FINANCING SANITATION PAPER SERIES #4

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The relevance of a cheap motorbike for Sanitation

The bill of quantities in sanitation and the cheap motorcycle index

GENERAL INTRODUCTION

Financing Sustainable Development

Governments have committed themselves to 17 ambitious Sustainable Development Goals that are designed to end poverty, protect the planet, and ensure prosperity for all. A question that requires an answer: how are we going to finance this? Many of the goals are interrelated and not exclusive. This implies that activities to achieve these goals should also be interlinked.

During the International Conference on Financing for Development in Addis Ababa in 2015, governments from all over the world came up with a package of more than 100 concrete measures that draw upon all sources of finance, technology, innovation and trade that are supposed to support the implementation of the Sustainable Development Goals. "Financing needs for sustainable development are high, but the challenges are surmountable", said UN Secretary-General Ban Ki-moon at the opening of the Conference.

I believe the world has all the resources and expertise it needs to reach those goals. With our Financing Sanitation Paper Series we hope to share our expertise on how we can finance Sustainable Development Goal 6: Ensure Access to Water and Sanitation for all.

The tangible benefits of sanitation

Sanitation is a broad term that includes safe disposal of human wastes, waste water and solid wastes, water supply, control of vectors of diseases, etc. These prevent waterborne diseases and are thus part of preventive health care. Proper preventive health care saves money in terms of reducing medicine bills, number of visits to the doctor and the associated travel costs etc. Preventive health care is also a time saver because there is less time spent travelling to medical facilities and pharmacies. Furthermore, where there are no toilets one needs to identify a suitable location to defecate, which is far away from home or place of work most of the time. This quite often is time consuming too. Lastly, sanitation provides income and employment, including for example the construction of toilets, supplying and stocking of sanitation products and latrine construction materials, and emptying toilets. The earning potential of properly and safely processed human waste – because of the nutrients and carbon that is present in the waste – is also something that is currently being explored in WASTE's sanitation programmes.

Financing Sanitation Paper Series

India and most Sub Saharan African countries have a large financially excluded population, who live to a large extent in poor sanitation and hygiene conditions. The poor sanitation and hygiene conditions, financial exclusion and poverty of these populations most likely reinforce each other. The Financing Sanitation Paper Series is a unique collection of originally six and now seven articles about different aspects of sustainable financing of sanitation (in emerging markets). The articles have covered topics from financial inclusion to private funding and from micro insurance to climate financing.

The first three papers in the series were well received and circulated widely through different fora. A similar process will be followed in launching the current paper: personal presentations of the paper are combined with making it available online.

The theme of this paper is the costs of sanitation. We narrowly define sanitation as toilets that are used, designed hygienic, provide medium to long term privacy and convenience AND systems that ensure safe long term excreta management.

Cost is an important driver of sanitation or rather ***the main reported reason for not owning a toilet – rather sanitation system - is cost***[1]. Indeed, reducing costs while maintaining quality is a key driver of WASTE's sanitation programmes. Yet, it is notoriously difficult to compare costs of sanitation systems even within countries, let alone between countries.

Some reasons are obvious: (1) definition of sanitation varies (see above); (2) sanitation is context related and contexts are difficult to compare; (3) the question arises: which unit should be used in the comparison?

1. Sanitation and child health in India, Augsburg & Rodriguez-Lesmes, UNU-Wider conference, Helsinki, 2016 available on Susana

However, if we manage to disentangle the context, comparisons may become possible. WASTE made a first attempt by developing the sanitation decision support tool, through which rational sanitation decisions can be made based on contextual factors. IRC has made another attempt in its WASH costing project, whereby it developed a Life Cycle Analysis Cost. Both of these approaches are outlined in short below.

In this paper we build on the work done by using a methodology well known in civil engineering; the Bill of Quantities. In the Bill of Quantities (BoQ) materials, parts and labour are all itemised. One needs to list the costs per item and add these up to get a complete overview of the cost of a system. Of course, this presupposes that items all use the same standards. Hence we have converted all locally used units into SI units. This addresses the third point above.

Even after establishing the cost of a sanitation system, what does it mean in practice? If a sanitation system costs € 180 in India and € 400 in Kenya (fictive numbers), what does this imply? Is the supplier in Kenya making massive profits or are other forces at work?

When studying International Economics at the university, "price purchase parity" is one of the subjects. In other words, what can one buy for one (converted) € (Euro) in different countries? One fairly accurate and quite simple method to estimate price purchase parity (PPP) is the Big Mac Index. This looks at how much a Big Mac costs in country X, Y or Z (local currency converted into the same currency). This gives you the PPP. The fact that the fast food chain has not entered the rural and smaller town markets in India or Sub Saharan Africa, makes this not a very suitable tool. So, we have been looking at an alternative that takes sanitation out of its isolation and puts it within the purview of economists. We do this by comparing it to the costs of relatively low cost and often Chinese made motorcycles[2]. Competition, the tax regime, import duties, transport and distribution costs and profit margins determine the differences in cost of these motorcycles between and within countries. These same factors will most likely affect the pricing of sanitation systems within and between countries[3]. Due to their affordability, Chinese motorcycles have become the standard in Africa. With a given manufacturing cost in China and a known cost in shipping, local sales prices are an indicator of the state of the local economy. The resale value of the motorcycles - just as in the case of a sanitation system - is quite low. So, against this we are formulating our **hypothesis: if your sanitation systems** (barring the arborloo and toilets linked to a biogas system) **is half of or less than the cost of a motorcycle, the sanitation system is well priced.**

Or in other words, if two sanitation systems cost more than one cheap motorcycle, the emphasis needs to be on lowering the cost of the sanitation systems per se. Chances are that:

1. the dimensions of the system are not technically correct;
2. erring on the side of over-cautiousness (engineered over-design);
3. the cost of doing business is too high;
4. profit margins are excessive.

This paper is very close to our daily practices as it is written purely on the basis of our experiences in sanitation. This is the reason why you will find very few references in this paper.

Finally, to be able to pursue SDG 6, we need to work together, build innovative partnerships and share knowledge. We have developed the Financing Sanitation Paper Series for this specific reason, to share our experiences on financing sanitation and to start an exciting discussion on this topic that can bring to focus linkages that would enhance the attainment of the SDGs. We therefore invite you to react to the papers on our blog, which you can find on **www.finishsociety.org**, **www.waste.nl**, **www.SuSaNa.org** and our LinkedIn group.

Looking forward to meet you there.

Valentin Post,

Financial Director WASTE

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2. This idea was first mentioned to me by my friend G. Anand.
3. Ethiopia is an exception as import duties on transport assets are very high distorting comparison.

GENERAL INTRODUCTION

"Financing Sanitation - an overview of the financial instruments for sanitation used in FINISH programmes in India and Kenya", and "the essence of public and private funding for sanitation" and "Deepening Financial Inclusion - the potential role of micro insurance in driving sanitation" are part of a series of papers on sustainable financing of sanitation.

Forthcoming papers are:

- Micro-finance of sanitation in detail
- Financial inclusion and sanitation from the beneficiary point of view
- Sanitation and climate financing

The relevance of cheap Motorbikes for Sanitation

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In the first paper we outlined the financial instruments used in the Financial Inclusion Improves Sanitation and Health programmes in India and Kenya (FINISH respectively FINISH INK). In the second paper, we described the essence of public financing of sanitation. In the third paper, we described the link between sanitation and one aspect of financial inclusion, namely micro health insurance. In this paper, we deal with the cost of sanitation and compare it to an alternative asset investment option: a (low cost) motorcycle. All papers are available on www.waste.nl, www.SuSaNa.org and www.finishsociety.org.

