Technology Justice and Faecal Sludge Management

Tackling the 'second-generation' sanitation challenge in South Asia

Emptying fee for collection service delivery, Faridpur *Source*: © Practical Action Bangladesh

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While globally rates of access to improved sanitation remain woefully low, Bangladesh stands out as a country that has made remarkable progress in eliminating the scourge of open defecation. However, across the country's growing urban centres, this success has created a so-called 'second-generation' sanitation challenge of how to deal safely with the faecal sludge collected from pit latrines and septic tanks. This challenge is likely to be replicated in many other countries as access to sanitation improves. This paper explores the problem of unsafe faecal sludge management as an example of a technology injustice. It goes on to discuss how systems analysis can guide the development of innovative new programmes by identifying barriers to accessing services and involving all stakeholders in designing innovative business models and institutional arrangements. The learning from this work has helped to shape new national-level regulatory frameworks to support and encourage nationwide scaling up.

PRACTICAL ACTION
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Executive summary

Dealing safely with the faecal sludge contained in hundreds of thousands of pit latrines and septic tanks across cities in Africa and Asia will be key to making urban living more healthy, productive, and dignified in the coming decades. The scale of the challenge is beginning to be appreciated, but the complexity of tackling it effectively and sustainably remains daunting. In this paper, we view the issue of faecal sludge management (FSM) from a 'Technology Justice' perspective, which examines the inequalities in access to suitable technologies, the misaligned drivers of innovation which result in too little attention being paid to sanitation systems for poor people, and the sustainability of technology options both now and in the future. This necessitates an understanding of this sanitation challenge as not just being about access to toilets, but requiring a holistic view of the functional, financial, and environmental dimensions of expanding urban sanitation access.

Tackling three compounding technology injustices in FSM provision requires new approaches to delivering sanitation services in rapidly expanding urban areas. *Access* for all to suitable sanitation technologies depends upon functioning and commercially driven faecal waste value chains, underpinned by institutional frameworks which foster *innovation* and regulate *use* to safeguard against practices harmful to both people and the environment.

Inclusive market systems approaches will help achieve the SDG sanitation targets in urban areas

Inclusive market systems approaches emerge as a viable response to help address these injustices and achieve the sanitation targets outlined in the Sustainable Development Goals (SDGs) in urban areas. By harnessing the innovative capacity of informal workers who already understand the needs of their customers, and by addressing social and institutional power imbalances between marginalized service providers and other system stakeholders, sanitation services can be reframed through a set of regulatory and economic incentives (Shaub-Jones, 2011). This creates truly circular economies, maximizing material value and operating within planetary boundaries.

This paper presents evidence of how tackling technology injustices using a systems analysis perspective enables the identification of socio-economical and institutional barriers to affordable access to safe FSM services; involves all stakeholders in the design of innovative business models and institutional arrangements; and contributes to national-level regulatory frameworks supporting these approaches more widely.

This paper calls for national and local governments, development agencies, donors, and sanitation service providers to design more sustainable sanitation programming for the urban poor, based on a holistic analysis of sanitation service and value chains. Emerging applications of inclusive market systems approaches in urban sanitation provide evidence of empowerment for highly vulnerable communities and increased business opportunities, which should improve the economic sustainability of services.

Introduction

Global scale of the challenge

1.8 billion people still use a source of drinking water that is faecally contaminated

Great progress has been made in recent years in increasing access to drinking water, with 91 per cent of the global population now using an improved source. However, this does not guarantee water quality, and 1.8 billion people are estimated to use a source of drinking water that is faecally contaminated (WHO, 2016). About 2.7 billion people are served by sanitation methods that require faecal sludge management (FSM) and that number is expected to grow to 5 billion by 2030 (EAWAG/SANDEC, 2014). These numbers are concentrated in urban areas, whose growth is putting increasing strain on already limited infrastructure and service provision. Sewerage systems generally do not extend beyond the centre of cities, and their expansion is up to five times more expensive than on-site sanitation (EAWAG/SANDEC, 2014). On-site systems (OSS) are built without sufficient attention to what can be done once their pits are full. This is despite the fact that, as a public good, improved sanitation brings significant health and economic benefits. The return on each US dollar spent on water and sanitation improvements in low-income countries is US$5–46 depending on the intervention (Hutton et al., 2007).

