tanker, treated on drying beds for disposal/reuse; and partially treated effluent from ABRs disposed of through existing surface drainage network

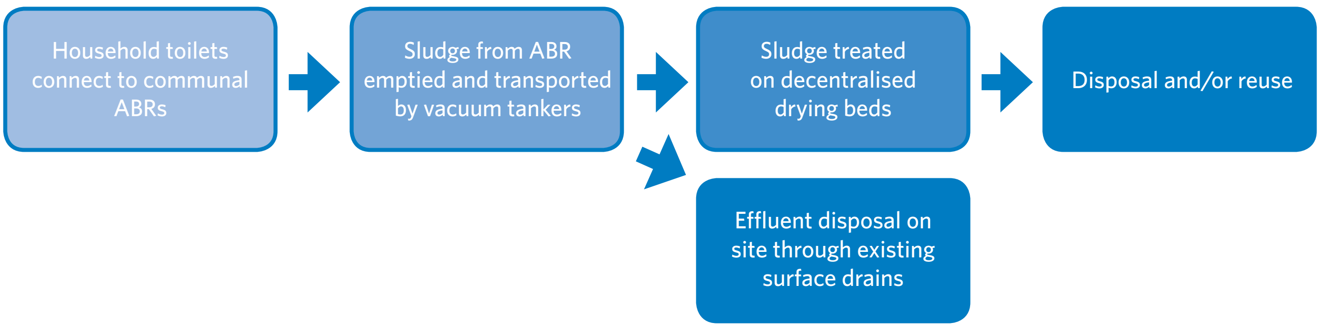
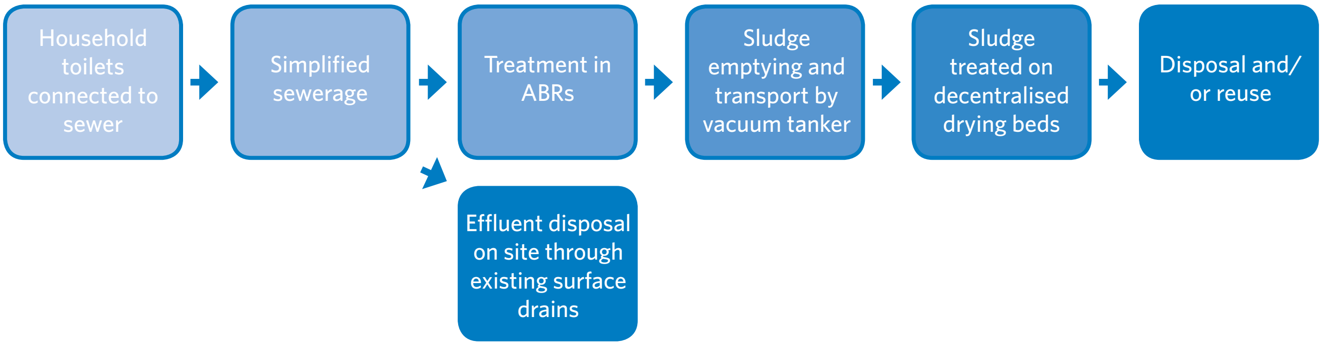


Figure 3 continued... System combinations.

System 5: Household toilets connected to an ABR; sludge treated on drying beds and treated effluent disposed of on-site



Source: *All system diagrams adapted from Mikhael 2012a.*

4.4. Unit cost calculations

Once the range of appropriate sanitation technologies within each component had been defined, a set of unit costs were developed. The quality and usefulness of such a tool is very much dependent on the data that is used to generate the outputs. A tool may comprise a comprehensive set of calculations and present the user with a handy summary of results, but if the input information is not robust then the results obtained are of little or no value. Therefore, in order to ensure that the prototype tool is based on solid evidence, WSUP engaged a local consultant to source and cross-check unit costs per household served for each of the sanitation technologies used. Where no costs were available, for instance for conventional sewerage, the consultant worked out the unit costs from preliminary designs; whilst time-consuming, this ensured that all the unit costs used were robust. In addition, an equation derived by Loetscher and Keller (1999) was used to estimate the unit cost per household for the simplified sewer technology.

Operation and maintenance unit costs for each of the technologies were also derived and included in the tool, along with an allowance for capital maintenance expenditure as a percentage of the original capital investment. This data is required so that the tool can be used to estimate the full life-cycle costs of each system and each option.

4.5. Identifying appropriate options

The household survey information, transect walks and interviews with stakeholders were used to establish which areas in each of the two wards were considered appropriate for which of the five sanitation systems. This information was then used to generate options for financial analysis.

