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RESEARCH REPORT

Governance for Decentralised Sanitation: Global Practice Scan

A WORKING DOCUMENT

COMMUNITY SANITATION GOVERNANCE

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'Community Sanitation Governance' is a joint research project led by the Institute for Sustainable Futures (ISF) at the University of Technology, Sydney, which investigates effective governance for successful long-term operation of community scale wastewater systems in Indonesia. Effective governance refers to the financial, stakeholder, organizational, regulatory, and technical support necessary for successful, long-term service delivery. The research is undertaken in collaboration with BORDA Germany, the Overseas Development Institute (ODI), AKSANSI (Association for Community Based Sanitation Organisations in Indonesia) and the Center for Policy Regulation and Governance at Universitas Ibn Khaldun Bogor (UIKB). The research has been funded through a research grant under the Australian Development Research Awards Scheme (ADRAS), an Australian Aid initiative.

This 'working document' is the first output of this research project and may be updated throughout the three-year project.

ABOUT THE AUTHORS

The Institute for Sustainable Futures (ISF) was established by the University of Technology Sydney (UTS) to work with industry, government and the community to develop sustainable futures through research and consultancy. ISF's mission is to create change toward sustainable futures that protect and enhance the environment, human well-being and social equity. We seek to adopt an inter-disciplinary approach to our work and engage our partner organisations in a collaborative process that emphasises strategic decision-making. Our projects foster lasting change and we aim to build independent capacity in our clients by passing on knowledge and skills. We focus on innovation and our research often extends sustainability practice and contributes to current thinking.

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1 Purpose of Global Practice Scan

The purpose of this scan of global practices, from developed and developing countries, is to review, bring together and synthesise insights on how others have approached governance of decentralised systems with respect to operational responsibilities (ORs) and institutional arrangements (IAs).

The scan of relevant practices, experiences and lessons from sanitation and other decentralised sectors, is intended to stretch imaginations and to seed ideas for new possibilities, for the project team, our participants, and our broader audiences.

The scan provides:

- A foundation for our research,
- Form and structured insights for how we engage, how we collaboratively diagnose, and what we collaboratively propose for the case studies,
- An opportunity for the project to collate the knowledge and experience in the broader project team.

The term 'scan' is especially chosen to indicate that the review of practices is intended to be comprehensive but not exhaustive (see Appendix for scan methodology). In reporting our findings, 'the literature' refers to the 70-plus documents scanned for the review within the timeframe, scope and budget for the task. As our first project deliverable, it is intended to inform the work that follows. We expect to have missed some valuable information resources, and intend this scan to continue to exist in some form after delivery, to serve as a living resource during the project timeframe as new information comes to light.

Box 1: Key Definitions for the Global Practice Scan

- **Governance:** arrangements for (decentralised sanitation) service delivery that includes day-to day activities ensuring functionality of the system, and formal and informal institutional arrangements that enable effective delivery of the required day-to-day activities. The definition draws on Kooiman's (2003) concept of first- and second-order governance that together incorporate financial, policy and regulatory, stakeholder, technical, and organisational domains (see definitions for ORs and IAs below for further explanation).

- **Sanitation services**: a system that 'Collects excreta, transports it to a suitable location and/or stores it for treatment, treats it, reuses it and/or discharges it to the environment. A good sanitation system also minimizes or removes health risks and negative impacts on the environment' (Sanitation and Hygiene Promotion - Programming Guidance (2005) Authors: USAID, WSSCC, UNICEF, WHO/PAHO, WEDC, the Water and Sanitation Program (WSP) and the London School of Tropical Medicine and Hygiene).

- **Decentralised sanitation**: community-scale sanitation systems that serve multiple households through small sewer networks and/or communal sanitation facilities, with sewage treated locally, often using passive anaerobic methods (based on definition by Eales et al. (2013))

- **Operational Responsibilities (ORs):** activities relating to the day-to-day functionality of the service delivery system – referred to as first-order governance (Kooiman 2003)

- **Institutional Arrangements (IAs):** the formal and informal institutional contexts that help or hinder the successful delivery of the day-to-day activities (ORs) – referred to as second-order governance (Kooiman 2003).

2 Scope of the Global Practice Scan

The primary focus of the scan is to illuminate how to enable efficient and effective decentralised sanitation services in the long-term.

Our enquiry is focused on the operational phase of existing systems. Decisions and actions in the pre-commissioning phases significantly impact on the operational phase, however the scan is focused on learning from and improving existing systems, from which we hope to draw inferences about design and construction for new sites.

The scope of the scan includes learning from successes and failures across:

- Systems in both **developed and developing** contexts, including select countries in North America, Europe, Australasia, South America, South Asia, South East Asia, and Africa,
- Systems that service **multiple households** (20 or more)
- Both **public and private roles, responsibilities, accountabilities**
- Operational responsibilities (ORs)
- Formal and informal institutional arrangements (IAs)

Our scope includes decentralised infrastructure/services from sectors other than sanitation, in recognition that they may have useful insights to offer while not being the core focus.

The language of ORs and IAs has been developed for this research project in order to usefully describe or categorise aspects of decentralised sanitation system governance. Therefore it was rare that we found these terms in our searches, but we found examples that resonate well with these concepts. For this practice scan we were particularly interested in how ORs were investigated and assigned and what types of IAs helped or hindered the sustainability of decentralised sanitation.

Learning from failure is also valuable and is facilitated by monitoring with a learning orientation and adapting in response (Jones et al., 2013). Reported failures were accompanied by recommendations on how to improve the system. However, much literature stressed that while each system may experience similar technical or institutional failures, the dynamics that lead to or influence these failures are entirely unique, and therefore solutions also need to be developed contextually. For this reason, close attention was paid in this scan to case studies demonstrating long-term success.

3 Governance Models of Decentralised Sanitation

There are a great many possible arrangements for governance of decentralised systems, determined by local contexts, especially by prevailing regulatory environments (national and local policy, legal, regulatory and institutional frameworks).

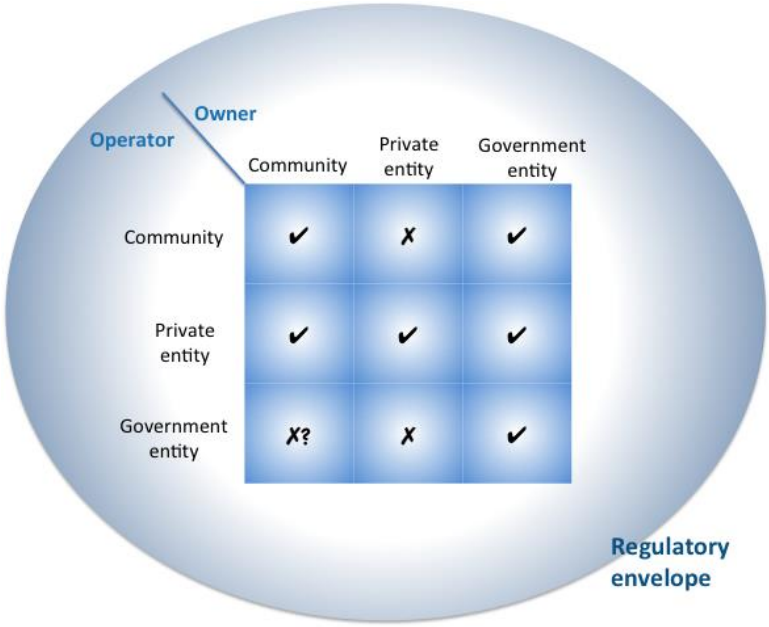
In this section we illustrate some of the diversity in the field explored through the global practice scan. As defined, governance of community-scale decentralised sanitation services encompasses arrangements for ownership, management and operation of the system within the institutional context and regulatory framework (including meeting requirements on service standards, effluent discharge standards, pricing guidelines, cost recovery principles etc.).