What is FSM?

Faecal sludge management is a management system that collects, transports, and treats faecal sludge from pit latrines, septic tanks, and other on-site sanitation facilities. Conventional sewerage is not included in a FSM system (ITN BUET, 2016).

FSM is about

- **Public health:** minimize contact between faecal waste and people
- **Privacy, security, dignity:** eradicate open defecation; adequate, safe facilities for all
- **Water resources:** reduce pollution of municipal raw water and thus reduce treatment costs
- **Environment:** improved downstream and beyond the city

The human right to water and sanitation, passed in 2010, encompasses an element which states that, 'Sanitation facilities must be safe to use and must effectively prevent human, animal and insect contact with human excreta, to ensure safety and to protect the health of users and the community' (De Albuquerque, 2014).

In 2015, the United Nations agreed the Sustainable Development Goals (SDGs), with Goal 6, Target 6.2 being to achieve universal use of 'safely managed sanitation services'. The importance of universal access to safe sanitation was reaffirmed by all UN Member States in the context of cities as part of the 2016 'New Urban Agenda' at the Habitat III conference. However, large portions of most major and secondary cities in the developing world are far from achieving these goals and delivering on this basic human right.

Equitable and safe access to sanitation services is therefore not only about providing people with toilets. It is about ensuring the safe management of contaminating matter along the whole service and value chain. This requires a combination of the right technologies and systems to ensure those technologies are safely used and maintained.

Bangladesh's emerging 'second-generation' sanitation challenge

The FSM situation in Bangladesh presents a particularly interesting and challenging case for some very positive reasons. After years of campaigning and implementing sanitation programmes in Bangladesh, rates of open defecation have fallen to just 1 per cent in 2015 from 34 per cent in 1990. This progress was achieved by the remarkable growth of OSS facilities. In most informal settlements and low-income urban areas with no sewers, residents now rely entirely on OSS including septic tanks, which are frequently installed without following adequate engineering design and encourage FSM practices that are a threat to human health and the environment. The absence of effective emptying services in these settlements means these toilets eventually overflow, which leads to open defecation reoccurring, and open exposure to the human waste. This situation has been called a 'second-generation' or 'post-open defecation free' challenge.

Accompanying the problems of continued exposure to faecal sludge for residents are the inhumane working conditions of informal pit emptiers. They are often socially excluded, extremely poor, and work in extremely hazardous conditions; a situation compounded by being considered 'untouchables' within Bangladeshi society. Manual pit-emptying is considered a breach of human rights (De Albuquerque, 2014). But recognizing their centrality to providing services at scale, in 2016 the Dhaka Declaration (SacoSan VI 2016) stated that South Asian governments explicitly commit to ensuring pit emptiers' 'dignity, adequate remuneration and occupational health and safety'.

Why FSM is a Technology Justice issue

Technology Justice is a concept which shines a light on global inequalities in the access to, innovation, and use of technology. It recognizes that technology is at the heart of human development, but its benefits are not fairly shared. The environmental impact of our use of certain technologies is pushing our planet to a crisis point. And the current innovation system for new technologies fails to address the most pressing global challenges (Meikle and Sugden, 2015).

The lack of access to adequate sanitation, including the safe management of faecal sludge, is a technology injustice. The concept highlights three key aspects of this:

- inequity in access to safe sanitation, including to FSM services;
- unsustainable use of sanitation technologies;
- misaligned drivers for innovation in the sector.

Inequity in access

Inequity in access refers to the gap in access to affordable, safe sanitation services, appropriate to the context. In urban areas, a stark divide exists between better-off populations and slum dwellers. In many cities, only the richest segments have access to sewers, and if they rely on OSS, they are better able to access regularized emptying services. Poor people, in particular those living in slums and informal settlements, are beyond these systems. Women are often more deeply impacted by this situation than men as they generally spend more time within the settlements, and have less disposable income to afford the use of better managed toilets. Women and girls also require adequate facilities for safe menstrual hygiene management practices. Children playing in open spaces are more likely to be exposed to the health risks of overflowing toilets.