	Low-income areas (LIC)	Non-low-income areas (non-LIC)
Percentage of population	12%	88%
Option A	System 1	System 2
Option B	System 1	System 3
Option C	System 1	System 4
Option D	System 1	System 5

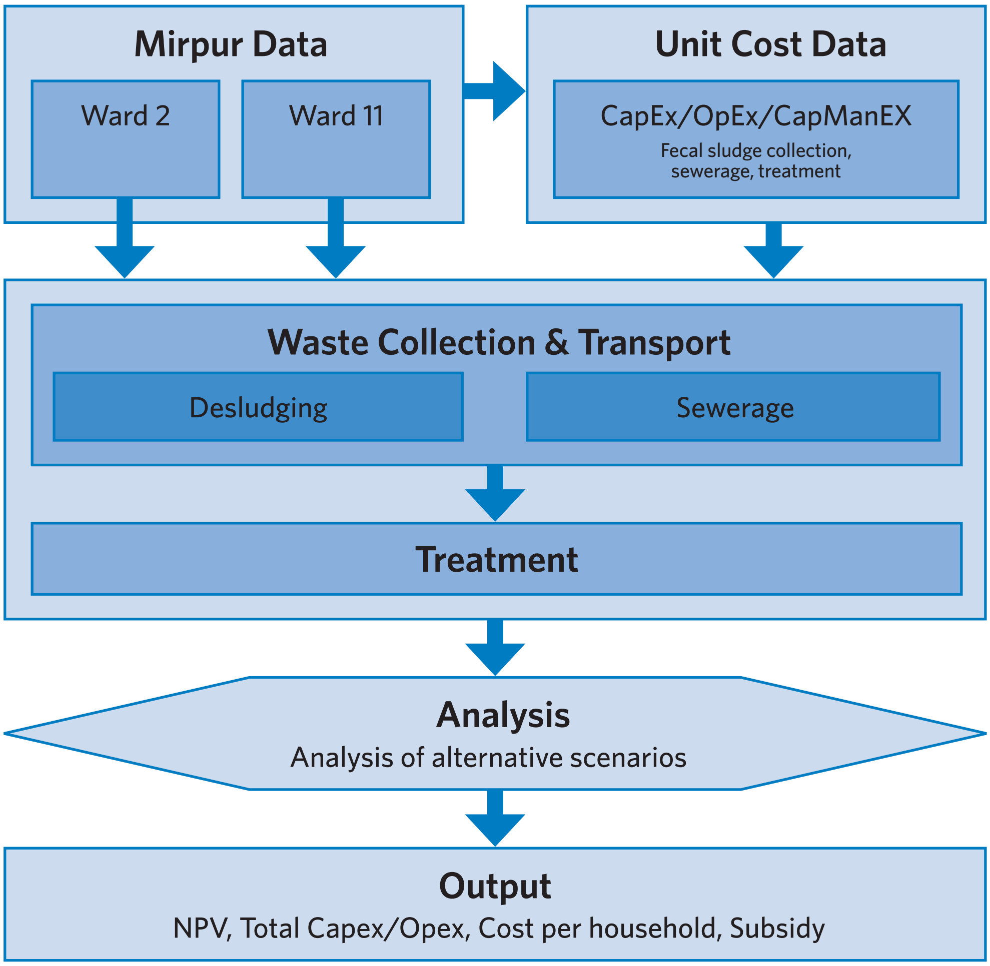
Table 2
Sanitation options analysed for Ward 2. Source: adapted from Mikhael 2012a

In both wards it was concluded that off-site systems – Systems 2, 3 and 4 – were not appropriate in some locations. These tended to be the low-income (LIC) areas, where an on-site solution (System 1) was the only feasible option because of limited accessibility and restrictions on affordability. In Ward 2 this corresponded to an area that contained 12% of the households (in Ward 11, it was estimated that 7% of the population live in the LIC areas). Meanwhile, System 5 was identified as an on-site solution for the non-low-income (non-LIC) areas and therefore an alternative to Systems 2, 3 and 4. The options considered for analysis in Ward 2 are presented in Table 2.

5. Building and using the tool

The tool was created using Microsoft Excel which has the benefit of being widely used and available without the need to download additional software. A key characteristic of the tool is flexibility; it is designed to allow the user to tailor the analysis to accurately reflect the location and context under consideration. The user inputs a range of variables – there are over 200 – from which the tool generates detailed, annual results in tabular and graphic formats. Figure 4 provides a schematic representation of the tool's structure.

Figure 4. Schematic representation of the financial analysis tool's structure.