The actors in the field include the community (community based organization (CBO)); government agencies; and private entities providing a range of sanitation-related functions (for simplicity we place NGOs and civil society organisations within the 'private entity' category).

These actors can have different roles and responsibilities in owning and operating the system as illustrated in Figure 1 below. The boundaries between actors in Figure 1 are deliberately blurred to represent the continuums that exist: for example, a water and sanitation utility may be a state owned enterprise (falling under 'government') or a private entity.

Management (administration, decision making etc. with respect to the services) is a third dimension that could fall on either the owner or the operator in different situations. We have not sought to disentangle management in the illustrative diagram as the distinction has seldom been explicitly made in the scanned literature.

Figure 1: The variety of possible owner/operator combinations for decentralised sanitation encountered in the global practice scan



Community owned systems (or key parts of systems) can be found in many places – home owner associations (HOAs) in the USA (ISF & Stone Environmental, 2009), community based organisation in Indonesia (Eales et al., 2013), and communities in Pakistan, Brazil amongst others (McGranahan, 2013; Ostrom, 1996). Some of these communities both own and operate their systems, while others may contract with private entities to provide some or all of the operations. While it may be within the realm of possible arrangements for community-owned systems to be operated by a government entity (ISF & Stone Environmental, 2009), we did not encounter any examples of this.

There are examples of government owned community-scale decentralised systems that are operated by all three groups: communities (Eales et al. 2013; IndII, 2013); private entities under public-private partnerships or direct service contracts (Leménager et al. 2010), or by (municipal) government entities (Nema, 2013).

Private entities can be found providing services under a full range of ownership arrangements, such as services under contract to a CBO (Eales et al., 2013) or government agency, and cases where systems that are both owned and operated by private entities (ISF & Stone Environmental, 2009). Unsurprisingly, we did not come across any examples of privately-owned systems that were operated by a CBO or government agency.

The scan highlighted opportunities for hybrid models where the actors work in cooperation to deliver effective sanitation as summarised by WSUP-BDP (2014):

> ***… c****ombine characteristics of community management, private management and often public service provision; that is mix values, principles and practices from distinct management models. This model can achieve corporatisation of community management organisations, specialisation and the delegation of functions, social entrepreneurship. Both formalisation/professionalisation and specialisation/delegation are typical processes of hybridisation*' (WSUP – BDP, 2013).

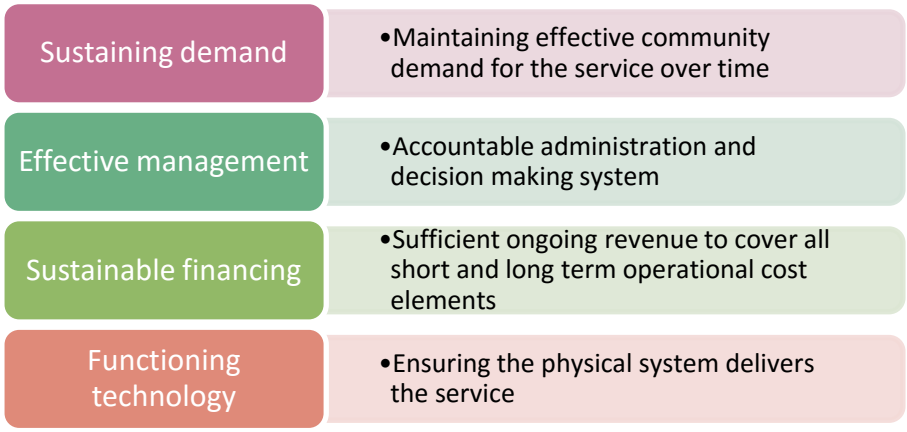
4 New Domains of Support for Decentralised Systems

Adequate governance as defined here is essential for the successful long-term operation of infrastructure services. Achieving adequate governance in practice encompasses a messy set of overlapping, complex processes and relationships. When the services are to remove something that is unwanted (such as sanitary waste) rather than provide something that is desired (such as water or electricity), governance arrangements are even more challenging due to the relative perceptions about private versus public benefit from the service.

Four distinct but intertwined domains emerged and were identified as a useful way of structuring the themes that came through the global practice scan – domains that are essential constituents of adequate governance for decentralised sanitation (Figure 2 below). Under each domain, we categorise our findings as either *operational responsibilities* – activities that are required more or less regularly on a day-to-day basis; or *institutional arrangements* – arrangements that enable the operational responsibilities, including the formal and informal processes, policies, regulations, and norms that govern approvals, ownership, management, pricing, and performance accountability and responsibility for decentralised systems. The essence of the findings are summarised in a title, framed as either a recommendation or an empirical observation, as appropriate.

Our findings did not always fall unambiguously within a single domain, and sometimes had characteristics of both ORs and IAs – symptomatic of their inter-twined nature. In such cases we have placed them within the domain and order of governance with which they appeared to align most closely.

Figure 2: The domains of adequate governance of decentralised systems emergent from the Scan



The sector actors, and who does what, are centrally important, and not always clear or simple. In the sections on ORs and IAs we have not sought to be definitive or prescriptive about actors except when the scanned literature was specific. To highlight the complexity of the multiple roles of each stakeholder with respect to ORs and IAs, we present a summary table (Section 6.5) of potential roles each stakeholder could take, based on our reflections on the global practice scan.

5 Summary of Key Themes

A synthesis of the key themes that emerged through the scan is provided in this section. The synthesis groups and draws linkages between the common types of ORs and the specific types of IAs that would support those ORs within each domain. Each of the bullet points in the tables in this section is effectively a synthesis in itself – each of the dot points functions as a sub-heading in the following section (Section 6), where they are expanded, explained and referenced.

5.1 Sustaining Demand

The following themes arose in relation to sustaining community demand for the service over time.

Theme	Operational Responsibilities	Specific IAs
Social marketing + engagement	• It is important to plan and budget for ongoing soft costs, not only initial soft capital investment.	• Effective 'soft interventions' can increase demand • Several common tools are used for engaging the community as a means to create or reinvigorate interest in sanitation systems. • Building trust between users and the CBO or provider can potentially increase use of the systems.
Ensure the systems meets the community's needs	• Linking social incentives to key local motivators can help sustain demand. • Understanding diversity and developing socially inclusive systems is needed, to increase inclusive community ownership and broaden the user base.	• Socio-cultural norms need to be mapped in order to construct locally appropriate systems. • Sustainable systems must necessarily be affordable and make users proud of.
Assess + monitor demand	• Monitoring perceptions and changing demand is important.	• There is potential to misinterpret demand
Holistic collaborative approach	• Collective demand is nurtured and sustained through community organisation.	• There is a need for cooperation with other NGOs working in the community. • Holistic approaches, where sanitation is part of a long-term community development/shelter program, have been related to successful sanitation systems. • Demand for ancillary services to keep systems operational can be sustained by complementary support for supply of those ancillary services.

5.2 Effective Management

Operational responsibilities and institutional arrangements for effective management are summarised under the following themes.