Financial inclusion

Financial inclusion encompasses offering a wide range of financial services to the hitherto financially excluded. These financial services range from financial literacy, micro credit, micro leasing, micro savings, micro insurance, money transfer and micro pensions.

In the sanitation financing series, we are linking financial inclusion to sanitation. Financially excluded will have great difficulties in acquiring high cost sanitation assets, yet sanitation that is affordable may give rise to new means of financing and perhaps even financial inclusion. So let us take a closer look at costing.

Complexity sanitation costing

Sanitation costing is complex, because sanitation systems are complex. The complexity stems from amongst others:

1. Unseen and unknown items (underground systems) quite often of a highly technical nature which makes them unknown to decision-makers.

2. Different local conditions: The socio-cultural, economic-financial, technical-environmental (population density, soil type, relief, water table), institutional and legal dimensions have to be worked out in a local setting.

3. Even in similar conditions, different technology options may emerge. In the end, the main interest of decision-makers lies with investment and (hopefully) operation and maintenance costs of the systems.

Sanitation decision support tool

To assist in making technology choices, WASTE developed the sanitation decision support tool, which you can find here: www.waste.nl/en/product/the-sanitation-decision-support-tool.

The tool is organised as follows:

1. Division into functional groups (user-interface ("toilet"), collection, storage, emptying, transport, treatment, reuse/disposal).

2. Set of fact-sheets (i.e. septic tank, simplified sewer, pit, composting, urine reuse…) for each of the functional groups enabling the choice[4].

3. Different flow parameters (grey water, black water, storm water, faeces, urine…).

The step-wise combination of elements in these functional groups create a sanitation system.

4. The fact-sheets also include: illustration of elements compatibility, table of option-specific technical/physical limitations, and description of the element.

First step: technical/physical feasibility: Screening of sanitation options to eliminate non-feasible elements. This involves matching the sanitation elements' limitations with the site's physical characteristics. It aims to highlight the major limitations that must be overcome to implement sanitation options that are effective for the specific site layout conditions. Only the technically feasible options proceed to the 2nd step.

Second step: Sanitation system assemblage. Through the combination of different suitable sanitation elements, appropriate sanitation systems are assembled. It uses compatibility illustrations and descriptions, analyses the operation and maintenance implications, and the advantages/disadvantages. Only a few system combinations will emerge as being viable.

The next steps have been planned but are not yet included in the decision support tool. Not yet developed are the operation and maintenance implications, strengths and weaknesses, **costs (bills of quantities)** and suitability assessment (socio-culturally acceptable, financially affordable and legal/institutionally feasible). The idea was that, once systems are selected, a corresponding bill of quantities emerges. Based on this the decision-maker will invite a minimum of three local contractors to give quotations for each of the viable systems for the specific site conditions. The bill of quantities provides the investment costs (or CAPEX), it is equally important that the operation and maintenance costs are taken into consideration too.

Although this support tool can be used independently, it is not a stand-alone unit; it is meant to provide the basis for the selection of sanitation options in a multi-stakeholder participatory process, such as the Integrated Sustainable Waste Management (ISWM) approach.

IRC WASH Cost project

WASTE collaborated with IRC under their Bill and Melinda Gates Foundation supported WASH Cost project, to develop a support tool to derive sanitation costings for different sanitation systems. Due to various complexities, IRC decided to focus on water. Yet they made a good attempt in sanitation, see text below[5]:

"Extensive household surveys across Burkina Faso, Ghana, Andhra Pradesh (India) and Mozambique, provide a bleak picture on the use and reliability of existing sanitation services. Therefore, there's much less data available on the expenditure required to provide a basic sanitation service.

The figures suggest that the cost of preparing and building a traditional pit latrine that can provide a basic level of service ranges from € 7-24 (at 2011 prices). The cost of a pit latrine with a concrete slab, or a VIP latrine ranges from € 33 to more than € 318. The benchmark costs of pour-flush or septic-tank latrines range between € 82-327. In all cases, these are the benchmarks for achieving a basic level of service.

Recurrent costs to achieve a basic service level (covering operation and maintenance, capital maintenance and direct support) range from € 1.4 for low-cost pit latrines per person per year to € 10.5 per person per year for the most expensive pour-flush or septic-tank latrines.[6]"

5. WASH Cost Fast Facts WASHCost Infosheet 1 . For sake of uniformity this has been converted into Euros at the rate of 1 € = 1.1 US$

6. Ibid, it further states that: ... cost benchmarks presented here are derived from three key sources: the WASH Cost database for capital expenditure and operation and maintenance expenditure; the database of one of the largest sanitation implementation programmes in the world for expenditure on direct support; and finally, for expenditure on capital maintenance, a study by Chowdhry, S. and Kone, D. in 2012: Landscape and business analysis for FSM emptying and transportation in Africa and Asia: final project report for the Bill & Melinda Gates Foundation.

Cost component	Latrine type in area of intervention	Cost ranges min-max in € 2011*
Total capital expenditure (per latrine)	Traditional pit latrine with an impermeable slab (made often from local materials)	7-24
	Pit latrine with a concrete impermeable slab, or VIP type latrine with concrete superstructures (with ventilation pipe and screen to reduce odours and flies)	33-325
	Pour-flush or septic-tank latrine, often with a concrete or brick-lined pit/tank with sealed impermeable slab, including a flushable pan	82-327
Total recurrent expenditure** (per person, per year)	Traditional pit latrines with an impermeable slab (often made from local materials)	1.4-3.6
	VIP type latrines	2.3-7.7
	Pour-flush or septic-tank latrines	3.2-10.5

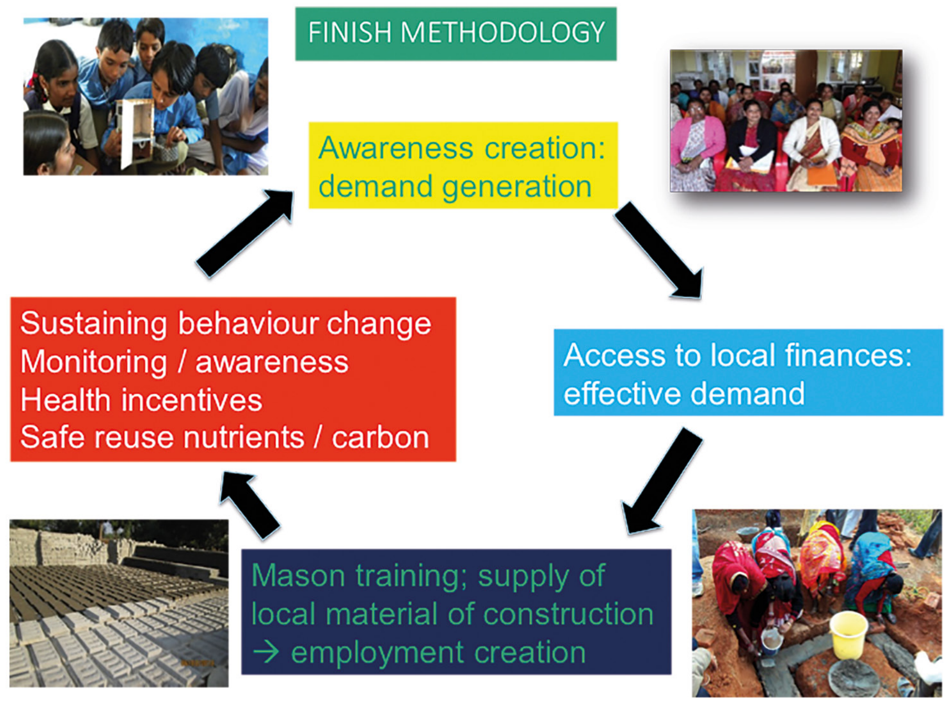
* Benchmark cost ranges given in all tables are based on interquartile values from the data.
**Recurrent expenditure is broken down further. Figures used for pit emptying assume that traditional VIP type latrines require emptying every five years, and pour-flush/septic-tank latrines every two years. These figures may be adapted to context-specific situations. Pit emptying is given as € 1 - 3 resp. 2-6 per person, per year.