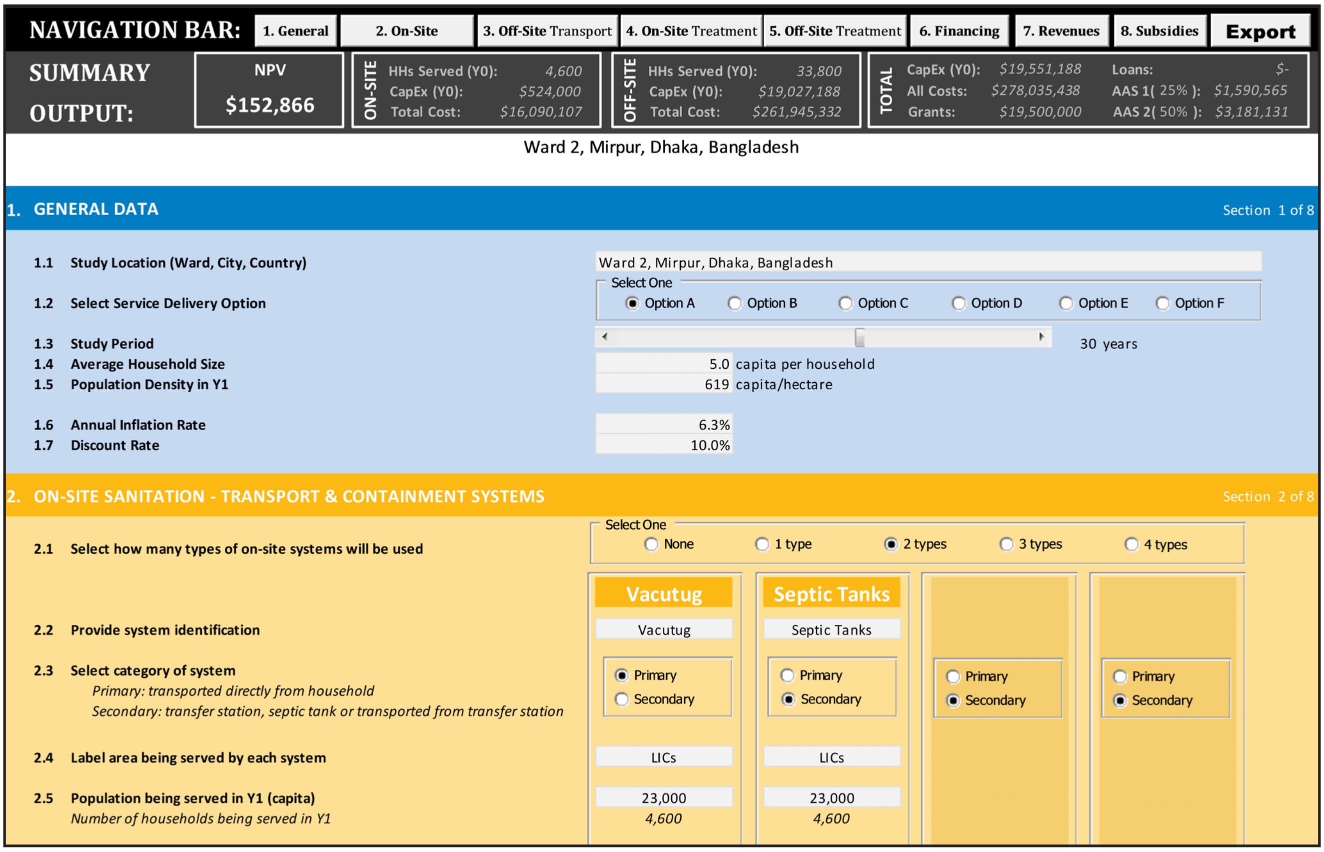
When the Excel workbook is first opened, the user is presented with instructions on how to use the tool. Six tabs are visible at the bottom of the screen. The first tab (in yellow) refers to the introduction page while the remaining five are the input, output, summary graph, summary output and tariff graph screens respectively. In the input tab, the light-coloured grey cells highlight the fields in which users are required to input variables; these are the only cells in the tool that can be altered. In addition, six "hidden" tabs (not visible to the user) contain the detailed calculations required for the tool to function.

The user-defined input variables are a combination of demographic data for the area under analysis – in this case, Ward 2 and Ward 11 – and unit costs for all sanitation technologies in each of the options analysed. Further, the user can stipulate the design period for the analysis and input the size of any subsidy for operational costs. The subsidy can be set at different percentage levels in order to analyse the effect of external financing both on the overall costs and on the level of the household tariff required for an option to be self-financing over the full project lifetime. The user can also define the size of any loans or grants made specifically for financing a percentage of (or all of) the capital costs.

If considered appropriate the user can even differentiate between the households in the LIC area and those in the non-LIC area; for instance, the tariff for LIC households can be set so that householders pay a percentage (for example 50%) of the tariff paid by non-LIC households.

A screenshot of the first page of a typical input screen for Ward 2 is shown in Figure 5.

Figure 5. Screenshot of a typical input screen; example shows Ward 2 Option A.



The tool automatically calculates the input data to present output information for comparison. The output information comprises the total cost of each option (including capital, capital maintenance and operational expenditures) over the specified design period, as well as other information required for decision-making, which includes:

- The annual capital, capital maintenance and operational expenditures;
- The average cost per household per month (i.e. size of tariff required to fully recover costs); and
- The net present value (NPV) over the study period.