Theme	Operational Responsibilities	Specific IAs
Management and planning	• Regular management meetings are needed • Planning and budgeting needs to be thorough and include often forgotten aspects such as management tasks, major expenses, inflation. • Planning for uncertainty improves long term sustainability. • The need for planning for emergencies is not adequately addressed in the literature.	• Succession planning is needed to maintain institutional and social capacity. • A large community organised in smaller organisational units of neighbours, has proven to be a successful management model • Forming a cooperative management institution of local community associations has proven to be a successful management model • Outcomes can depend on which tasks are community managed. • Good dialogue and communication between stakeholders is key to coordinating services across multiple actors. • Clarity of ownership guides responsibilities for management. • Matching the level of management of decentralised systems to the level of risk can be an efficient and effective path to achieving outcomes.
Clear responsibilities	• Gap in literature	• Clearly defined roles and responsibilities, with a single 'lead agency' in a coordinating role would improve service delivery • There is a variety of means to formalise commitments between parties, depending on the context and need. • Clear decision-making and administration structure increases capacity to deal with issues.
Attuned to community needs	• Fee collection system must be designed to meet the specific needs of the community. • Women are often preferred in treasurer roles. • Accessible complaint mechanisms can be used to improve services.	• Local capacities should be matched and developed to meet the needs of efficient and effective sanitation.
Incentives	• A paid manager is more likely to deliver on responsibilities than volunteer managers/operators.	• Creating incentives can motivate operators' and local government performance. • Encouraging innovation and expansion of scope of services by the private sector can bring in much needed capacities
Monitoring of management systems	• Establishing systems to monitor management can enable improving management to meet local needs. • Reporting needs to be standardized, transparent and regular. • Modern technology can offer for improved information management.	• Keeping management monitoring focused on learning, adaptation and evolution can lead to improving management

5.3 Sustainable Financing

The following themes provide insight on ensuring sufficient ongoing revenue to cover all short and long term operational cost elements (recurrent costs, operating and minor maintenance, capital maintenance, etc).

Theme	Operational Responsibilities	Specific IAs
Sustainable cost recovery	• Sustaining service levels is dependent upon accurate forecasting of recurrent costs.	• Shifting discourse on the mechanism for full cost recovery towards 'sustainable cost recovery'. • Financial planning should use a lifecycle perspective. • There are multiple views on who should pay for capital maintenance costs. • There are multiple views on tracking informal tariffs from households.
Innovative financing	• Supplementary income streams can be created from recycling and reuse.	• Innovative financing mechanisms may foster experimentation and learning.

5.4 Functioning Technology

The ORs and IAs required to ensure the physical system delivers the service, can be technology-specific, and are well documented, therefore the scan was directed to synthesise common or more general technology ORs and IAs.

Theme	Operational Responsibilities	Specific IAs	Over-arching IAs
Operation and Maintenance	• Important day-to day ORs, including training, coordination and education. • Longer term ORs are often forgotten during planning, but are essential.	• Capacity building is necessary and involves training, skills development, knowledge sharing processes. • Clearly define roles and responsibilities support service delivery. • Technical assistance can be provided in a variety of ways. • Access to externally provided services, such as those relating to sludge services and local, transparent supply chains, can be crucial.	• Accountability for routine operations and maintenance can be facilitated through incentives and implementation partners. • Standards and regulation can drive long-term success, but need to be achievable and equitable.
Monitoring	• On-going monitoring of system performance is an essential, but often missing element of O&M. • Members of the community can play an important role in monitoring and reporting faults. • Regulatory monitoring regimes and frequency may be based on risk level.	• Scheduled monitoring and maintenance protocols need be developed and adopted to each context. • There is a gap in relation to nutrient pollution impacts	

6 Global Practice Scan Synthesis

The section explains and references the themes arising across the four domains of support for decentralised sanitation.

6.1 Sustaining Demand: Maintaining effective community demand for the systems over time

A significant body of literature indicates that effective community demand is fundamental to the sustainability of decentralised sanitation systems (Gutterer et al. 2009; Montgomery, Bartram, & Elimelech, 2009; Nelson & Murray, 2008; Parkinson & Tayler, 2003; Roma & Jeffrey, 2010; Sansom, 2011). Although much of the literature emphasized the importance of demand during the pre-development phase, sustained demand is equally important. As demand can influence people's willingness to use the service, pay for operational costs and take on management responsibilities, systems without ongoing demand are unlikely to be sustainable in the longer-term.

6.1.1 Demand Operational Responsibilities (ORs)

It is important to plan and budget for ongoing soft costs, not only initial soft capital investment.

Ongoing post-construction public education and health promotion including social marketing is needed to ensure sustained demand and improved sanitation that lasts (Eales, Siregar, & Febriani, 2012).

While *creating* community demand and establishing 'demand-responsive approaches' to sanitation, are widely recognized as essential, and therefore planned and budgeted for, post-construction support to local-level users and user groups including *sustaining* demand is rare (Fonseca et al., 2011). Utility-managed services generally plan for 'expenditure for direct support (ExpDS)' such as surveying user satisfaction as an operating expenditure (OpEx), and Fonseca et al (2011) note the need for equivalent allocation of funds within other management models.

Linking social incentives to key local motivators can help sustain demand.

Social incentives that speak to the key motivators that led people to invest in sanitation in the first place, can be used to maintain demand (Robbins, 2011). Robbins proposes that evidence-based information gathering activities such as surveys and focus group discussions can be used to determine motivators, that may include factors such as health and disease reduction, status, convenience, community pride, shame avoidance, etc. Examples include a program in the Philippines that rewards participating families with a window sticker advertising that the family is part of a growing movement for environmental protection; and another in Indonesia where families that improve their latrines earn signs for display ("WC-Ku Sehat!" or "I have a healthy latrine!") to demonstrate their pride in their community and their commitment to improving health (Robbins, 2011). Johnson, Prudencio & Stoner (2011) note the use of sanitation promotion campaigning that has led to increased stigma against open defecation, a different (and sometimes controversial) form of social incentive to maintain demand. They suggest that increased social pressure in support of sanitary practices will result once a critical mass is reached.

Understanding diversity and developing socially inclusive systems is needed, to increase inclusive community ownership and broaden the user base.

Communities are not homogenous, but have diversity in terms of gender, ethnicity, age and mobility: men and women, children, and people with different disabilities and religious or cultural practices have different priorities and needs. It can be misleading to consider communities and even households as units with common priorities for sanitation (McGranahan, 2013), that can lead to the exclusion of some vulnerable groups of people (Eales et al., 2012; WSSCC, 2013). The diversity of needs should be taken into consideration when investigating the local context and developing sanitation systems (Oosterveer & Spaargaren, 2010). Existing systems may need to be evaluated for the degree to which they are meeting the diverse needs of the communities they are intended to serve. For example, according to WASPOLA (2006), '*Sanimas locations are in densely populated slum areas. There are almost no open areas, just alleys and narrow streets, and the houses are packed together. Into these crowded residential areas, Sanimas brought the esthetic of imposing sanitation facilities and clean and beautiful parks. These facilities have become play areas for children as well as places for people to pass the time of day with each other*.' This suggests that sites with other activities may increase the user-ship. However, other locations are not used by certain users exactly because there is too much activity around, and people do not feel comfortable to go there for 'private matters' (ibid). This highlights the importance of Evans & Saywell (2006) approach that people must share and decide on what the objectives are for the system (i.e., do they want a community space or just a sanitation space; this is something that can be addressed retroactively).

Monitoring perceptions and changing demand is important.

Preferences can change over time, that risks leaving stranded investments such as communal facilities if, for example, households subsequently invest in home latrines (Eales, Siregar, Febriani, & Blackett, 2013). Ongoing monitoring of community perceptions to determine causes of shifts in demand is important (Johnson et al., 2011), in conjunction with evaluation of how such shifts impact on the sustainability of the services (Jones et al., 2013). Monitoring mechanisms could include those mentioned above – user satisfaction surveys (Fonseca et al., 2011), focus groups (Robbins, 2011).

Collective demand is nurtured and sustained through community organisation.