Slum dwellers, Faridpur *Source:* © Noemie de La Brosse

A Technology Justice lens helps to highlight several reasons for this inequitable situation:

- Poor people are rarely regarded as a priority for public investment.
- Their rights and those of the most marginalized (suffering discrimination based on age, disability, gender, or caste) to access technologies and technical knowledge are overlooked.
- Their potential as technology innovators is ignored.
- The technologies that do exist are often unaffordable for the poor, or are not suitable in densely populated neighbourhoods, and for the types of toilets they use (Practical Action, 2016: 9).

Unsustainable use of technology

The bias towards large-scale sewered systems as the long-term solution to cities' sanitation problems seems *unsustainable in its use of resources* and can lead to the economic exclusion of informal waste workers. Often these systems require significant amounts of water and energy, which is simply not feasible where water resources are scarce, and would take many years to implement. The latest global assessment found that only 43 per cent of country expenditure on the water, sanitation, and hygiene (WASH) sector goes to sanitation. Although 82 per cent of country expenditure goes to urban areas, over half of this (56 per cent) is directed to 'large systems' (such as pumping stations and large-scale sewerage) (UN-Water and WHO, 2014) which rarely serve low-income populations.[1]

Concurrently, the prevailing situation is that urban sanitation is mainly viewed as a household responsibility and is therefore largely ungoverned and unfunded, which leads to huge inefficiencies (Fonseca and Rognerud, 2015). The economic costs of poor sanitation in Bangladesh are US$4.2 bn each year. This was equivalent to 6.3 per cent of Bangladesh's gross national product in 2007 (DeFrancis, 2012).

Misaligned drivers of innovation

The *drivers of innovation* are misaligned in the WASH sector, compounding the injustices of access and use. The lack of investment in improving OSS and FSM is one indication of this. The vast majority of national and international investment in the sector is targeted at water access rather than sanitation, and mostly to improve existing technologies of communities already served, rather than investing into new technologies for those who lack adequate, safe access. Another key driver of innovation comes from the way incentives are structured within sanitation service systems. The Bill & Melinda Gates Foundation's (BMGF) 'Reinvent the Toilet' initiative and the discussion of urban sanitation and faecal waste as part of '50 critical scientific and technological advances needed for sustainable global development' (Buluswar et al., 2014) underline the need for new technologies. Including end-users in developing new technologies through participatory approaches is essential to ensure the choice of appropriate solutions and ownership in sustainable sanitation programming.

Business model innovation is needed to improve access to quality services

At the same time, innovation is needed in business models and approaches so that they help create the financial incentives to improve the quality of service and to expand delivery to meet the needs of all residents. National governments can also play a role in shaping innovation through the way they set standards and regulations. For example, if standards are set too high and manual pit-emptying is outlawed, as is happening in several South Asian countries, the potential for innovation based on their existing knowledge and experience is lost.

Systems approaches to address FSM injustice

If we are to address the technology injustices outlined above we need a systemic approach which works with the existing actors in the system and across the different stages of the sanitation chain. Systemic approaches are well geared to considering the incentives and drivers which influence how particular parts of the system operate (Uraguchi, 2016), and changing these to create better outcomes (better access to sanitation and less faecal sludge openly dumped in the environment). The approach allows practitioners to explore all the barriers faced by the various stakeholders of a system, the drivers, and (political, socio-economic, or cultural) blockages for innovation, and an appreciation of the need for circular material flows to address environmental concerns.

What is a systems approach?

'This approach tries to (re)define the role of development agencies – from always doing things by themselves and thus substituting actors and players towards supporting individuals, communities, enterprises and governments in finding solutions to problems they face.'
(Uraguchi, 2016)

Barrier analysis tools such as the 'social model' of inclusion can provide insights to understand what prevents marginalized people from participating (Gosling, 2009). This enables us to understand the root causes of inequity in access to technologies, and the reasons why governments and service providers have opted for unsustainable technology choices.

Systemic approaches with NGOs playing a role as a temporary facilitator of change contrast with traditional sanitation programming as they put the emphasis on fostering linkages between permanent stakeholders (policy makers, local governments and duty bearers, communities, informal waste workers, etc.). Development agencies, their partners, and civil society organizations help to mediate challenging relationships and enhance marginalized stakeholders' literacy of the FSM system, its regulations, and its development constraints and opportunities.