Despite some drawbacks on data as indicated by the authors, the strength of this project was clearly its emphasis on operation and maintenance and on life cycle costs. An example of what a sanitation costing structure using the WASH Cost set-up could look like is in Annex 1.

Sanitation under FINISH

As per the sanitation decision support tool, sanitation systems need to take into account excreta management (disposal/reuse). The IRC WASH Cost project smartly distinguished between investment and operation and maintenance costs (CAPEX and OPEX).

The FINISH methodology is outlined in the graph below. It starts with awareness creation and demand generation (top). The challenge lies in sustaining behaviour change, but this is not the topic of this paper. FINISH programmes are currently operational in India and Kenya, and set to expand to Uganda and other countries.



Under the FINISH programmes, the sanitation system design takes excreta management into account from the beginning. Initial implementing partners were socially oriented micro-finance institutions (MFIs). Partner MFIs had a large predominantly rural presence, a good infrastructure to reach out to their clients, but with relatively limited experiences on the technicalities of sanitation. Thus, MFIs urged the sanitation specialists to standardise sanitation systems in such a way that they could make a sanitation loan product in support thereof. The sanitation systems should be context adjusted, yet **simple to understand and as much standardised as possibl**e.

Off-site and on-site sanitation[7]

- **Off-site sanitation** is a form of sanitation where the human excreta are transported away from the place of defecation, via drains or sewers and treated in a centralised facility like a sewage treatment plant.

- **On-site sanitation** is a form of sanitation where human excreta are contained and treated at the place of defecation.

We started with on-site systems or rather integrated stand-alone sanitation systems - space typically not being much of an issue in rural settings.

We took the following into account whilst developing standards:

The toilet is a primary barrier between people and the pathogens present in faeces, as it contains the collection of excreta in a designated and controlled location. A toilet provides privacy, safety and comfort to the user. Typically, this is captured by one aspect of the toilet, commonly known as the superstructure. The superstructure of the toilet needs to be seen by the users as safe and attractive to use, while construction and maintenance costs are affordable. The superstructure should be according to users' wishes, considering the climatic conditions and amount they wish to spend. Materials could be various, including bricks, palm leaves, concrete, straw etc. In this respect, we consider the approach known as community led total sanitation (CLTS) to be very relevant.

The toilet seat or toilet pan is also an area where the preference of the users prevails. For elderly or disabled users, a seat is preferred. In the majority of cases the squatting slab is preferred. The seat or pan is placed on a slab (usually cemented). For ease of maintenance the slab can be tiled.

Collection and safe disposal of excreta is much less visible. The safe disposal of excreta is an area where expert advice is most important. User preferences cannot be the guiding principle here. Yet it is preferred that users are offered several safe options from the different systems, considering existing practices (wipers or washers), costs, ease of operation and maintenance, and the use of treated products, if any.

The sanitation system needs to include the means for hand-washing and provide privacy, safety and comfort to the user. FINISH promoters have clearly stated that the programme will not be operational in areas where there is no water availability.

A toilet generally has three components:

- A superstructure for privacy and protection from climatic factors

- A meso-structure (e.g., platform with a pedestal, squatting pan or hole)

- A sub-structure (pit, septic tank, biogas installation, etc.) that is eventually linked to a collection and transport system to take the excreta to the point of treatment and disposal or reuse. Only for a urine diverting dry toilet (UDDT) collection and transport for disposal and treatment is linked to the meso-structure.

7. Though still used, the terms on-site and off-site are slowly being replaced by sewered /unsewered or centralised/decentralised. The main reason for this is faecal matter from even 'on-site' systems is disposed off or treated off 'off-site'.

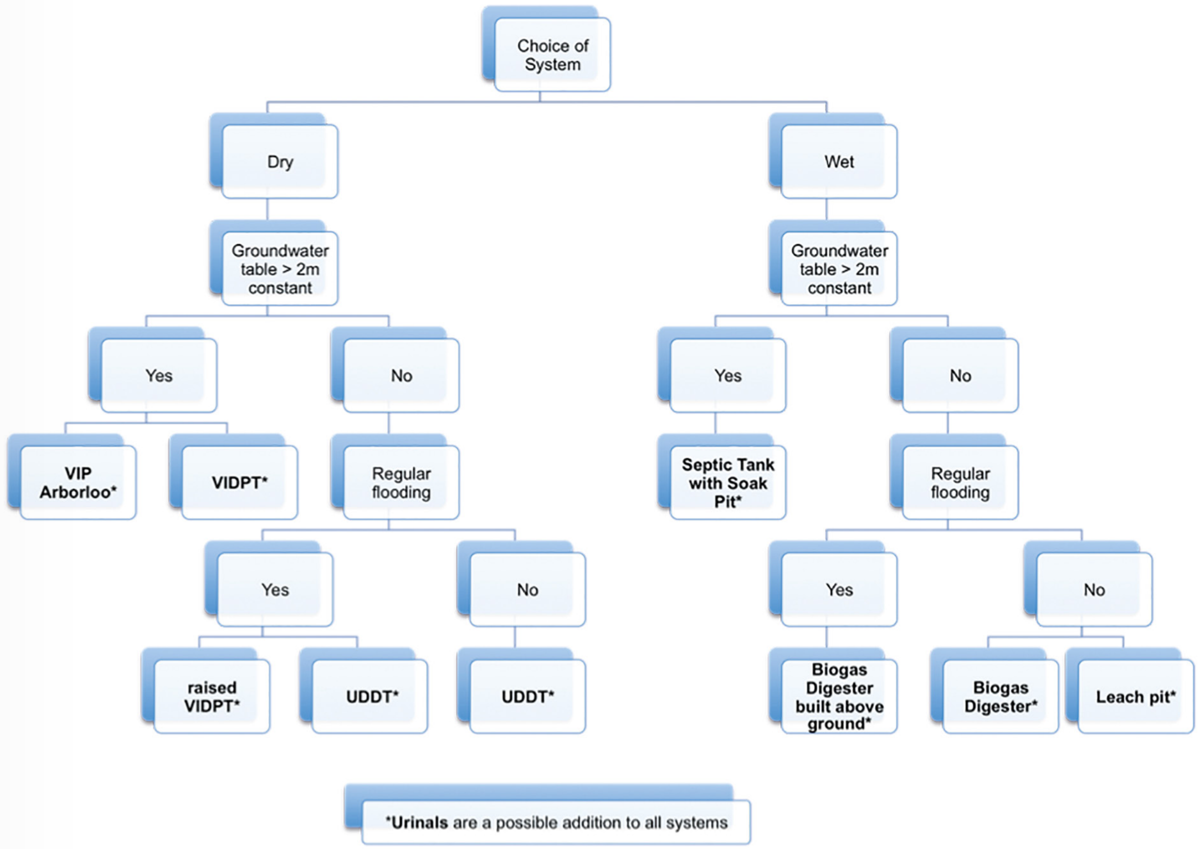
Flush and dry toilets

The first critical decision that needs to be made is choosing between a dry and (pour) flush toilets. A toilet that is not flushed with water is a **dry toilet**. These include the old pit toilets, which could just be the traditional hole in a wooden plank placed over a pit or one where the excreta falls into a lower chamber that is then cleaned manually. The modern version of this traditional technology is a urine diverting dry toilet (UDDT) and its refinement, the urine diversion flush toilet (UDFT), both of which are ecologically safe. **Dry toilets** were the standard in many parts of Africa, but slowly the flush toilets are gaining popularity there too.