While social incentives target demand at household level, McGranahan (2013) points out that improved sanitation requires *collective* demand, since the benefits that each individual gains is dependent on the actions of others also engaging in complementary behaviors that provide protection from each other's excreta. Drawing on two long-lived community sanitation programs (20+ years), McGranahan concludes that this requires the facilitation of community organisation "in such a way that their collective demands could be articulated and acted on collectively". Local NGOs have played a critical role in educating the community about sanitation and health and facilitating such community organisation.

6.1.2 Demand Institutional Arrangements (IAs)

Effective 'soft interventions' can increase demand

Advocacy (Parkinson & Tayler, 2003) and social marketing campaigns (Nelson & Murray, 2008; Montgomery, Bartram, & Elimelech, 2009) are examples of 'soft interventions' that have the potential to establish political support for improved wastewater management, and increase community demand for sanitation services. Evaluating failing systems may involve assessing the extent to which advocacy and social marketing campaigns garnered adequate support from local government officials and community leaders, or has continued to influence community demand over time.

Several common tools are used for engaging the community as a means to create or reinvigorate interest in sanitation systems.

Community mapping or sanitation mapping and CLTS (Harris, et al, 2011) have been recognized as tools to increase community demand for sanitation, or other participatory processes, such as people's statistics, where users gather monitoring data (ISSDP, 2009). Other tools may include encouraging consumers to demand their rights by supporting consumer voice initiatives (Wild & Harris, 2012; Winterford, 2009). This is particularly important in countries where civil society does not have a strong voice, and public debate around pro-poor service delivery and equitable access is lacking (WSUP – USAID, 2012)

Building trust between users and the CBO or provider can potentially increase use of the systems.

A comparison between users and potential recipients of communal ablution blocks in South Africa shows that perceived health benefits, attitudes in case of problems, and trust are affected by use of the facilities (Roma, et al, 2010). Tools such as electing community members to sit on CBOs has shown to increase trust between the community and service provider, and therefore increase community demand for service providers (De La Harpe, 2003)

Socio-cultural norms need to be mapped in order to construct locally appropriate systems.

Peoples' needs and preferences vary dramatically among unserved populations, as do the financial and institutional resources available to support them, as a consequence decentralised systems should be appropriately scoped to fit their local socio-cultural context. For community-managed systems in particular, operational sustainability is dependent upon local resident's willingness to both use and manage these systems, as well as their capacity to carry out certain technical, financial and managerial responsibilities. A 'one-size fits all' development approach is unlikely to work when scaling up community-managed decentralised wastewater treatment services (Oosterveer & Spaargaren, 2010), and a lack of demand may be associated with a failure to provide services that are both 'affordable and desirable' in the minds of the local residents (Nelson & Murray, 2008). Prevailing socio-cultural norms must be understood (Sansom, 2011) in order to establish hard (technological) and soft (governance) systems that are appropriate for each context. Local contextual analysis and engagement are key to ascertaining whether particular technological and governance options can be embedded into existing socio-cultural and political systems. Evaluating failing systems could involve assessing the extent to which these existing systems may fail to align with local user preferences and operational capacities. This includes personal attitudes and motivations. (WSUP – USAID, 2012)

Sustainable systems must necessarily be affordable and make users proud of.

McGranahan (2013) argues that creating systems that are affordable is a requirement for sustainable systems – the capital and ongoing cost contributions from users and government partners need to be within the means of both. The concept of affordability itself is complex, as it depends on the quality of the goods/services provided and the perceived benefit (Gutterer et al., 2009; McGranahan, 2003). McGranahan advocates sanitation systems that achieve an "affordable improvement of the highest quality", that users can feel proud of, over the more common tendency to try to achieve some predetermined standard at the least cost (that could result in substandard materials and workmanship, etc).

There is potential to misinterpret demand

Project proponents conducting 'community engagement' to create and establish demand can draw conclusions about the strength of demand that is not always borne out in practice. Systems installed on the basis of such overestimation are particularly challenging for the financial viability of long term operation with less subscribers than designed, because for example, the projected take-up of connections do not eventuate (Leménager et al., 2010), or people revert to open defecation instead of using communal sanitation centres perceived to be too far away (Eales et al., 2013). Communities may sometimes agree to take responsibility for management of sanitation systems that they have no capacity or interest in reality, because they want to be courteous to the 'powerful' government officials making the suggestion (pers comm Heuvels/BORDA) – another manifestation of misinterpreted demand. Inherent biases such as those identified by Munasinghe (1992) for willingness-to-pay methods may be relevant to other demand assessment methods – notably *strategic bias*, when respondents believe they can influence outcomes in their favour (for example, attract further government support of other developments), *compliance bias* when respondents may desire to please the proponents; or *hypothetical bias* when they do not understand the characteristics of the option or do not take it seriously. In the context of rapid scale-up of sanitation with community demand as a foundation, the implications of misinterpreting demand can be significant.

There is a need for cooperation with other NGOs working in the community.

When more than one NGO has a sanitation program in the same locality/community, there is potential for creating competing demands that can undermine sustainable sanitation. NGOs have provided household toilets without adequate wastewater treatment that moves users away from using communal toilets with full treatment, making the latter financially unviable (Pers Comm. BORDA; Eales et al., 2013). Some failures have been attributed to NGOs offering different subsidies that have undermined each others programs (Jones et al., 2013). There are some examples of NGO coordination that brings together government, NGOs, UN agencies, donors and universities, for example, in Sri Lanka (ISF-UTS, 2011a). Locally coordinated forums for sector actors to communicate and collaborate can increase the effectiveness of interventions.

Holistic approaches, where sanitation is part of a long-term community development/shelter program, have been related to successful sanitation systems.

Some renowned success stories involve local NGOs facilitating a broader development agenda that includes sanitation. In the Orangi Pilot Project (OPP), simple sewer systems were constructed by residents in the informal settlement in Karachi in the 1980s, preceded by a period of *social infrastructure building* that included basic education, training of leaders, and developing complex community consultation approaches (Zaidi, 2001). The Indian Alliance - a partnership between a women's collective around savings groups, the National Slum Dwellers Federation and the NGO SPARC (the Society for the Promotion of Area Resources Centre) - facilitated the construction of communal toilets for pavement dwellers beginning in the early 1980s, as part of a broader effort to improve living conditions (McGranahan, 2013). A more recent example of community based sanitation implemented in 2010 in peri-urban Delwara in Rajasthan, India came about through a process of social transformation commenced in 2003 of a previously fragmented community, facilitated by local NGO Seva Mandir (Anand & Mehtta, 2012; Plan, 2011). Unique features of each case study could have contributed key success factors, however, as observed by Zaidi (2001) with respect to OPP's holistic approach: "it can still be argued that the reason for the failure of replication in other communities may have to do more with problems of social preparation or with the nature, ability, capacity and resources of community groups and local NGOs" than with the technical OPP model.

Demand for ancillary services to keep systems operational can be sustained by complementary support for supply of those ancillary services.

Entities managing decentralised sanitation systems are reliant on services of external providers, such as for periodic desludging, supply of spare parts, repairs etc. While there is need to sustain demand for these services to keep decentralised systems operational, the need to simultaneously support the supply side for servicing the sanitation value chain is increasingly being recognised and beginning to be addressed (Johnson et al., 2011; WSP, 2013a). This could be broadly categorised as 'sanitation marketing' but goes beyond marketing sanitation to individuals – it involves mobilising communities, suppliers, local government, financing institutions (including microfinance) and NGOs to work together (EUWI & SHARE, 2012; Johnson et al., 2011).