In the remainder of this paper, we describe Practical Action's experience of adopting a systems approach to tackling FSM issues in Faridpur Municipality, Bangladesh. We have worked there to develop institutional and business models that ensure inclusiveness, affordability in access to, and profitability in provision of FSM services, addressing all aspects of technology injustice.

Facilitating the creation of inclusive business models

The objective of adopting a role as a facilitator of systemic change, rather than as an active participant in the market system, is largely to ensure sustainability and the potential for scaling up. It helps to create partnerships and business models that meet both the short/medium-term needs of service providers (e.g. regular revenue streams) and longer term, city-wide objectives for public health and environmental protection.

Organizations such as BMGF, DFID, and USAID are supporting pioneering research and action addressing the root causes of the lack of efficient FSM services. Projects in Dakar[2] and Lusaka (WSUP, 2015) serve as insightful models for Africa on urban sanitation. In West Africa, the Sanitation Service Delivery project (USAID, 2015) is putting a similar emphasis on developing scalable business models that engage private sector service providers, and works on creating a strong enabling environment for sanitation. Insights from India are highlighted in Box 2.

In Bangladesh, *Paurashavas* (municipalities) are responsible for WASH and waste management service provision (under the Paurashava Act 2009). In many cases this means that they own and operate a small number of exhauster trucks to empty septic tanks. However, Practical Action's initial situation analysis in the town of Faridpur showed that customers strongly prefer informal services, which they found more affordable and reliable than the municipality service.

Although considered as temporary solutions, onsite sanitation systems are often here to stay

Sanitation market systems have the potential to create business opportunities from service operation and reuse, particularly for marginalized workers. OSS systems are often considered temporary solutions until sewerage systems can be implemented. In reality they are often here to stay as permanent, stand-alone solutions, as private actors have recognized more quickly than policy makers (EAWAG/SANDEC, 2014).

Whichever system was being used to empty the pits in Faridpur, however, only 10 per cent (at most) of the sludge was being safely disposed of by the Municipality's Conservancy Department (CD) and the informal workers, i.e. the Muslim Sweeper Group (MSG) and the Harijan Sweeper Group (HSG) (see Figure 1). The quality and safety of the service needed to be significantly improved, but there was also a clear case for incorporating