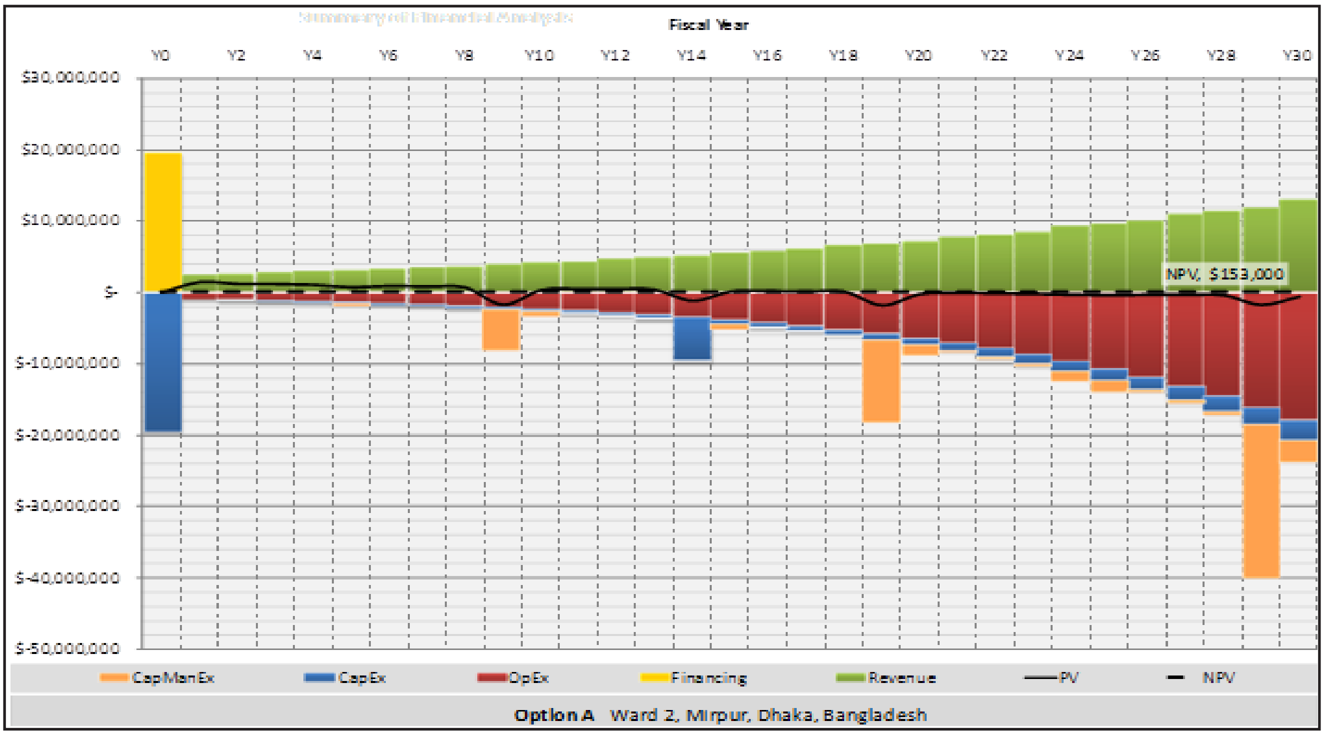
All the results can be viewed by the user in either tabular or graphical formats; a typical tabulated output screen for Ward 2 is shown in Figure 6 and the corresponding graphical output in Figure 7 (all the screenshots are from Mikhael 2012a).

Figure 6. Screenshot of a typical tabulated output screen; example shows Ward 2 Option A.