A **pour-flush toilet** is a **flush toilet** whereby the water is poured in by the user. So, when the water supply is not continuous, any toilet that is normally flushed with water stored in the attached cistern can become a pour flush toilet. In both cases, there is a water seal that prevents odours and flies from coming back to the pipe. Water is poured into the bowl to flush the toilet of excreta; approximately 2 to 3 litres is usually sufficient. The quantity of water and the force of the water (pouring from a height often helps) must be sufficient to move the excreta up and over the curved water seal. In the case of India, barring exceptional circumstances (extreme high groundwater or extreme water scarce), the opted system is (pour) flush.

In summary, sanitation must meet the needs of the user, must be simple to use, maintain and repair, be possible to replicate and be affordable. A sustainable and safe sanitation system comprises a toilet, and systems for collection, transport, treatment, and use/disposal[8] of excreta.

The chart below gives a broad overview of the series of local conditions that are considered in opting a sanitation system for school sanitation under the FINISH programme in Kenya. Once the decision is made, the bill of quantities is derived.



8. Disposal of excreta is an area that warrants considerable attention, as unsafe disposal of excreta may have significant health impact.

FINANCING SANITATION

Bill of quantities

In this paper, we describe an important part of sanitation financing, namely its costing. The lower the cost, the more local financial alternatives are available. We calculate costing by means of a tool called the bill of quantities. A **Bill of Quantities** (BoQ) is a methodology used in tendering within the construction industry and in which materials, parts, and labour (and their costs) are itemised. It also (ideally) details the terms and conditions of the construction or repair contract and itemises all work to enable a contractor to price the work he or she is bidding for (Wikipedia, 17 February 2011).

The online Oxford dictionary (17 February 2011) defines the bill of quantities as: ***a detailed statement of work, prices, dimensions, and other details, for the erection of a building by contract.*** The civil engineering sector uses this method extensively.

Use of the same units is critical if one wants to make international comparisons. For this we are using SI units.

The **International System of Units** (abbreviated SI from the French Système International d'unités) is the modern form of the metric system and is generally a system of units of measurement devised around seven base units and the convenience of the number ten. It is globally the most widely used system of measurement, both in everyday commerce and in science. The system has been nearly globally adopted. Three principal exceptions are Burma (Myanmar), Liberia, and the United States. The United Kingdom has officially adopted the International System of Units but not with the intention of replacing customary measures entirely (Wikipedia, 17 February 2011).

BILL OF QUANTITIES

The bill of quantities is provided for individual household systems, both wet (double leach pit, septic tank and toilet linked to biogas) and dry (Arborloo, ventilation improved double pit toilet and urine diversion dehydration toilet).[9]

Wet systems – pour flush toilet (super- and mesostructure)

POUR FLUSH TOILET (1.3 x 1.3 m) [including pour flush pan and P trap/water seal]

	Component	Details	Unit	Quantity	Unit Cost (€)	Cost (€)[10]
1	Foundation Stones		Basket	10	0.7	7
2	Cement Hollow Block	0.4mx0.2mx0.1m	Number	90	0.2	22
3	Cement	53 grade	50kg bag	3	4.5	14
4	Sand		m^3	7.5	9	11
5	Basin		Number	1	3.5	4
6	PVC Pipe	110mm	m	6	2	13
7	Labour – Mason		Day	3	7	22
8	Unskilled Labour	Male	Day	1	4	4
9	Unskilled Labour	Female	Day	3	3	9
10	Steel Door	1.5m x 0.61m	Number	1	11	11
11	Roof Slab	1.2m x 0.61m	Number	2	4.5	9
Total						126

9. In Annex 2 we provide an overview of some Bill of Quantities for more complex larger wastewater treatment systems.

10. All cost estimates were derived from Indian Rupees (INR) with Rate of Exchange being 1 € = INR 70 and based on 2011 prices, specific to Tiruchirapalli in India.

Substructure

__Twin leach pits__ ***[Costs are per pit of 0.9m diameter x 1.25m depth designed for 5 users. For 10 users increase pit dimensions to 1.2m x 1.4m and for 15 users to 1.6m x 1.88m]***

	Materials	Details	Unit	Quantity	Unit Cost (€)	Cost (€)[11]
1	Brick	First class, wire cut, Lot	Number	4	7	28
2	Cement	53 grade	kg	25	0.1	2.5
3	Sand		Lump sum			1
4	Cover Slab	for Junction Box	Number		2	2
5	Cover Slab	for Pits	Lump sum			7
6	Labour	110mm	Lump sum			14
Total						54.5

The septic tank is connected to a soak pit. Other alternatives exist, such as leach field, for which a separate bill of quantity has been made but for clarity's sake this is not presented here.

SEPTIC TANK [inner dimensions of 2.25m x 0.75m x 1.4m]

	Materials	Details	Unit	Quantity	Unit Cost (€)	Cost (€)[12]
1	Bricks	First class, wire cut	Numbers	1,500	4	6,000
2	Cement		kg	200	6.6	1,320
3	Sand		m^3	14.28	105	1,499
4	Pipes & Specials	PVC	Lump sum			1,000
5	Slabs		Number	4	400	1,600
6	Labour		Lump sum			2,700
Total						14,119

SOAK PIT [1m diameter x 1m depth]

	Materials	Details	Unit	Quantity	Unit Cost (€)	Cost (€)[13]
1	Brick	First class, wire cut	Numbers	250	4	1,000
2	Cement	53 grade	kg	25	6.6	165
3	Sand		Lump sum			50
4	Cover slab	for Pits	Lump sum			500
5	Labour		Lump sum			800
Total						2,515

A toilet connected to a biogas digester is another system that is actively promoted in the FINISH programmes. Yet as the dimensioning of the digester mainly depends on availability of other types of organic waste, we have not included the bill of quantities here. The super- and meso-structure is similar to the one given earlier. As for the meso-structure it is important to note that from the toilet a completely separate pipe goes into the digester. The pipe should not connect to the mixing tank at the inlet of the digester!

12. All cost estimates are in Indian Rupees (INR) and based on 2011 prices, specific to Tiruchirapalli in India.

13. All cost estimates are in Indian Rupees (INR) and based on 2011 prices, specific to Tiruchirapalli in India.

FINANCING SANITATION

Dry systems

Urine diversion dehydration toilets

	Details	Details	Unit	Quantity	Unit cost	Cost[14] (INR)
1	Earth work, Foundation	Random Rubble (RR) rough stones	Lump sum			600
2	Cement Hollow Blocks	0.4m x 0.2m x 0.1m	Numbers	180	15	2700
3	Cement	53 Grade	kg	280	6.6	1848
4	Sand		Unit	1	750	750
5	Iron Rods	6 mm	kg	25	44	1100
6	Binding wire		kg	0.25	100	25
7	Steel Door	150cm x 60cm x 10cm steel clamp	Numbers	1	750	750
8	PVC Pipe	110 mm	m	3.33	60	199.8
9	PVC 'L'	110 mm	Numbers	1	60	60
10	PVC Cowl	110 mm	Numbers	1	40	40
11	Steel Clamp	110 mm	Numbers	2	25	50
12	Nails		Numbers	4	1.25	5
13	PVC Pipe	40 mm	Lump sum			225
14	PVC 'L'	40 mm	Numbers	4	25	100
15	PVC 'T'	40 mm	Numbers	2	30	60
16	PVC Paste		l	0.1	300	30
17	Red Oxide		kg	0.25	200	50
18	White cement	For colouring	kg	10	15	150
19	Blue Paint		l	0.1	400	40
20	Yellow Paint		l	0.1	400	40
21	Black Paint		l	0.1	400	40
22	Paint Brush	50 mm size	Numbers	1	35	35
23	Paint Brush	100 mm size	Numbers	1	70	70
24	Kana Indica Plant		Numbers	2		0
25	Plastic Bucket + lid	5 litre volume: 1 Green 1 Red	Numbers	2	45	90
26	Mug		Numbers	1	10	10
27	Mud Pot & Jerry can	5 litre	Numbers	1	100	100
28	Brick Jelly		Baskets	2	15	30
29	Charcoal		Baskets	2	25	50
30	Mosquito Net		m^2	0.1	400	40
31	Pan	3-in-1 Fibre Reinforced Polymer	Numbers	2	1200	2400
32	Labour	Skilled	Numbers	56	50	2800
33	Labour	Unskilled Female	Numbers	7	150	1050
34	White & colour washing	Labour charges	Lump sum			250
35	Transportation Charges		Lump sum			400
Total Cost						16,188