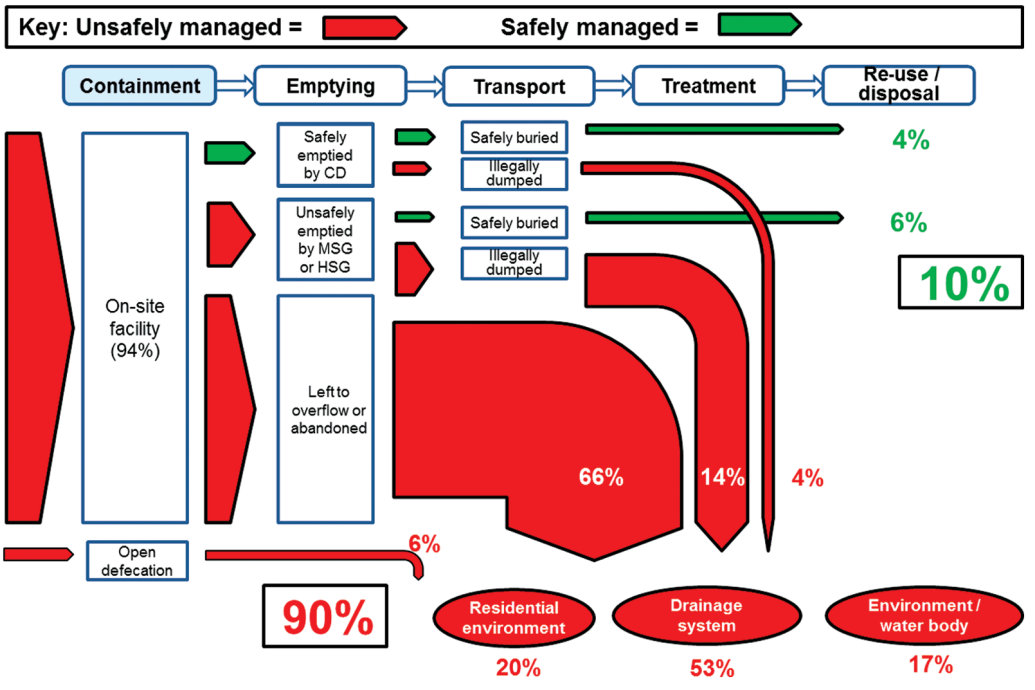

Figure 1 Faridpur faecal waste diagram *Source:* © Lucy Stevens, Practical Action

the informal sector as a central part of innovative institutional arrangements. Box 1 and Figure 2 describe the approach we took (see de la Brosse et al., forthcoming, for details of the financial flows).

In Faridpur, the municipality was strongly committed to facilitating city-wide FSM, incorporating it into the City Master Plan and allocating land for a treatment plant. While needing support and capacity building, the existing informal waste workers were already providing a valued service, and could see the importance of disposing the sludge safely.

The systems analysis enabled stakeholders to explore business and value chain opportunities from a new perspective. This highlighted opportunities to establish circular economy models, incentivize safe disposal and treatment of faecal sludge, and provide opportunities to maximize the material value of the waste through technologies which use this waste for biogas and organic fertilizers.

The increase in quality of service to the customer resulting from this business model is already promising. Access to safe and clean collection machinery and personal protective equipment contributes to improving the status and decency of the work. This system allows service providers to get part of their revenue from the emptying fee paid by customers and the other part from the treatment plant operator when they deliver sludge. This ensures reliable revenues for the service providers, safe management of faecal matter, and a service that remains affordable even to the poorest households. These models ensure a much greater financial viability and performance of the service, using municipal resources more efficiently than before.

One ongoing challenge is the viability of resource recovery from the treated faecal sludge, as market demand for organic fertilizers remains weak because

Desludging technologies used by Khutibari Cleaners Cooperative, Faridpur
Source: © Practical Action Bangladesh

of unfavourable government regulations, imbalances in subsidies, and cultural acceptance by farmers, despite studies demonstrating the positive cost–benefit analysis of organic matter in farming (Hasan et al., 2016). Practical Action is working with the national government, agribusinesses, and research institutions to facilitate a change in perceptions and on marketing strategies for fertilizers made from human waste (Cook et al., 2017).

The systems analysis highlighted that ongoing demand generation and awareness-raising activities are key enablers to strengthen trust in FSM business models, a situation also found by WSUP in India. Residents being sensitized to stop illegal connections of toilets to drains and water bodies and matching the financial incentives for service providers and users have combined to reduce public health and environment hazards. To date, the model has been piloted in two wards covering 13 per cent of the city, including some slum areas, with plans for scaling up city-wide, and with the potential to be replicated in other cities. The experience has been important in informing the development of a new national framework for FSM.