Option A

1. General											
1.1 Year	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
1.2 Number of Households	38,400	38,400	39,967	41,597	43,295	45,061	46,899	48,813	50,805	52,877	55,035
2. Capital Expenditure (CAPEX)											
ON-SITE											
2.1 Faecal Sludge Emptying and Transport	$ -384,000	$ -	$ -16,950	$ -18,017	$ -22,345	$ -20,359	$ -25,249	$ -26,839	$ -52,169	$ -30,328	$ -41,449
2.2 De-centralised Faecal Sludge Treatment	$ -140,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OFF-SITE											
2.3 Conventional Sewerage	$ -16,652,188	$ -	$ -136,349	$ -150,852	$ -166,899	$ -184,652	$ -204,293	$ -226,024	$ -250,066	$ -276,666	$ -306,095
2.4 Semi-centralised Wastewater Treatment	$ -2,375,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.5 Total CapEx	$ -19,551,188	$ -	$ -153,298	$ -168,870	$ -189,243	$ -205,011	$ -229,542	$ -252,863	$ -302,235	$ -306,993	$ -347,544
2.6 CapEx per HH	*-$509*	*$0*	*-$4*	*-$4*	*-$4*	*-$5*	*-$5*	*-$5*	*-$6*	*-$6*	*-$6*
3. Capital Maintenance Expenditure (CAPMANEX)											
ON-SITE											
3.1 Faecal Sludge Emptying and Transport		$ -	$ -	$ -	$ -	$ -8,144	$ -	$ -	$ -	$ -	$ -229,904
3.2 De-centralised Faecal Sludge Treatment		$ -	$ -	$ -	$ -	$ -38,004	$ -	$ -	$ -	$ -	$ -51,581
OFF-SITE											
3.3 Conventional Sewerage		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -5,771,659	$ -
3.4 Semi-centralised Wastewater Treatment		$ -	$ -	$ -	$ -	$ -322,352	$ -	$ -	$ -	$ -	$ -437,518
3.5 Total CapManEx		$ -	$ -	$ -	$ -	$ -368,499	$ -	$ -	$ -	$ -5,771,659	$ -719,004
3.6 CapManEx per HH		*$0*	*$0*	*$0*	*$0*	*-$8*	*$0*	*$0*	*$0*	*-$109*	*-$13*
4. Operational Expenditure (OPEX)											
ON-SITE											
4.1 Faecal Sludge Emptying and Transport		$ -22,080	$ -25,162	$ -28,673	$ -32,675	$ -37,235	$ -42,431	$ -48,353	$ -55,102	$ -62,792	$ -71,555
4.2 De-centralised Faecal Sludge Treatment		$ -9,200	$ -10,179	$ -11,261	$ -12,459	$ -13,784	$ -15,251	$ -16,873	$ -18,668	$ -20,653	$ -22,850
OFF-SITE											
4.3 Conventional Sewerage		$ -836,550	$ -925,534	$ -1,023,984	$ -1,132,905	$ -1,253,413	$ -1,386,739	$ -1,534,247	$ -1,697,445	$ -1,878,003	$ -2,077,767
4.4 Semi-centralised Wastewater Treatment		$ -59,218	$ -65,517	$ -72,486	$ -80,196	$ -88,726	$ -98,164	$ -108,606	$ -120,159	$ -132,940	$ -147,081
4.5 Total OpEx		$ -927,048	$ -1,026,391	$ -1,136,404	$ -1,258,235	$ -1,393,159	$ -1,542,585	$ -1,708,079	$ -1,891,373	$ -2,094,388	$ -2,319,253
4.6 OpEx per HH		*-$24*	*-$26*	*-$27*	*-$29*	*-$31*	*-$33*	*-$35*	*-$37*	*-$40*	*-$42*
5. Cost of Promotion											
5.1 On-Site Sanitation Services		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5.2 Off-Site Sanitation Services		$ -	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
5.3 Total Promotional Costs		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6. Revenue											
6.1 Total revenue collected *(Variable Rate)*											
LICs		$ 108,933	$ 113,378	$ 123,904	$ 128,959	$ 134,220	$ 146,681	$ 152,666	$ 158,895	$ 173,647	$ 180,731
Non-LICs		$ 2,396,529	$ 2,494,307	$ 2,725,878	$ 2,837,094	$ 2,952,848	$ 3,226,990	$ 3,358,651	$ 3,495,684	$ 3,820,224	$ 3,976,089
-		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6.2 Total Revenue		$ 2,505,462	$ 2,607,685	$ 2,849,782	$ 2,966,053	$ 3,087,068	$ 3,373,672	$ 3,511,317	$ 3,654,579	$ 3,993,870	$ 4,156,820

Figure 7. Screenshot of a typical graphical output screen; also for Ward 2 Option A.



Notes: *PV = present value, NPV = net present value*

[10] United States Dollar (US$) 1 = Bangladesh Taka (Tk) 79 (February 2013)

6. Financial analysis of Ward 2

6.1. Results obtained

The results of the financial analysis for Ward 2 (summarised in Table 3) indicate that the initial investment required to achieve 100% sanitation coverage for the population of 175,000 ranges between US$ 16 million and US$ 20 million.[10]

Option D has the lowest overall full-lifetime cost (all expenditure year 0 to year 30 = US$ 190 million) which suggests that provision of on-site sanitation services to both low-income (LIC) and non-low-income (non-LIC) areas of Ward 2 would be the lowest-cost option. The cost of Option B – providing on-site services to the LIC area and off-site sanitation services to the non-LIC area using a sequential system of simplified sewers discharging into conventional sewers – is 34% higher than Option D, and has the next lowest overall cost. Providing an on-site service in the LIC area and either simplified sewerage (Option C) or conventional sewerage (Option A) in the non-LIC area are the most expensive options, at 40% and 46% higher than Option D respectively.

Table 3
Ward 2 financial analysis: summary of results (US$ millions). Source: adapted from Mikhael 2012a.