6.2 Effective management*:* Accountable administration and decision-making system

Effective management is essential to enabling the long term provision of sanitation services (ISF & Stone Environmental, 2009). Successful service provision is characterised by having good administration, planning, decision making systems in place (ISF & Stone Environmental, 2009; Yeager, Ehrhard, & Murphy, 2006).

6.2.1 Management Operational Responsibilities (ORs)

Regular management meetings are needed

Meetings scheduled with regularity enable the community organization to deal with issues as they arise. Failure to meet regularly while the service is running well is a common weakness identified by Mozar & Sijbesma (2012), as it means the committee is not able to deal systematically with their various areas of management, and "when problems emerge, it may turn out that they are already serious, and confidence of the members and tariff payers is lost." In contrast, committees that meet monthly have "empowered and prepared them to self-manage and administer their civic amenities" (Anand & Mehtta, 2012).

Planning and budgeting needs to be thorough and include often forgotten aspects such as management tasks, major expenses, inflation.

A range of management tasks need to be planned and budgeted for, including payment of wages, purchase of consumables and electricity, operation and maintenance, setting fees, collecting payment collection, book-keeping, and reporting (Eales et al., 2013; Mukheibir, 2000; Sijbesma & Mozar, 2011). Assessment of income and expenditure and planning ahead for major expenses is important (Eales et al., 2013).In setting fees, necessary adjustments for inflation are frequently forgotten (Kerstens, Legowo, & Hendra Gupta, 2012). Close attention to collection of fees is important as well as fees that encourage operational efficiency, as seen in SISAR (McCann, 2011).

Planning for uncertainty improves long term sustainability.

In the water sector globally, there is increasing recognition of the need for and value of planning for uncertainty (Mukheibir et al 2012) Whilst no-one can predict the future, it is possible to systematically think through the kinds of things that could change, the scale of impact those changes would have on the success of the systems, and how such risks might be managed. The principles from processes developed for minority world scenarios (e.g., Mukheibir and Mitchell 2011) could be adapted for developing country scenarios. Firstly, thinking tools such as PESTLE (political, economic, social, technological, legal, environmental) can help to ensure a broad set of risks are identified. At the same time, changes can be characterized as gradual shifts or sudden shifts (shocks) (Mukheibir and Mitchell 2011). Then, a standard risk assessment matrix can be used to collectively estimate the likelihood of the uncertainty occurring, and the scale of the impact if it did occur. Identifying those uncertainties where the risk is high allows some forethought about mitigation strategies.

The need for planning for emergencies is not adequately addressed in the literature.

There is a gap in the literature about arrangements for emergencies such as accidents, floods, earthquakes. Such arrangements include insurance, emergency protocols, clarity on who is responsible for rectification or compensation, etc.

Fee collection system must be designed to meet the specific needs of the community.

It is important that the timing and method of fee collection is designed to meet needs of community and maintain demand. People on low incomes are frequently better able to manage daily payments but have difficulty with monthly payments (Sijbesma & Mozar, 2011). If frequent collection is required, an intermediary such as a local shop may be used to reduce transaction costs (ibid).

Women are often preferred in treasurer roles.

User associations frequently choose female treasurers. Sijbesma & Mozar (2011) cite a couple of reasons: it is the women who make small household payments and they often prefer to make these to another woman. If home visits are decided on, they are also more easily made by a woman to other women. In the Orangi Pilot Project, the treasurer is frequently a respected older woman "who has long-term standing with the residents" (Zaidi, 2001).

Accessible complaint mechanisms can be used to improve services.

Establishing a helpline and training the community in using it to report faults and complaints, maintain complaints log and responses, all combine to improve sanitation services (Eales et al., 2013; Nema, 2013; WSP, 2011a)

A paid manager is more likely to deliver on responsibilities than volunteer managers/operators.

A study to identify attributes for success of decentralised wastewater systems across the USA notes "the existence of a paid manager" as being strongly related to good organizational management (Yeager et al., 2006). South African studies have demonstrated that the voluntary nature of community participation has negative impacts on community organization (Mulenga, 2011). Eales et al (2013) observe the high turnover of unpaid (or low paid) operators in Indonesia, and resultant loss of capacity and training. The risks and consequences of inadequate management of wastewater systems are too great to be left in the hands of volunteers

Establishing systems to monitor management can enable improving management to meet local needs.

A system to monitor management processes is needed, to track performance with respect to accountability, documentation, contracts, training, database or register, maps of system or users (Mukheibir, 2000). Clements et al (2010) emphasise monitoring of outcomes and adapting management, especially when trialling new approaches in the face of uncertainties, so outcomes can be improved. Monitoring the effectiveness of management processes with the aim of learning (rather than compliance) is an important way of adapting and improving management to meet local needs (Jones et al., 2013).

Reporting needs to be standardized, transparent and regular.

One indicator of good administration in the local operator Community Based Organisations (Kelompok Swadaya Masyarakat, KSM) is the adoption of standard and transparent reporting systems (WASPOLA, 2006). Financial transparency and regular report-backs to the local community builds trust by accounting for how and why the money has been spent, which is important for motivating regular payments (Eales et al., 2013).

Modern technology can offer for improved information management.

While operators and management committees of individual community sanitation systems may not require complex systems to manage information, government authorities with responsibilities and interests in improving the sector would need to maintain databases of information such as installed decentralised systems (locations, characteristics), cost information, etc. Modern technology offers a number of cost-effective tools that can support authorities to collect and manage information. Kluge (2013) highlights opportunities for communities to be involved in data-gathering via new smart-phone apps, camera phones, integrated GPS and SMS surveys, which can "bypass organizational filters, creating more accurate data and greater transparency…(putting) reporting power directly in the hands of users." Several innovative tools have recently been developed to enable citizen engagement in monitoring and data collection and mapping, such as Taarifa (Sanitation Hackathon, 2012), and FLOW – field level operations watch (Water for People, n.d.).

6.2.2 Management Institutional Arrangements (IAs)

Access to water and sanitation is a human right, thus provision of access to these services is a responsibility of the state . Typically, the responsibility for sanitation is spread across different government departments based on their interests (e.g., health, environmental protection) – and with administrative decentralization, to regional and local governments (Rouse, 2007). In most parts of the world, the responsibility for sanitation generally falls on the local government or municipality (Gutterer et al., 2009).

In the case of community-managed sanitation, a government agency is thus ultimately responsible for service provision, making it an integral partner and stakeholder. For an effective partnership, Ostrom (1996) proposes three challenges to be overcome:

- the organization of citizens to undertake collective action
- good teamwork within the relevant government agency
- effective coordination between citizens and government agency.

There is a gap in the scanned literature on good teamwork within government, but the other points are discussed below.

***Management IAs:* The organization of citizens to undertake collective action**

Local capacities should be matched and developed to meet the needs of efficient and effective sanitation.

Mozar & Sijbesma (Mozar & Sijbesma, 2012; Sijbesma & Mozar, 2011) observe that the process of selecting committees to manage community sanitation is often flawed, due to community men and women who select the management committee lacking adequate understanding of the capacities required for management. Eales et al. (2013) observe: “Many office bearers were prepared poorly for their role.” To reduce the mismatch of capabilities with assigned roles, responsibilities and authority, a detailed process for a facilitated community workshop to list the full range of management tasks associated with a SSS system and select community members to fulfill those tasks, is described by Sijbesma & Mozar (Sijbesma & Mozar, 2011). They strongly argue that the community should take responsibility for all required management, with training and capacity building where required. There is no discussion on whether this has been trialed in practice, or how feasible this is.