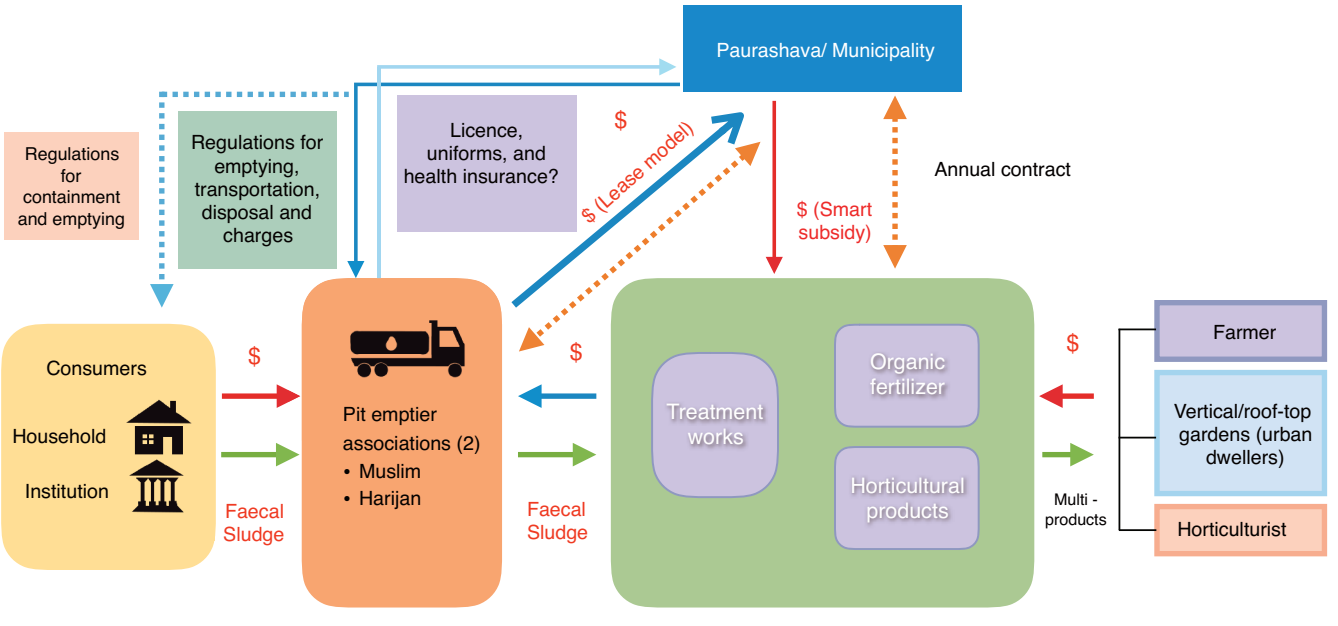

Figure 2 Proposed institutional set-up for market-based operation of FSM

Case studies of inclusive FSM business models

Box 1: Practical Action's inclusive systems approach to urban sanitation

As part of the 'Public Private Partnerships for Sustainable Sludge Management Services in Faridpur, Bangladesh' project implemented with the support of BMGF (2014–2017), Practical Action has adopted a holistic approach to sanitation by identifying social, attitudinal, and institutional barriers and leverage points for innovation at all levels of the sanitation chain (containment, collection, disposal, reuse). We have built upon existing market-based practice to design innovative business models with stakeholders, in a context where discrimination and marginalization are prevalent.

The challenge was to generate financial and non-financial (social status and protection, health, environment) incentives for the informal actors to buy in and stay engaged in a model that they see as profitable, trustworthy, and self-rewarding.

This model relies on training the informal workers on regulation, safety, and business planning to partner with the municipality and an operator of the newly constructed treatment plant, with a system of cross-subsidies to incentivize pit emptiers to safely dispose of the sludge. The public–private partnership provides flexibility as the service is adaptable for city-wide upscale beyond the initial pilot in two wards. The model focuses on creating both social recognition and business opportunities to increase ownership for the pit emptiers now working in formal associations.

They have been empowered as their literacy of complex market systems increased and their representation and negotiation skills were strengthened. This supports them to become more proactive and confident in developing solutions for improved livelihoods and to change society's perception of them. In Bangladesh, this approach has put manual pit emptiers in a position to negotiate for their rights.

(Stevens et al, 2015)

Box 2: WSUP support to city-wide coordination of the septage management market in Vizag, India

Visakhapatnam (Vizag) is one of the cleanest cities in India, but a new challenge is emerging to strengthen provision of FSM services and keep pace with rapidly increasing levels of toilet access under Swachh Bharat Mission (SBM). WSUP, funded by USAID, is currently undertaking activities to support the Greater Visakhapatnam Municipal Corporation in stimulating and coordinating the FSM market at a city-wide level, improve the quality and affordability of the services, and provide financially and technically viable decentralized faecal sludge disposal, treatment, and re-use facilities.

A rapid assessment of the supply market showed that city-wide demand for mechanical emptying services had dropped in the last 15 years as a result of increased connections to sewers. As the number of emptying operators multiplied 15-fold, demand for services stagnated, thus resulting in reduced efficiency. Operators looked to cover their cost in a saturated market; many did so by resorting to collusion, thus driving prices up beyond levels affordable to many of the urban poor.