Options and systems proposed			Total initial capital expenditure (year 0)	All expenditure (year 0 to 30)	Total capital expenditure (year 0 – 30)	Total capital maintenance expenditure (year 0 – 30)	Total operational expenditure (year 0 – 30)
Option	Low income (LIC) area (12% of population) (see note)	Non-LIC area (88% of population) (see note)					
A	System 1	System 2	20	278	51	51	176
B	System 1	System 3	16	255	34	41	180
C	System 1	System 4	20	266	88	56	111
D	System 1	System 5	18	190	87	44	58

Notes: *Summary of systems 1 to 5.*

System 1: on-site: communal toilets connected to a septic tank with sludge treatment on decentralised drying beds.

System 2: off-site: conventional sewers with wastewater treatment in semi-centralised waste stabilisation ponds (WSP).

System 3: off-site: sequential simplified sewers and conventional sewers with wastewater treatment in semi-centralised WSP.

System 4: off-site: simplified sewers with treatment using decentralised anaerobic baffled reactors (ABR) and decentralised drying beds

System 5: on-site: toilets connected to an ABR with sludge treatment on decentralised drying beds.

For full description of systems see Figure 3.

It is understood that an off-site solution for the non-LIC area may be considered preferable by some stakeholders in Dhaka, and interestingly Option B would require the lowest initial total capital investment (US$ 16 million), the lowest total capital investment over the 30 years (US$ 34 million) and the lowest capital maintenance investment over the 30 years (US$ 41 million). In contrast, it would require the highest expenditure on operation and maintenance (US$ 180 million); considerably higher than Option D which would require an investment for operation and maintenance of only US$ 58 million.

6.2. Affordability in Mirpur

The tariff analysis compares the size of the household tariff required for recovery of the full costs (capital, capital maintenance and operation) over the 30-year design period with an estimation of how much households in Mirpur would be able to afford to spend on sanitation. Cleaver and Lomas (1996) calculate that, in general, households can afford to spend 5% of their income on water and sanitation; for the purpose of this analysis WSUP assumed that households spend 3% of their monthly income on sanitation. In Mirpur, this corresponds to up to US$ 1.80 in the LIC areas and up to US$ 6.00 in the non-LIC areas. By comparison, the estimated current average DWASA sewerage tariff is US$ 2.79 per month.

The results of the tariff analysis revealed that, as illustrated in Table 4, in all four options the size of the Year-1 tariff required to fully recover the lifetime costs would be greater than the 3% affordability threshold for both the LIC and non-LIC households. However, if a 100% grant for the initial capital costs was made available it would make Options B, C and D affordable for both groups (Option A remains unaffordable for the LIC households). Affordable tariffs are shown in bold.

Table 4
Ward 2 financial analysis: comparison of household (hh) tariffs in Year 1 (US$). Source: adapted from Mikhael 2012a.

Level of financing or annual subsidy	Tariff/hh/month in Year 1				Estimated affordable tariff/hh/month in Year 1 (at 3% of hh monthly income)		DWASA – average tariff/hh/month
	No financing or subsidy		100% grant for initial capital investment				
Option	LIC area	Non-LIC area	LIC area	Non-LIC area	LIC area	Non-LIC area	
A	2.90	8.70	1.97	**5.91**	1.80	6.00	2.79
B	2.60	7.80	**1.80**	**5.49**			
C	2.60	7.80	**1.64**	**4.92**			
D	2.06	6.18	**1.22**	**3.66**			

Interestingly, comparison of these tariffs with the current estimated average DWASA monthly household sewerage tariff suggests that the non-LIC households would be required to pay substantially more than they do currently – at US$ 3.66, the monthly tariff for Option D with 100% financing of the initial capital investment is 30% higher than the DWASA monthly household average sewerage tariff – while the few LIC households who currently pay a DWASA tariff would be required to pay US$ 1.22, i.e. 56% less than the current average.

Table 5
Ward 2 financial analysis: comparison of average household (hh) tariffs using an annual subsidy. Source: adapted from Mikhael 2012a.

Option	Average cost of annual subsidy (US$ millions)		Average tariff/hh/month required for full cost recovery (US$)					
			0% subsidy		25% subsidy of all costs		50% subsidy of all costs	
	25% subsidy of all costs	50% subsidy of all costs	LIC area	Non-LIC area	LIC area	Non-LIC area	LIC area	Non-LIC area
A	2.34	4.68	4.41	11.03	3.31	8.27	2.21	5.51
B	2.10	4.21	3.96	9.91	2.97	7.43	1.98	4.96
C	2.10	4.19	3.95	9.88	2.96	7.41	1.98	4.94
D	1.66	3.32	3.13	7.83	2.35	5.87	1.57	3.92

Notes: *The analysis assumes that the tariff would increase at a rate of 5% every three years throughout the study period.*