14. All cost estimates are in Indian Rupees (INR) and based on 2011 prices, specific to Tiruchirapalli in India.

As under the FINISH programmes, facilities for reuse of human waste are integrated in the design. For systems of choice in rural areas - where space is not a constraint - the arborloo has been included (the original idea has been derived from Peter Morgan (Peter Morgan and SEI, The Arborloo Book, 2004). The arborloo is a single ventilation improved pit that is considered 'improved' in our definition of the word, i.e. meaning that human waste is converted into other products. In this case it uses the human waste – when the pit is full - as a manure to grow trees. A new hole is dug elsewhere and the super- and meso-structure are removed and placed above the new pit.

Arborloo – bill of quantities meso-structure

	Item Description	Size	Quantity	Unit	Unit cost in Ksh	Total	Function
Meso-structure							
1	Bricks	35x17.5x17.5 cm	18	pcs	35	KES 630.00	
2	Plastic sheet					KES 0.00	to pour slab on
3	Formed plastic bucket or brick as drophole placeholder					KES 0.00	
4	Ventilation pipe placeholder	11 cm diameter				KES 0.00	
5	Cement		0.008	m3		KES 0.00	
6	Clean river sand		0.03	m3		KES 0.00	
7	Water		0.002	m3		KES 0.00	
8	Reinforcing wires	3-4 mm dia, 90 cm long	4	pcs		KES 0.00	
9	Hand wires		2	pcs		KES 0.00	
10	Plastic sheet					KES 0.00	to cover slab while curing
	Brick ring beam						
11	Bricks	35x17.5x17.5 cm	30	pcs	35	KES 1,050.00	
12	Anthill soil					KES 0.00	
13	Water					KES 0.00	
	Cement ring beam						
14	Plastic sheet					KES 0.00	
15	Bricks	35x17.5x17.5 cm	37	pcs	35	KES 1,295.00	
16	Wet sand					KES 0.00	to fill the spaces in the inner brick mould
17	Cement		0.008	m3		KES 0.00	
18	Clean river sand		0.03	m3		KES 0.00	
19	Water		0.002	m3		KES 0.00	
20	Wire	3-4 mm dia, 291 cm long	1	pcs		KES 0.00	
21	Anthill soil					KES 0.00	
SUBTOTAL						KES 2,975.00	

Arborloo – bill of quantities super-structure

	Item Description	Size	Quantity	Unit	Unit cost in Ksh	Total	Function
Super-structure							
1	Bricks	26.5x14x10cm	200	pcs	17	KES 3,400.00	soil stabilised interlocking bricks
2	Cement		0.017	m3		KES -	for the weak mortar mix (1:4)
3	Sand		0.067	m3		KES -	for the weak mortar mix (1:4)
4	Panels	2.8m	1	pcs		KES -	for door frame
5	Door	2m x 0.6m	1	pcs		KES -	
6	Nails	standard	1	kg	150	KES 150.00	
7	Screws	4.4 cm	20	pcs	5	KES 100.00	
8	Galvanized clamped hinges	4cm x 8cm x 2mm galvanized	3	pcs	100	KES 300.00	fix door off true vertical
9	Tower bolts	5.08 cm	2	pcs	50	KES 100.00	
10	Tower bolts	10.16 cm	2	pcs	100	KES 200.00	
11	Tin sheet	1.4m x 1.4 m	1	pcs		KES -	for the roof
12	Panels	0.05m x 0.05m	5.4	m		KES -	for the roof
SUBTOTAL						KES 4,250.00	

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Arborloo – bill of quantities additional items and labour charges

	Item Description	Size	Quantity	Unit	Unit cost in Ksh	Total	Function
Additional structures							
Ventilation pipe							
1	PVC ventilation pipe class B	3.45m x 11cm diameter	1	pcs	1600	KES 1,600.00	
2	Black paint	5 litres				KES -	
3	PVC ventilation pipe cover		2	pcs	500	KES 1,000.00	
4	Cowl		1	pcs		KES -	
5	Watertight seal					KES -	
SUBTOTAL						KES 2,600.00	
Labour							
	Description	**Number of people**	**Day(s)**		**Cost/day**	**Total**	
A	Skilled labour	1	1		1,000	KES 1,000.00	
B	Unskilled labour	1	2		400	KES 800.00	
SUBTOTAL						KES 1,800.00	
GRAND TOTAL						**KES 11,625.00**	

Ventilated Improved Double Pit Toilet (VIDPT). Each pit is used alternately, so the human waste can decompose in the non-used pit and be readied for reuse.

VIDPT– bill of quantities substructure

	Item Description	Size	Quantity	Unit	Unit cost in Ksh	Total	Function
Sub-structure							
1	Cement mortar		0.2592	m3		KES -	foundation outer wall
2	Cement mortar		0.0394	m3		KES -	foundation partition wall
3	Bricks	35x17.5x17.5 cm	13	pcs	35	KES 455.00	lining pit bottom
4	Bricks	35x17.5x17.5 cm	23	pcs	35	KES 805.00	partition wall
5	Bricks	35x17.5x17.5 cm	21	pcs	35	KES 735.00	pit wall lined
6	Bricks	35x17.5x17.5 cm	48	pcs	35	KES 1,680.00	pit wall honeycombed
7	Cost cutting bricks		105	pcs	2	KES 210.00	
8	Cement mortar		29.02	m3		KES -	for joints
9	Compacted free draining soil						
SUBTOTAL						KES 3,885.00	

VIDPT– bill of quantities meso-structure

	Item Description	Size	Quantity	Unit	Unit cost in Ksh	Total	Function
Meso-structure							
1	Squatting slabs with 230 mm drop hole	r: 0.8375 m; thickness: 5.1 cm; arc: 1.755 m	2	pcs		KES -	
2	Cement mortar					KES -	to fix the squatting slabs
3	Removable slab, reinforced	r: 0.8375 m; thickness: 5.1 cm; arc: 1.755 m	1	pcs		KES -	
4	BRC mesh (commercial)	medium gauge				KES -	
5	Squat plate with footrests		2	pcs		KES -	
6	Removable cover with handle		2	pcs		KES -	
7	strong cement mortar mix (1:2,5 cement:sand)					KES -	to pour the in-situ slab
SUBTOTAL						KES -	