The analysis of the current services helped the Vizag municipality to develop a deeper understanding of the market barriers, and start developing solutions to address major market failures. An assessment of the potential market for faecal sludge by-products and of the interest of private actors in running a resource-recovery business will be explored in future through a feasibility study. Lessons from these activities could support other Indian cities in better understanding and influencing FSM markets. This also demonstrates that access to technologies alone is insufficient to address the interdependent technology injustices which constrain suitable sanitation service access for the urban poor.

The creation of a national FSM framework in Bangladesh

Our efforts to find new and innovative ways of addressing the FSM challenge in Faridpur (and those of others in a few other locations in Bangladesh) are beginning to show signs of success, and there has been much to learn. However, they are currently operating in a localized way, highly reliant on the political enthusiasm of local municipal leaders. If such models are to be adopted across the country, new guidelines and a clearer institutional framework and division of responsibilities will be required. Regulations, laws, and strategies need to be clearly defined, and include a set of incentives. These are also a way to shape the enabling environment so that efforts are more focused on sustainable solutions which put the needs and livelihoods of the poor at the heart of responses to the 'second-generation' sanitation challenges.

The Government of Bangladesh has acknowledged that appropriate institutional arrangements are a prerequisite for effective FSM. However, the development of a new national framework is a delicate balancing act. Too much regulation can act as an entry barrier if containment standards are too high and unaffordable for the poor (Blackett et al., 2014), who fall back into unregulated services. On the other hand, the absence of a framework means that there is no driver for municipalities to leverage any change.

Institutional frameworks clarify roles and responsibilities, and incentivize safe treatment of faecal waste

Practical Action and ITN–BUET (International Training Network – Bangladesh University of Environmental Technologies) supported the participatory design of an Institutional and Regulatory Framework in Bangladesh that aims to encourage a more systematic approach to FSM, to clarify the role of different levels of government and other actors, and to establish a model to encourage circular economy principles in dealing with faecal waste.

This framework has been designed for different scales of urban areas: City Corporations, Dhaka city, *Paurashavas*, and rural areas (MoLGRDC, 2015). It provides a uniform set of guidelines for municipalities on ensuring the proper construction of sanitation facilities and of disposal options for faecal sludge and solid waste. Each framework provides guidance on:

- *The responsibilities of authorized stakeholders for each step of the service chain, their roles and obligations*, and the mechanisms responsible for the monitoring and enforcement of each activity,
- *A focus on proper design and construction of sanitation and disposal facilities,* social sustainability (i.e. social discrimination, rights, and safety for pit emptiers), environmental sustainability (i.e. stopping illegal connections to, and disposal into, water sources by integrating an 'Environmental Police' to ensure compliance), and economic sustainability (i.e. sustainable business models for FSM, including cross-subsidies for more pro-poor service-level agreements, and 'safe sludge transfer' incentives, gradually developing a database of all sanitation facilities and their emptying frequency).
- *Capacity building, training, and research* including filling knowledge gaps, technical assistance, training, and quality assurance of processes and products (e.g. compost) in the FSM service chain.
- *Awareness-raising campaigns,* promoting private-sector participation, and demonstrating FSM business.
- *Technical assistance and funding support from the government for capital infrastructure and other assistance*, (for example securing land for construction of the treatment facility).
- *Guidance on FSM business models*, whereby treatment-plant operators pay the collection and transportation operators a discharge incentive to dump the sludge safely. This financial incentive rewards socially desirable behaviours, and encourages re-use and resource recovery.

Business management training for pit emptiers, Faridpur
Source: © Practical Action Bangladesh

In addition to this framework, a National FSM Network is being established to promote peer-learning. Its first convention included a session on 'Dignity for Septic Tank Emptiers' where manual pit-emptiers had an opportunity to share their challenges with a variety of national and local stakeholders. This contributes to building a strong momentum around not only the business potential of FSM, but also the rights of both service users and providers for healthier life conditions. The network will also support integrated approaches, such as the nexus between farming and urban sanitation that can alleviate the cultural concerns about the safety of faecal compost use in agriculture.