Table 5 shows that if an annual subsidy policy were adopted, a 25% subsidy would cost on average between US$ 1.66 million and US$ 2.34 million per annum depending on the option chosen. Increasing the subsidy to 50% would result in a doubling of the average annual costs (ranging from US$ 3.32 million for Option D to US$ 4.68 million for Option A). Using annual subsidies would reduce the monthly household tariff to more affordable levels: for instance, the 25% annual subsidy would make Option D

> "A major difficulty was establishing unit costs for the various sanitation technologies"

affordable, while a 50% annual subsidy would reduce the household tariffs for all options in both the LIC area and the non-LIC area to what are considered to be very affordable levels (between US$ 1.57 and US$ 5.51). [Note: these are average monthly figures, so in theory they should not be compared directly to the affordable tariffs shown in Table 4, which are Year 1 tariffs. However, the figures do give a very good indication of the level of affordability.]

6.3. Overall outputs

Overall, these results indicate that securing financial investment for the full initial capital costs or introducing an annual subsidy to cover 50% of all costs could result in a financially sustainable sanitation service for both the LIC and non-LIC areas in Ward 2 and so enable 100% of households to access an improved sanitation service.

For all four options analysed, the initial financial commitment required to enable 100% of households to access an improved sanitation service in Ward 2 is considered to be of a size investors could afford. Furthermore, securing financial investment for the full initial capital costs would enable an affordable household tariff to be levied that would recover the remaining capital, operational and capital maintenance expenditure for all households using Options B, C or D.

Alternatively, if an annual non-returnable subsidy of 50% of all costs were provided, an affordable tariff structure for all households could be established to construct and operate any of the four options; the least costly average annual subsidy being Option D, at US$ 3.32 million.

An identical analysis was performed for Ward 11 which revealed that Options D and B are also the lowest-cost options in this location. It also found that a similar level of financing or subsidy would be required to reduce the average household tariff to an affordable level.

7. Lessons learned

7.1. Limitations

A major difficulty in preparing the tool was establishing the unit costs for the various sanitation technologies. WSUP engaged local consultants who were tasked with estimating capital, capital maintenance and operational unit costs for all the components. The consultants found these hard to find and difficult to derive, which illustrates both the acute lack of readily available unit cost data and the low capacity of local engineering personnel to address such issues in Dhaka. The costs were eventually calculated from various sources with assistance from WSUP international consultants, but it is acknowledged that further work in this area, including greater use of specialist cost engineers, would strengthen the tool; this is regarded as a key step in ensuring that the conclusions drawn are based on solid evidence.

In addition, the tool does not address all the components of the sanitation value chain; it includes only the two main components, namely transport (including emptying where required) and treatment of all waste streams. Further work is therefore required to include the costs of the disposal and/or reuse component and, where appropriate, the containment and/or collection components. WSUP envisages that a suite of sub-tools will follow which will concentrate on streamlining input data for each component of the sanitation value chain. This will facilitate cost analysis at an operational level.

7.2. Continued collaboration is key

Importantly, the in-depth study of sanitation in Ward 2 and Ward 11 and the results of the financial analysis were shared with stakeholders at a formal workshop where it was acknowledged that the approaches modelled are considered compatible with the World Bank-supported Dhaka Sewerage Master Plan project (DWASA 2011). At the same time the Local Government Division of the Government of Bangladesh (GoB), who have responsibility for improving sanitation access, communicated their request for WSUP to take the lead and collaborate with the GoB in further developing the tool and using it to address the huge task of improving access to sanitation services in Dhaka. This is seen as an indicator of the success achieved by the intervention so far.