VIDPT– bill of quantities superstructure

	Item Description	Size	Quantity	Unit	Unit cost in Ksh	Total	Function
Super-structure							
1	Reinforced cement concrete		0.021	m3		KES -	
2	Bricks	26.5x14x10cm	200	pcs	17	KES 3,400.00	soil stabilised interlocking bricks
3	Cement		0.017	m3		KES -	for weak mortar mix (1:4)
4	Sand		0.067	m3		KES -	for weak mortar mix (1:4)
5	Panels	2.8m	1	pcs		KES -	for door panel
6	Door	2m x 0.6m	1	pcs		KES -	
7	Nails	standard	1	kg	150	KES 150.00	
8	Screws	4.4 cm	20	pcs	5	KES 100.00	
9	Galvanized clamped hinges	4cm x 8cm x 2mm galvanized	3	pcs	100	KES 300.00	fix door off true vertical
10	Tower bolts	5.08 cm	2	pcs	50	KES 100.00	
11	Tower bolts	10.16 cm	2	pcs	100	KES 200.00	
12	Tin sheet	1.4m x 1.4 m	1	pcs		KES -	for the roof
13	Panels	0.05m x 0.05m	5.4	m		KES -	for the roof
SUBTOTAL						KES 4,250.00	

VIDPT– bill of quantities additional items and labour charges

	Item Description	Size	Quantity	Unit	Unit cost in Ksh	Total	Function
Additional structures							
Ventilation pipe							
1	PVC ventilation pipe class B	3.45m x 11cm diameter	1	pcs	1600	KES 1,600.00	
2	Black paint	2 litres				KES -	
3	PVC ventilation pipe cover		1	pcs	500	KES 500.00	
4	Cowl		1	pcs		KES -	
5	Watertight seal		1	pcs		KES -	
6	Seal for ventilation pipe					KES -	
SUBTOTAL						KES 2,100.00	
Labour							
	Description	**Number of people**	**Day(s)**		**Cost/day**	**Total**	
A	Skilled labour	1	3		1,000	KES 3,000.00	
B	Unskilled labour	1	3		400	KES 1,200.00	
SUBTOTAL						KES 4,200.00	
GRAND TOTAL						**KES 14,435.00**	

When the FINISH programme started in Kenya, the first sanitation system visited was a rock-solid toilet – build like a fortress – with an allegedly 10m deep single pit, costing € 2,000 (KSh 200,000) or more than 2x the price of a motorcycle in Kenya. Gradually, the partnership has reduced the costs to the prices you find in the tables above. This is further outlined below.

Lowering the cost of sanitation systems

Based on our experiences, the easiest gains can be made in proper dimensioning[15]. The bill of quantities can be the tool here. For instance, in Kenya, we have reduced the cost of an improved sanitation system by 60% or more through proper dimensioning. The depth of the pit has been reduced from 10-20m to 2m. This proper dimensioning needs to be accompanied by training masons/artisans.

15. As a rule of thumb, engineers have nothing to gain by designing on the basis of the minimal requirements. Rather they stand out to lose; when structures collapse or are deficient, the fingers will be pointed out the poor design by the engineers. For integrated stand-alone sanitation systems, there will be little justification for cautious overdesigning, perhaps with the exceptions of strong slabs and load bearing support structures.

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In the sanitation field, you find many non-governmental organisations (NGOs) involved in construction of sanitation systems. The systems constructed are often grant based and hence small in number. Additionally, the NGO needs to factor in, its overhead, reporting and quality control costs. As of late sustainability clauses may be added to this, i.e. a guarantee or monitoring that the system will be operational for 10 years. This makes the systems expensive.

Prior to construction, an elaborate consultation process may have taken place as well. We would argue that these latter costs cannot be avoided as the toilets may otherwise not be used in the end by the beneficiaries.

At the same time the NGO distorts the market, smaller local manufacturers, artisan and masons that can also construct sanitation systems, lose out to the grant dominated NGO.

Directly outsourcing the work to contractors – instead of the NGO doing it by itself - may not be much cheaper, if the client is not familiar with the basics. The quality control and checking costs need to be factored in at any rate and besides the contractor would like to make a (attractive) profit.

We would argue that instead it may be more efficient to enhance the capacities of the local masons, artisans and manufacturers on construction and proper dimensioning of sanitation systems.

Lowering the cost of sanitation – part 2

If all of the above have been addressed adequately we can take a next step. In the FINISH and FINISH INK programmes we have been working on several (mostly supply side) interventions, to reduce the cost further. These are:

1. reducing itemised costs, e.g. doors/roofs, either by itemised bulk purchase or use of lower cost alternatives;
2. negotiations with suppliers to get supplier's credit;
3. aggregating demand and matching this with supply of goods (lowering transport costs);
4. use of prefab units.

Why are cheap motorcycles considered?

In sub Saharan Africa, (Chinese) motorcycles are widely used as a means of transport for people and goods. Driving a Chinese motorcycle carrying people and/or goods is either a full-time profession or an additional source of revenue (akin to part time Uber drivers). It is thus a direct income-generating activity and has a profit & loss statement as such, with a break- even point, a payback period etc.

The average cost of a normal motorcycle in Kenya is KSh 90,000 (just over € 800). The riders normally pay the motor bike owner around Ksh. 500 (€ 4.5) per day, bringing the monthly income to about Ksh 15,000/- (€ 140). The loan is considered relatively risky so the repayment period is normally capped at 1 year. However, depending on other factors, such as whether the loan was a salary loan, it can be extended to between 18 to 24 months, though only under special circumstances.

An improved sanitation system can improve income generation (less working days lost through being sick, going to the hospital or taking care of sick relatives) and can save money on transport to hospital or the clinic and on doctor's fees and medicines. Yet we do have too little information on the savings to make qualified statements. If the cost of a sanitation system is known and large amount of data on health expenditure is available, basic calculations can be made on the payback period of a sanitation system. So, the challenge is: can we get sanitation to this level, whereby people would make an investment decision similar as they do today for the purchase of a motorcycle?

The cheap Motorcycle Index

One of the most common means of transport in for instance Kenya or Uganda is a motor cycle. In view of its affordability, Chinese motorcycles have become the standard in Africa. With a given manufacturing cost in China and a known cost in shipping, local sales prices are an indicator of the state of the local economy. The resale value of the motorcycles is - just as in the case of sanitation systems - quite low. So, against this we are formulating our hypothesis: if your sanitation system (barring the arborloo and toilets linked to a biogas system) is half or less of the cost of a motorcycle, the sanitation system is well priced.

Or, in other words, if two sanitation systems cost more than one cheap motorcycle, the emphasis needs to be on lowering the cost of the sanitation systems per se. Chances are that:

1. the dimensions of the system are not technically correct;
2. erring on the side of over-cautiousness (engineered over-design);
3. the cost of doing business is too high;
4. profit margins are excessive.

Thus this comparison offers a basic, though practical tool to evaluate costing.

	Cheap Motorcycle (Chinese / Indian[1])	Arborloo	VIDPT	UDDT	Toilet with double leach pit	Toilet with septic & soak pit
Bangladesh	€ 720	€ 48**	N/A	N/A	€ 25-300***	€ 700
Ethiopia	€ 1,500	€ 350	N/A	€ 525	N/A	€ 700
Ghana	€ 960	€ 160**	N/A	N/A	N/A	N/A
India	€ 500*	N/A	N/A	€ 300	€ 210	€ 290
Kenya	€ 800	€ 90	€ 320	N/A	€ 230	€ 360
Malawi		€ 120	N/A	N/A	€ 600	N/A
Mozambique		€ 230	€ 320	N/A	€ 414	N/A
Nepal	€ 1,338	€ 230	€ 293	€ 209	€ 293	€ 920
Uganda	€ 774	€ 240	€ 1,250	€ 1,000	€ 450	€ 1,100

** Direct single pit not used as arborloo

***Offset single pit, wide variation in cost is due to differences in superstructure

16. Indian motorcycles are not used in the same way in India, people use it to transport goods and services but hardly as a profession.