The National FSM Network can build support for realizing the rights of manual pit emptiers and of service users

Concerns about sustainability have long been a high priority in the WASH sector, with even successful Community-Led Total Sanitation projects being prone to slippage, especially where a supportive system has not been built (Thomas, 2016). Without a strong enabling environment that supports both access to appropriate technology and linkages between market actors, FSM programmes cannot be sustainable, and will fail to address growing access issues in rapidly expanding urban areas. But with national and locally applied regulation, institutional frameworks can support access to technologies through inclusive models, which take demand-growth of low-income consumers into consideration. Such systems approaches enable successful models to be taken to scale across a nation, but defined and adapted locally, to ensure sustained access for the millions of people who need it.

The Institutional and Regulatory Framework contributes to fostering relationships between stakeholders from technology and business-model perspectives. A variety of stakeholders including research institutes, universities, and private-sector stakeholders have been engaged in defining the regulations. This aims to tackle the injustices in innovation in the sector, aligning aims and investments towards the needs of low-income consumers and the informal service providers. This should result in more cost-effective services that fill the gaps between demand and municipalities' ability to supply FSM services.

Moreover, the National FSM Network ensures that the innovative capacities of informal workers are harnessed and integrated into localized responses. By creating clear guidelines, incentives, penalties, and responsibilities, institutional frameworks can ensure that the use of sanitation technologies is not harmful to people or the environment. At the same time, we recognize that adopting these approaches represents a significant change in approach for municipalities, and they will need ongoing support and capacity building to make it a success.

The example of Bangladesh shows the extent to which government commitment can improve sanitation. This National Framework opens the path for implementing collection and transport systems that address the sanitation needs of the entire population at affordable prices, for all types of onsite technologies, including in densely populated informal settlements that mechanical emptying vehicles cannot access. It provides both a robust foundation to avoid uncontrolled discharge into the environment and incentives to favour viable resource recovery.

A systems approach to FSM has therefore highlighted opportunities to move beyond a 'do no harm' approach, to establishing truly circular economies to tackle the prevailing technology injustices in sanitation services. By utilizing treatment technologies which

can create significant added value from faecal waste as a commodity, there exist even greater incentives for establishing sustainable sanitation systems.

Conclusion

Bangladesh, along with other large South Asian countries, is beginning to recognize the enormity of its 'second-generation' sanitation challenge of tackling unsafe FSM. The lack of access to safe sanitation and FSM services is a technology injustice. The prevailing injustices in access to suitable sanitation technologies are compounded by injustices in the drivers of innovation and investment into the sector, and by the environmental health hazards caused by unsustainable use of certain technologies, which can lead to slippage back to open defecation.

The Technology Justice approach also highlights the need to assess the impacts of sanitation technology choice on the livelihoods and work opportunities of informal waste workers, who are vital actors in sanitation service systems, but who are often marginalized in responses to deal with safe sanitation practices. It emphasizes that technologies are not neutral and their impacts can be both positive and negative for different people, and may change over time.

We have illustrated how using systemic analysis helps guide interventions to respond effectively to the growing sanitation service needs of urban areas. Focusing on empowering informal workers through inclusive business models can transform sanitation service delivery for the urban poor and address the three interdependent technology injustices, utilizing circular economy models. When coupled with improved national regulatory systems to be adapted and applied locally, the system has the potential to scale up city-wide and nationwide.

Organizations and governments working hand-in-hand pioneering this multilevel approach and putting inclusive market systems theories to sanitation into practice are opening the path for durable and safer FSM.

NGOs have a key role to play as temporary facilitators of systems change

Building on this evidence, national and local governments, development agencies, donors, and sanitation service providers should adopt more holistic, systemic approaches to improving sanitation services and value chains. NGOs have a key role to play as temporary facilitators of systems change. Emerging applications of inclusive market systems approaches in urban sanitation provide evidence of how highly vulnerable communities can be empowered, and business opportunities developed. Their potential is just beginning to be explored, but they offer the promise of helping to address one of the most challenging SDGs in sustainable and scalable ways.

Notes

1. At the same time, comprehensive data is scarce, and only 25 of 94 countries who responded could provide an expenditure breakdown, even at a basic level, and treatment of sludge from OSS was not captured at all.
2. A pilot project supported by the Bill & Melinda Gates Foundation and ONAS.

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