Decentralised systems may fail when operational responsibilities, including management processes, do not easily translate into existing socio-cultural and political contexts (Oosterveer & Spaargaren, 2010). While an effective management structure is crucial for good governance (Murray & Drechsel, 2011), this structure must also be developed to reflect the local context. Although capacity building activities can be used as a strategy to address certain vocational gaps where community members are willing to take on new roles, the extent to which the community actually has the capacity to manage and administer the systems effectively in the long-term must be carefully evaluated. Existing local or regional government agencies can also be evaluated for their capacity to provide on-going management support or co-management through a public-private partnership.

Succession planning is needed to maintain institutional and social capacity.

Around the world, transfers of staff (especially local government staff) are frequently cited as a reason for loss of accumulated experience and institutional memory and capacity over time (Mitchell, Abeysuriya, & Willetts, 2008; Nema, 2013; WSP, 2011a). Opportunities for enhanced training and peer learning are cited as important ways for maintaining institutional capacity, such as:

- self-paced, online training resources (Clements et al., 2010; Mitchell et al., 2008)
- training and certification programs provided by educational institutions (Clements et al., 2010)
- conferences to exchange ideas (ibid)
- communities of practice with opportunities for peer-to-peer exchange and learning (Lohaus, 2012)

Nationally consistent frameworks and guiding principles for local governments can also reduce complexity and enable greater collaboration across councils (Mitchell et al., 2008).

A similar loss of capacity occurs with CBOs when membership of the committee changes. In some cases the CBO ceases to exist: 'the term of office of the original committee had come to an end, and no arrangements had been made to elect or appoint a new committee. Alternatively, the chairman had died or moved away and had not been replaced', and there are no provisions to induct new members to the CBO (Eales et al., 2013).

Current guidance literature describe how to set up sanitation management committees (SANIMAS Team, AusAID, & BORDA, 2002; for example, Sijbesma & Mozar, 2011), but there is a gap in the literature for succession planning. This is especially important because the mostly volunteer nature of management committees leads to a high turnover (Eales et al., 2013).

A large community organised in smaller organisational units of neighbours, has proven to be a successful management model

Two high profile community managed sanitation systems in Recife,Brazil and Orangi, Pakistan [1] (simplified sewerage systems or SSS) have their communities organized in smaller nested organization units or 'mini-polities' (Ostrom, 1996) – groups of households organised according to 'lanes' or 'blocks', nested in neighbourhoods, in municipality, etc. (McGranahan, 2013; Ostrom, 1996; Zaidi, 2001) . In the Orangi Pilot Project serving some 92,000 families, the smallest unit ('lanes', typically consisting of 20-30 households) has two people nominated or elected as lane leaders: an *organiser* representing the needs of the community to higher organisational levels, and a *treasurer* who collects fees and keeps accounts (Zaidi, 2001).

Community based organisations (CBO) for management of DEWATS in Indonesia have a single level of organisation, that may be at a level of an existing community organisation (at RT/RW or kelurahan[2] level) or or as a specially formed committee (SANIMAS Team et al., 2002; Sijbesma & Mozar, 2011). Compared to community managed SSS systems in Pakistan and Brazil (McGranahan, 2013; Ostrom, 1996; Zaidi, 2001), DEWATS systems in Indonesia serve smaller communities – 50 households on average for SSS and 22 households for communal sanitation centres, although national program implementation guidelines assume larger scales (Eales et al., 2013). Kerstens et al's (2012) review of 9 DEWATS systems suggests there could be economies of scale to be gained by increasing the scale of systems to serve larger communities. In larger scale projects it could be beneficial to consider community organisation as nested 'mini-polities' that have proved to be an effective management model as described above.

[1] These are not examples of *decentralised* sanitation because their small sewers connect to the city's centralised sewer network, but they are useful for illuminating governance issues.

[2] RT- neighbourhood association (Rukun Tetangga) may consists of 10 - 20 households, while an RW -community association (Rukun Warga) consists of 5 to 10 RTs. A kelurahan is the urban administrative division equivalent to a village, typically around 100 households.

Outcomes can depend on which tasks are community managed.

A study of 7 SSS systems in South African concluded that participation in *mobilizing and decision-making* were associated with better performance, but that participation in construction and maintenance were not (Nance & Ortolano, 2007, cited in McGranahan, 2013).

Management IAs: ***Effective coordination between citizens and government agency***

Good dialogue and communication between stakeholders is key to coordinating services across multiple actors.

Developing an effective management system for decentralised wastewater treatment facilities may involve coordinating support from multiple actors (with different roles) across multiple scales. Establishing dialogue and communications between these actors may be a fundamental enabling action (Oosterveer & Spaargaren, 2010; J. Parkinson & Tayler, 2003; Sansom, 2011). Establishing communication is important as divergent approaches between government agencies and intervening actors may damage relations and hamper development in the longer-term An intervening actor may also need to play a coordinating role between multiple government agencies when sanitation has no clear institutional home within government (Nelson & Murray, 2008).

Clarity of ownership guides responsibilities for management.

Clarity on the ownership of the various physical assets involved in sanitation services leads to a natural division of responsibility to manage and maintain those assets. For example in Orangi, homeowners own and maintain the in-house assets (latrines, connection lines); the community owns the small diameter sewers and takes responsibility for maintaining them and keeping them in good repair using fees raised from the community; and the local government owns the trunk sewers and treatment plants which it manages (McGranahan, 2013; Zaidi, 2001). In an Indian SSS system installed progressively since 2002 and still operating to the satisfaction of users, infrastructure outside individual properties is completely owned and maintained by the municipality, while householders take on tasks such as clearing silt from their connection boxes (Nema, 2013).

In contrast, ownership of assets in Indonesian SSS systems is not clear, a gap in the scanned literature. A single mention was found in Eales et al (2013) which suggests that governments may be pursuing a strategy to transfer assets to communities, and getting them off government asset registers, making it difficult to justify using public funds for maintenance or asset renewal. The situation could be more complex: central governments own some assets because they provide working capital, but transferring ownership to local government is fraught, not least because local governments prefer not to have the responsibilities that come with ownership (pers comm. Handy 2013). More recent laws allow central government to transfer funds directly to communities for construction. There are conflicting views about whether this implies community ownership of assets (pers comm. Handy; Bustraan). Recommended priorities for the Indonesian Infrastructure Initiative includes building local government capacity for asset management and incentivising local government investment and ownership of sanitation infrastructure: "…it is important that LG agencies own sanitation infrastructure. This builds their commitment to properly operate and maintain it. Further, LGs can only raise budgets to operate and maintain assets that they own." (IndII, 2013).

Matching the level of management of decentralised systems to the level of risk can be an efficient and effective path to achieving outcomes.

The US EPA has created guidelines for risk-based management of decentralised systems (US EPA, 2003), where controls are related to the level of risk to public health and the environment and/or complexity of the treatment technology. A similar risk-based management regime is established in New Zealand. In low-risk contexts, O&M management of onsite systems, for example, is left in the hands of homeowners, but "the local authority develops an inventory of systems, and provides information to owners and users on a regular basis"(Ferguson, Dakers, & Gunn, 2003). As the level of risk increases, the US EPA Guidelines and the New Zealand regime require increasing levels of professionalisation, from requiring service contracts from professional service contractors, to utility management and operation. In the highest risk contexts, all assets are also owned by the utility (Ferguson et al., 2003; US EPA, 2003).(Ferguson et al., 2003)

Clearly defined roles and responsibilities, with a single 'lead agency' in a coordinating role would improve service delivery

While a variety of different entities may be involved in delivering services that constitute the sanitation service chain, the designation of a lead local government agency in a coordinating role can enable efficient and effective services that make best use of scarce resources (IndII, 2013). A recent review and recommendations for the Indonesian Infrastructure Initiative recommends that this lead local government agency should bear direct responsibility for sanitation and "this should be codified in its legally defined roles and functions" (ibid).