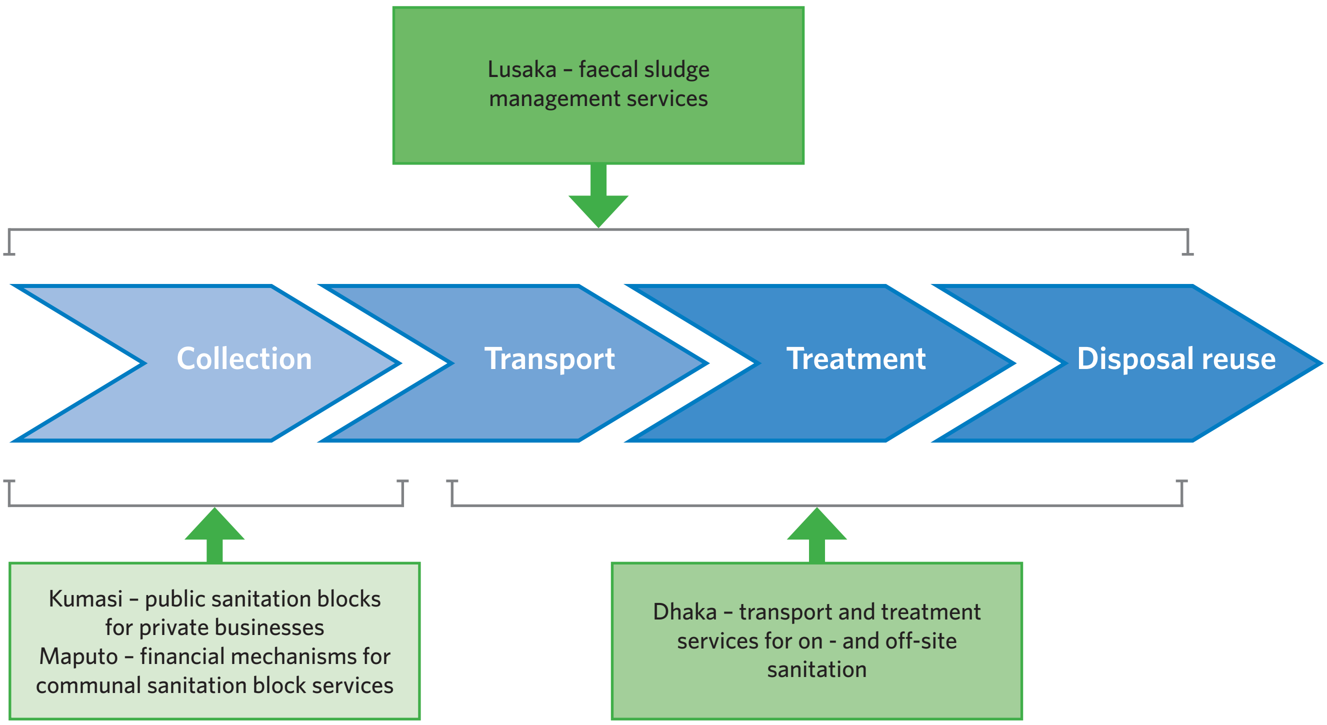
8. Wider applicability

A significant strength of the tool is its flexibility and adaptability. It can easily be adapted to analyse other neighbouring wards in Mirpur, revised for use in other areas and zones of Dhaka, or used in other cities in Bangladesh. Further afield, WSUP has already started improving the current financial tool and sub-tools for use in other countries. Figure 8 shows cities in which a tool is currently being developed and the different areas of focus in each location.

These diverse uses illustrate how flexible the tool is. In essence, depending on the context, it could be adapted to include any sanitation technology, which could then be costed and combined with other costed technologies to produce a range of sanitation systems. Alternative tariff structures and subsidy mechanisms could then be constructed and applied to each option to generate a range of results for comparison.

The tool focuses on financial analysis at a preliminary rather than detailed design level. This is nevertheless an essential part of any sanitation planning process, and the tool's flexibility would allow it to be used in conjunction with or to complement integrated planning frameworks, such as Sanitation 21 and Community-Led Urban Sanitation Planning (CLUES),[11] which address all sanitation planning-related issues, not just finance. It could therefore be adapted for use by other sanitation sector partners and stakeholders.

Figure 8. Where and how WSUP is using the financial analysis tool. Source: adapted from Mikhael 2012b.



[11] For more information on these planning frameworks, see (for Sanitation 21) IWA 2012 and (for CLUES) Lüthi et al. 2011.

“Tools of this type are useful to municipal governments worldwide”

9. Future development

Weakness in financial analysis capability in Dhaka is contributing to the low level of access to sanitation services and is a key area that needs strengthening. The lack of financial data and the subsequent absence of analysis have left decision-makers without the information required to mobilise investment and plan service improvements.

The financial analysis tool developed in Dhaka demonstrates how estimates of the cost of improving sanitation for a defined area can fill this gap and engage stakeholders in order to stimulate investment in the sector. The benefit of this ward-based approach is that it furnishes potential investors with key financial information on a scale that is both affordable and manageable in terms of practical implementation. The intervention has elicited considerable engagement with key stakeholders in Dhaka and most importantly with the Local Government Division (LGD) of the Government of Bangladesh. The LGD are very supportive of the approach and concur with WSUP and its partners’ view that the tool provides a solid initial overview of the situation at a macro-planning level in Ward 2 and Ward 11 of Mirpur, notwithstanding the limitations noted above.

Work is needed (and is ongoing) to move from this initial financial analysis planning phase, through a detailed design phase, to an implementation phase. WSUP, along with other development partners working in the sanitation sector, is well positioned to build on and further develop the approach in order to support the Government of Bangladesh in achieving their important goal, i.e. enabling access to sanitation services for 100% of the urban population.

WSUP believes that tools of this type are useful to municipal governments and service providers worldwide who are interested in achieving pro-poor water and sanitation service delivery. WSUP intends to continue to develop, monitor and evaluate them over the coming years, ensuring all processes and outcomes are documented properly, so that a clear case for further support and implementation can be made. We invite requests for further information and support.

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