	Cheap motorcycle (Chinese / Indian)	Arborloo	VIDPT	UDDT	Toilet with double leach pit	Toilet with septic tank & soak pit
Bangladesh	100%	7%			3- 42%	97%
Ethiopia	100%	23%		35%		47%
Ghana	100%	17%				
India	100%			60%	42%	57%
Kenya	100%	11%	39%		28%	44%
Malawi	100%	17%	22%	16%	22%	69%
Mozambique	100%	23%	32%		41%	
Nepal	100%	17%	22%	16%	22%	69%
Uganda	100%	31%	161%	129%	58%	142%

Annex 1: Example of data disaggregating for capital investments - sanitation based on IRC WASH costs

Table 1 Example of data disaggregating for capital investments – sanitation

Level 1		Level 2	Level 3	Level 4	Level 5	Comments
Generator	Toilet Pour flush Dry Urine diversion	Flush toilet	Inside house Outside house	Superstructure Toilet slab/ seat Finishing Pipings from toilet		Bill of quantities in principle available, water brought to the toilet is excluded from the bill of quantities
		Pour flush	Inside house Outside house	Superstructure Toilet slab/ seat Finishing Pipings from toilet		
		Dry	Inside house Outside house	Superstructure Toilet slab/ seat Finishing Pipings from toilet		
		Urine diversion	Inside house Outside house	Superstructure Toilet slab/ seat Finishing Pipings from toilet		
	Bathing/ washing/ cooking	External water source	Black water separate	Finishing Pipings from toilet, grey		Bill of quantities not yet ready – following agreement in principle - water brought to the house is excluded from the bill of quantities
			Mixed	Finishing One piping		
		One tap inside house	Black water Separate	Finishing Pipings from toilet		
			Mixed	Finishing One piping		
		Multiple taps	Black water Separate	Finishing Pipings from toilet		
			Mixed	Finishing One piping system		
Collection	Individual	Septic tank	One compartment	Size (m^3) Inlet/outlet arrangements Fume vent Slopes		Bill of quantities in principle available
			Multiple compartments	Size (m^3) Inlet/outlet arrangements Fume vent Slopes		
		Imhoff tank				
	Sewer connection	Manhole				

Level 1		Level 2	Level 3	Level 4	Level 5	Comments
Collection	Individual	Septic tank	One compartment	Size (m^3) Inlet/outlet arrangements Fume vent Slopes		Bill of quantities in principle available
			Multiple compartments	Size (m^3) Inlet/outlet arrangements Fume vent Slopes		
		Imhoff tank				
	Sewer connection	Manhole				
	Common collection tank	Small (up to 5 households)				
		Medium (5-15 households)				
		Large (above 15 households)				
Transport	Vehicle	Small (up to 3,000 l capacity)		Tractor with bowser	Volume l or m^3 storage capacity	When working on costing, operational costs (fuel, driver, licenses, insurance etc) should be requested for too
				Small truck	Volume or m^3 storage capacity	
		Medium (3000-10,000 l. capacity)		Truck / tanker	Volume or m^3 storage capacity	
	Pipes	Pumping		HDPE	Pumps (flow, head, rated output (N in kW), NO (f mm), number, pumping well(s) Accessories Power /standby power HDPE specs.	Installed capacity includes any standby provisions. Mechanical and electrical prices may be relatively stable per m^3 of capacity in which case it may not be appropriate to specify three ranges but rather let the user input the pumping capacity (either power requirements or flow plus pumping head) and for the rate to be derived from a statistical algorithm embedded in the programme. Civil works may not be relatively uniform as pumping stations may need to be built to accommodate future expansion and may distort unit prices.
				PVC	Pumping stations Pumping wells Standby power PVC (DN)	
		Gravity		Concrete (hume)	Outer dimension mm or m Culverts Man holes	
				HDPE	Outer dimension mm or m Culverts Man holes	
				PVC	Outer dimension mm or m Culverts Man holes	

Level 1		Level 2	Level 3	Level 4	Level 5	Comments
Waste water treatment	Individual	Small (up to 10 m^3 /day)	Primary treatment	Septic tank		Land
				Integrated settler batch reactor		
			Secondary treatment	Constructed wetland		
				Up flow anaerobic filter		
			Tertiary treatment	Disinfection		
				Pressure sand filter		
				Activated carbon filter		
				Constructed wetland		
	Common Medium 100 m^3 /day and above)	Small (up to 20 m^3 /day)	Primary treatment	Septic tank		
				Integrated settler batch reactor		
				Settling tank		
			Secondary treatment	Constructed wetland		
				Upflow anaerobic filter		
				Activated plant (submerged aerobic fixed film reactor, submerged packed bed reactor, fluidised aerobic bed reactor)		
			Tertiary treatment	Disinfection		
				Pressure sand filter		
				Activated carbon filter		
				Constructed wetland		
		Small – medium (up to 50 m^3 / day)	Primary treatment	Integrated settler batch reactor		
				lick and type, Kop Annex>Settling tank		

				Constructed wetland		
		Small – medium (up to 50 m³ / day)	Primary treatment	Integrated settler batch reactor		
				lick and type, Kop Annex>Settling tank		
			Secondary treatment	Constructed wetland		
				Upflow anaerobic filter		
				Activated plant (submerged aerobic fixed film reactor, submerged packed bed reactor, fluidised aerobic bed reactor)		
				Upflow anaerobic sludge blanket		
			Tertiary treatment	Disinfection		
				Pressure sand filter		
				Activated carbon filter		
				Constructed wetland		
		Medium 100 m3 /day and above)	Primary treatment	Settling tank		
				Integrated settler batch reactor		
			Secondary treatment	Constructed wetland		
				Upflow anaerobic sludge blanket		
				Activated plant (submerged aerobic fixed film reactor, submerged packed bed reactor, fluidised aerobic bed reactor)		
			Tertiary treatment	Disinfection		
				Pressure sand filter		
				Activated carbon filter		
Disposal / reuse	Disposal	Pipes				
	Reuse					
Design and other costs	Tree to be developed Much thought is needed as to how to reflect these costs in the WASH cost system.					

Annex 2 bill of quantities common systems

Under FINISH several bills of quantities have been developed for individual household systems. Under the ISSUE 2 programme bill of quantities have been developed for some off-site systems. The part we did not do, though, is include transport as the context (local geodetic conditions) is the determinant in the costing.

The selection of a suitable system requires involvement of many different stakeholders each with their own experience and expertise but also with their opinions and, sometimes vested interests too. At ground level, the stakeholders seldom come together to be actively involved in the decision-making process. Often these stakeholders do not have the knowledge or tools to make an evaluation and decide on a suitable system. The parameters in the decision-making process involve variables like capital investment, Operation & Maintenance (O&M) costs, availability of land, degree of treatment required and facilities for safe disposal/reuse. Over and above these, the local conditions like legal, political, institutional, socio-cultural and environmental aspects also have to be factored into the decision-making process.

In many developing countries, the person making the decision on the type of treatment system seldom has the required information mentioned above to make an appropriate decision about the treatment system and hence tends to follow the common treatment system (such as an activated sludge system) used elsewhere without a proper evaluation of its viability vis-à-vis the local conditions.