There is a variety of means to formalise commitments between parties, depending on the context and need.

Community and government participants need to be able to build a credible commitment to one another. Generally is easier to get on the ground shifts, if those in power have formally committed to it. Ostrom (1996) suggests that *clear and enforceable contracts between government agencies and citizens* enhance that credibility, and set expectations so that if one side increases input, the other will continue at the same or higher levels. With the exception of Ostrom's mention of formal contracts being exchanged in her case study of Brazil condominial sewers (SSS), agreements appear to have previously been more informal social contracts (e.g. McGranahan 2013). The Indonesian SANIMAS arrangements include a Memorandum of Understanding between municipal or district government and community outlining the duties and rights of each party (SANIMAS Team et al., 2002). The MoU stipulates financial contributions from each party and assigns all management responsibilities to the community. However, more formal legally binding commitments (along with constitutions, structured meetings, setting targets and indicators) are now recognised as appropriate methods for creating accountability (WSUP – USAID, 2012).

Clear decision-making and administration structure increases capacity to deal with issues.

Although decentralised wastewater treatment system faults and failures are frequently technical in nature, they often stem from 'institutional bottlenecks' that restrict effective management of the hard systems (Murray & Drechsel, 2011). Confused decision-making structures and restrictive administrative processes can prolong the time between fault diagnosis and action taken to address it. Systems may have a greater capacity to deal with maintenance and repairs in an efficient and timely manner when they operate with clear decision-making processes; a streamlined administration structure; and well-defined protocols for carrying out operational tasks and addressing faults. City-wide plans can facilitate clear decision-making and administration. City-wide plans can be encouraged by linking national funding to the adoption of city-wide plans (WSP, 2009). National strategies can provide a framework for action at a municipal level and bolster local political will, if they include defined objectives and institutional roles from national to local level (WSP, 2009).

Forming a cooperative management institution of local community associations has proven to be a successful management model

SISAR is a Brazilian example of a non-government, non-profit institution created by the representatives of rural local user groups to provide regional scale management support. Under this institutional model, SISAR's and local user groups become responsible for the decision making process related to the administration of systems and for assuring long-term sustainability in the provision of improved water services. SISAR's functions include: 'administration of finances, including appropriately redistributing funds among systems to cover operational expenses; social work and capacity building with local user groups; selection and implementation of appropriate technical standards and operation and maintenance routines; defining an adequate strategy for guaranteeing financial sustainability; assuring maintenance of the systems occurs (hydraulic, electromechanical repairs, water treatment installations, etc.) through the implementation of preventive plans and execution of corrective measures; controlling water quality and improving treatment processes; training and monitoring for the execution of services by local operators; evaluating the technical conditions of systems with an interest in joining SISAR; and overall monitoring and benchmarking through the implementation of technical indicators' (Meleg, 2012).

Creating incentives can motivate operators' and local government performance.

The incentives that drive individuals and groups to act are complex, and important to consider in planning for sustainable long term delivery on responsibilities. (Ostrom, 1996; Verhagen & Carrasco, 2013). Effective incentives seek to encourage efficiency in the established system (McCann, 2011) or encourage innovation among operators. Well-organized peer-to-peer networks and mentoring can be a powerful avenue for maintaining motivation and capacity for delivering on ORs (PT. Qipra Galang Kualita, 2012). Effective models include the Water Operational Partnerships, originally trialled as mentoring between Indonesia and Malaysia (Baird, 2012) and the German Association of Water Wastewater and Waste (DWA) Neighborhoods model (Lohaus, 2012).

In the case of the WOPS, the ADB and Waterlinks supported the program. Giving recognition and celebrating successes and good practices are simple but powerful incentives (Ostrom, 1996). Local government commitment was improved by offering awards for their progress in decentralised sanitation (AKSANSI, 2012).

Keeping management monitoring focused on learning, adaptation and evolution can lead to improving management

Management approaches that use monitoring and evaluation with the aim of learning, including learning from failure, can assess progress towards goals and make corrections to plans, designs and operations as needed (Clements et al., 2010; Jones et al., 2013). Monitoring objectives that are limited to 'compliance' can limit learning and miss the opportunity for meeting sustainable sanitation goals (Jones et al., 2013).

Encouraging innovation and expansion of scope of services by the private sector can bring in much needed capacities

Greater private sector participation is recommended as a way of bringing in investment and services required for scaling up access to sanitation (IndII, 2013; Sy & Warner, 2013). Small private entities typically provide fragmented services within the supply chain. Larger private enterprises can be encouraged to enter the sanitation sector through incentives, and form partnerships with smaller enterprises where the larger partner coordinates the supply chain while the smaller partners maintain (Sy & Warner, 2013). Accreditation and quality assurance can enable continuity of service quality (ibid).

6.3 Sustainable financing: Sustainable funding and business system

Pro-poor financing approaches to sanitation systems must necessarily guarantee post-construction financial sustainability (IRC & WSUP, 2012). A lifecycle perspective on sanitation costs is critically important for recognising the significance of recurrent costs and planning for adequate resourcing to fund long-term operations (Fonseca et al., 2011; IRC & WSUP, 2012; Trémolet & Rama, 2012).

6.3.1 Financing Operational Responsibilities (ORs)

Sustaining service levels is dependent upon accurate forecasting of recurrent costs.

Projecting the financial requirements for recurrent maintenance is key to being able to sustain service levels (Fonseca & Verhoeven, 2013; Fonseca et al., 2011; ISF & Stone Environmental, 2009).

According to WASHCost literature (Burr & Fonseca, 2011; Fonseca et al., 2011), the main components for recurrent costs are categorised as:

- *Operational and minor maintenance* (regular ongoing expenditures such as wages, energy, chemicals, cleaning products and other materials)
- *Capital maintenance* (asset renewal, rehabilitation and replacement – occasional and lumpy costs for restoring the functionality of a system - such as desludging, or replacing a pump)[3].
- *Cost of capital* (interest payment on loans, and returns and dividends to investors in the case of commercially structured service elements)
- *Direct support* (expenditure to support local-level stakeholders). They could include user surveys, complaint handling, as well as supports to ensure "local governments have the capacities and resources to plan and implement, manage contracts or emergency situations when systems break down, and to monitor private or public service providers' performance"

They include a further category that is less useful at the level of community-based urban sanitation systems: "*Expenditure for indirect support*" - supports to "sector working capacity and regulation, but are not particular to any programme or project".

Mitchell et al. (2007) identify regulatory compliance costs as another cost element that WASHCost resources do not mention explicitly, but could be included in operating costs: costs such as performance monitoring and meeting standards, reporting, licensing, audits, inspection fees, etc. In a coproduction case study described in McGranahan (2013), for example, the government's contribution to the provision of communal toilets for pavement dwellers included relevant permissions and supports to ensure sanitary improvements conformed with and were recognised by regulators.

There is a gap left in how to translate the WASHCost insights into usable methods for CBOs or local governments to estimate their cost requirement, beyond easily tracked operational and minor maintenance costs and desludging costs. The Guidelines prepared by Sijbesma and Mozar (2011), for example, provide a sample table with indicative recurrent cost elements, that leaves the fields for asset renewal/rehabilitation/replacement as "to be decided". These Guidelines may represent the 'best' resource available at present as they claim to "integrate new insights on project planning and implementation and especially post-construction service management into the already existing guidelines for decentralised, community-managed simplified sewerage services". Yet its advice on estimating the more significant elements of 'capital maintenance' costs is: "Financial advice on alternative ways to make financial reservations may be required," highlighting the lack of a generalised approach to estimating these important costs. The

[3] Depending on prevailing accounting rules, capital maintenance expenditure (CapManEx) could be based on actual expenditure on capital maintenance or on accounting charges for depreciation (Fonseca et al., 2011)

WASHCost project is in the process of developing costing tools that may help to fill this gap.