In many developing countries, the local body assigned with the responsibility of managing the treatment system does not have the expertise of monitoring/control of the treatment system, nor have the financial resources to meet the O&M costs of the system, especially when the system is power intensive and needs round-the-clock skilled operation. As a result of the above scenario, in many cases, the treatment system seldom functions properly after installation, resulting in:

1. Environmental pollution due to poor treatment efficiency
2. Wastage of resources by investing in the plant
3. Loss of a valuable resource - the effluent itself

In this background, it was felt that if a basic programme allowed the user to find the important criteria, such as approximate capital investment, O&M costs, land requirement etc., a more sustainable and suitable (for local conditions) decision can be made. Accordingly, this tool to estimate the above parameters has been prepared.

In order not to complicate the decision-making tool, only the minimum conditions to meet the environmental standards and to stay within the legal framework is considered at present, for preparation of the BoQ. The conceptual design is considered while leaving out the detailed engineering part of it. Before going into detailed designing, the different technology options and the economic implications are compared on a more basic level. It intends to assist a wide range of stakeholders from city officials, planners, NGOs, CBOs, users, service providers, financial and political authorities. The use of the tool will consist of three steps

First step: After opening the BoQ sheets, the user may enter the basic values. The minimum basic value input is the number of people to be covered under the system. The default value given is 100, yet the same can be altered within a range of 10-1000. The per-capita waste water generation is given as 150 liters/person/day. Though, this too can be altered if information on the same is available. The organic load will change automatically. At a more technical level, if analysis results of effluents are available, corresponding values of parameters such as BOD, COD and TSS may be given in the input cells to design the system.

Second step: If information on the construction costs is available, the same can be entered into the sheet 'rates'. The cost of treatment units will modify itself accordingly. All costs are given in Indian rupees.

Third step: Once all the inputs are given, the corresponding bill of quantities will emerge. Based on this, the decision-maker can select one of the systems, considered viable by him and then invite local contractors to set up quotations for the viable system(s) for the specific site conditions.

The technologies considered are

- Septic Tank followed by Constructed Wetlands followed by filtration
- Anaerobic Baffled Reactor followed by Constructed Wetlands followed by filtration
- Anaerobic Baffled Reactor followed by Anaerobic Upflow Filter followed by Constructed Wetlands
- Anaerobic Baffled Reactor followed by Anaerobic Upflow Filter followed by filtration
- Extended Aeration Activated Sludge Process

The characteristics of the raw effluent as well as the flow rates can be varied to design each of the treatment units in all the systems under consideration. A standard structural design is assumed for estimation of capital investment. Based on these, the capital investment and O&M costs have been arrived at. By altering any of the parameters, like the one or more of the characteristic of the raw or treated effluent, the hydraulic and process design will change and new estimates will arrive. Likewise, the population is fixed at 100 households for calculation purposes. This figure also can be altered to arrive at different estimates. The local rates for construction materials can be altered to arrive at the contextual cost estimates.

Thus the tool can be used to calculate the investment requirements to suit:

- Different sets of population
- Different flow rates
- Different raw effluent characteristics
- Different treated effluent characteristics
- Different rates for construction materials

The tool is designed in such a way that the decision-makers can easily arrive at approximate financial needs for budgeting purposes as well as vital information such as approximate operating cost and land requirements.

Once the selection is made, detailed engineering may be required at subsequent stages of the project implementation, depending on the site conditions.

Note: In the spreadsheet the primary date can be modified

FINANCING SANITATION

Construction of WWTP for Communities

Program 1: Small to Medium Communities

Detailed Bill of Quantities - Summary

Primary data

1	No. of people covered	100

Secondary Data

1	Wastewater generation per capita l/d	150
2	BOD concentration in raw sewage, mg/l	250
3	TSS concentration in sewage, mg/l	150
4	COD concentration in sewage, mg/l	500
5	BOD concentration in treated water, mg/l	20
6	TSS concentration in treated water, mg/l	20
7	COD concentration in treated water, mg/l	100
8	Per capita BOD, g/d	37.5

Note: If different value of per-capita BOD is needed, concentration of BOD may be adjusted as needed (usual range is 35-60 g/d).

Sl. No	Description of materials	Unit	Cost of material (Rs)
1	Cement	t	5,400.00
2	Sand For Mortar	m^3	630.00
3	20mm HBG metal	m^3	910.00
4	40mm HBG metal	m^3	840.00
5	Country Brick 8 3/4"x4 1/4"x2" (22.2x10.8*5.1 cm)	1000 Nos	3,600.00
6	6mm HBG chips	m^3	770.00
7	MS structural steel	kg	45.00
8	Reinforcement steel	kg	39.00
9	Silver Oak linings	m^3	10,340.00
10	Mason I Class	No	400.00
11	Mason II Class	No	350.00
12	Mazdoor I class	No	300.00
13	Mazdoor II class	No	250.00
14	Carpenter I Class	No	350.00
15	Fitter II Class	No	250.00

FINANCING SANITATION

Summary of Treatment scheme options

Sl.No.	Treatment Scheme	Capital cost, ₹	Area requirement, m^2	Operating cost Rs/day
1	Scheme-1: Septic Tank followed by Constructed Wetland followed by Filtration	689,741	400.9	272.63
2	Scheme-2: Settler Batch reactor followed by Constructed Wetland followed by Filtration	803,103	351.7	288.32
3	Scheme-3: Settler Batch reactor followed by Upflow filter followed by Constructed Wetland	743,567	180.5	177.38
4	Scheme-4: Settler Batch Reactor followed by Upflow Filter followed by disinfection and filtration	834,243	92.5	274.69
5	Scheme-5: Activated Sludge extended aeration process	805,526	104	529.19

Implementation cost of the Systems

Scheme-1: Septic Tank followed by Constructed Wetland followed by Filtration

Sl.No.	Description	Amount (Rs)
A	Septic Tank	1 23 957.60
B	Constructed Wetland	4 34 207.41
C	Treated water collection Tank-cum-disinfection	38 116.04
D	Electro-Mechanical Works	79 258.36
E	Miscellaneous	14 201.56
	All total	**689,741**
	Total area requirement, m^2	**400.9**

Scheme-2: Settler Batch reactor followed by Constructed Wetland followed by Filtration

Sl.No.	Description	Amount (Rs)
A	Settler	20 844.41
B	Anaerobic reactor	77 579.26
C	Constructed Wetland	4 34 207.41
D	Treated water collection tank	38 116.04
E	Electro-Mechanical Works	2 18 153.92
F	Miscellaneous	14 201.56
	All total	**803,103**
	Total area requirement, m^2	**351.7**

Scheme-3: Settler Batch reactor followed by Upflow filter followed by Constructed Wetland

Sl.No.	Description	Amount (Rs)
A	Settler	20 844.41
B	Baffled reactor	77 579.26
C	Upflow Anaerobic Filter	3 43 154.12
D	Constructed Wetland	1 63 658.32
E	Treated water collection tank	38 116.04
F	Electro-mechanical works	86 013.29
G	Miscellaneous	14 201.56
	All total	**743,567**
	Total area requirement, m^2	**180.5**

Scheme-4: Settler Batch Reactor followed by Upflow Filter followed by disinfection and filtration

Sl.No.	Description	Amount (Rs)
A	Settler	20 844.41
B	Baffled reactor	77 579.26
C	Upflow Anaerobic Filter	3 43 154.12
D	Treated water collection tank	38 116.04
E	Electro-mechanical works	3 54 549.66
	All total	**834,243**
	Total area requirement, m^2	**92.5**

Scheme-5: Extended aeration activated sludge process

Sl.No.	Description	Amount (Rs)
A	Collection Tank	39 746.12
B	Aeration Tank	1 07 169.10
C	Secondary settling tank	27 450.58
D	Sludge drying beds	88 998.30
E	Treated water collection Tank-cum-disinfection	38 116.04
F	Electro-mechanical and miscellaneous works	5 04 045.54
	All total	**805,526**
	Total area requirement, m^2	**103.7**

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