While WASHCost takes a multi-scale sector-wide perspective (including costs ranging from toilet cleaning products to policy and regulation making), Mitchell et al. (2007) note that it is important to specify three further dimensions in addition to quantifying costs:

- Who will incur the cost/receive the benefit?
- When will the cost be incurred?
- What is the level of certainty in the cost estimate?

Disaggregating roles and responsibilities for sanitation between users, CBOs, governments, contracted service providers, etc, to be clear about who will incur the cost, the timing of costs, and the level of certainty of costs, can be a good starting point for filling this important gap.

Supplementary income streams can be created from recycling and reuse.

Clements et al. (2010) argue for water and sanitation planning to be guided by a new paradigm with a social, environmental and economic sustainability as a goal. Under this paradigm, the resources in 'waste' will be valued and infrastructure will be designed to simultaneously yield multiple benefits. Early examples of such approaches are beginning to emerge. A community sanitation project in Indonesia is developing an aquaculture venture fed by treated effluent, where the income from fish sales is projected to cover all operating costs (Kerstens et al., 2012), while a sludge treatment plant in Cambodia is using an innovative low-cost design to produce high quality compost (Korea International Cooperation Agency, UNEP, & Center for Advanced Philippine Studies, 2011). Murray et al (Murray, Cofie, & Drechsel, 2011) explore several business models involving aquaculture, biogas recovery, compost production and use of faecal sludge as an industrial fuel, and argue that there are unexplored opportunities for developing viable public-private partnerships to create value from the reuse of human waste, that could generate revenues that can help offset the cost of other parts of the sanitation service chain (Abeysuriya, Mitchell, & Willetts, 2005).

6.3.2 Financing Institutional Arrangements (IAs)

Financial planning should use a lifecycle perspective.

A failure to plan for realistic operation and maintenance costs over the life of the infrastructure is a substantial barrier to funding preventative maintenance and paying for repairs as necessary (Murray et al., 2011). A financial plan should calculate and determine: 'sources of funding for direct operation costs, future repair costs, and institutional training costs, including monitoring, and expansion costs' (Montgomery, Bartram, & Elimelech, 2009). The literature discusses the role that private sector can play in building capacity of CBOs for business planning, or contributing their business planning skills to communities with decentralised systems. In Alaska, the Rural Utilities Business Advisor Program, a state-run program, develops skills at a local level so that revenues meet costs (ibid).

Shifting discourse on the mechanism for full cost recovery towards 'sustainable cost recovery'.

The discourse on who should pay for urban water and sanitation has shifted radically over time, from being solely a government responsibility until the early 1980s, to the promotion of the 'user pays' principle for full cost recovery through user fees. The discourse is now shifting towards 'sustainable cost recovery' in non-OECD countries through what is known as the 3Ts (Trémolet & Rama, 2012): cash flows from a combination of *tariffs* (user contributions), *taxes* (domestic taxes from all levels of government) and *transfers* (funds from donors and charitable foundations including NGOs). Gutterer et al. (2009) similarly note the need for 'multi-source financing', that may also include cross subsidies. The concept of 'sustainable cost recovery' (cost recovery that enables sustainable service provision in the long term) acknowledges that public spending will often be required to complement revenues from tariffs (Trémolet & Rama, 2012). Studies such as by Mikhael, Peal and Parkinson (2012) demonstrate that poor communities cannot afford the tariffs required to sustain sanitation systems without external support.

There are multiple views on who should pay for capital maintenance costs.

The community sanitation model such as the Indonesian SANIMAS program expects that all recurrent costs including capital maintenance (desludging, large repairs and replacement costs) would be paid for through user contributions (tariffs) (Kerstens et al., 2012). Some authors cite the 'polluter pays principle' as a basis for justifying community responsibility for all lifecycle costs related to their excreta (Kerstens et al., 2012; Sijbesma & Mozar, 2011), although its application would appear to mainly penalises those connected to decentralised sanitation systems, but not 'polluters' who are connected to centralised sanitation systems or who use (unmanaged) onsite systems or practice open defecation. An opposing argument for using taxes and transfers to fund sanitation (Trémolet, 2012) is supported by the recognition that economic benefits of investing in sanitation extend well beyond users (WSP, 2011b). Rather than the 'polluter pays' principle, the 'beneficiary pays' principle may be better suited to sanitation markets. This alternative principle recognises both 'private' benefits that should be funded by users, and 'public' benefits that should be paid for by government on behalf of public, justifying financial sufficiency through cost sharing (Abeysuriya et al., 2005). Eales et al (2013) recommend "a straightforward division of responsibilities" that is consistent with the 'beneficiary pays' principle: that communities be responsible for 'above ground' day-to-day operation and maintenance and minor repairs that they can easily detect and fix (and provides them with direct benefits), while local government (and/or private partners to whom activities are outsourced) are responsible for 'below ground' infrastructure including sludge management and major maintenance support (that provide wider benefits beyond the local community). Such an approach would mirror what happens in reality, where even in the best cases, the community only takes responsibility for daily operational and minor maintenance expenditure (Eales et al., 2013; Kerstens et al., 2012). In Indonesia, communities are beginning to access funds from local governments to pay for large, clearly defined one-off repairs – for example, repairs to DEWATS plant in Jogjakarta following the Merapi volcanic eruption (pers. comm. Heuvels).

There are multiple views on tracking informal tariffs from households.

Communities may contribute cash, materials and labour to construct, operate and maintain their sanitation system – contributions that all fit within Tremolet and Rama's (2012) definition of 'tariffs'. They argue that the non-monetary 'informal tariffs' need to be tracked "so they are not overlooked in the sector policy-making process". Including user contributions in cost calculations is also recommended by the New Zealand Handbook for Sustainable Wastewater Management for Small Communities (Ferguson et al., 2003) which argues that failing to factor in operating costs represented by users' "time and effort to monitor and look after the system" is misleading because these contributions are a critical factor in their long-term success. "At the very least, the time needed by an owner to run a system should be estimated and converted to some sort of hourly rate. If the community decides to commission external operations and maintenance, the costs will then be comparable" (Ferguson et al., 2003)

Whether to include or exclude user contributions appears to depend on the objective of the costing exercise. In contrast with Tremolet and Rama (2012) and Ferguson et al. (2003), Fonseca et al. (2011) recommend excluding user contributions in recurrent cost estimations. While they recognise these contributions can be significant, they are often difficult to quantify, and they state: "this 'economic cost' is not usually included in costing services, since the purpose is to budget for actual costs that need to be spent. Of course, if it was necessary to pay community members for this work in a situation of full employment, the real cost of water and sanitation services would rise accordingly" (Fonseca et al. 2011).

User contributions are a critical component of ORs that need to be met for long term success in the context of the current ADRAS study. Including these contributions in estimating lifecycle costs will support planning for adequate tariffs to explicitly cover this cost.

Innovative financing mechanisms may foster experimentation and learning.

With the seriously underfunded sanitation sector, innovative mechanisms are needed to fill the funding gap (OECD, 2010). Funding for capital maintenance in particular presents a significant gap (Eales et al., 2013; Kerstens et al., 2012). The authors of the OECD (2010) study distinguish between filling the gap (through revenues from tariffs, taxes, transfers – the 3Ts)) and bridging the gap (through repayable finance) as long-term and interim sector goals respectively. Bridging finance can be used for lumpy capital investment and capital maintenance, but requires that revenue from the 3Ts are sufficient to cover ongoing O&M costs (recurrent costs) as well as any payments associated with repayable finance.

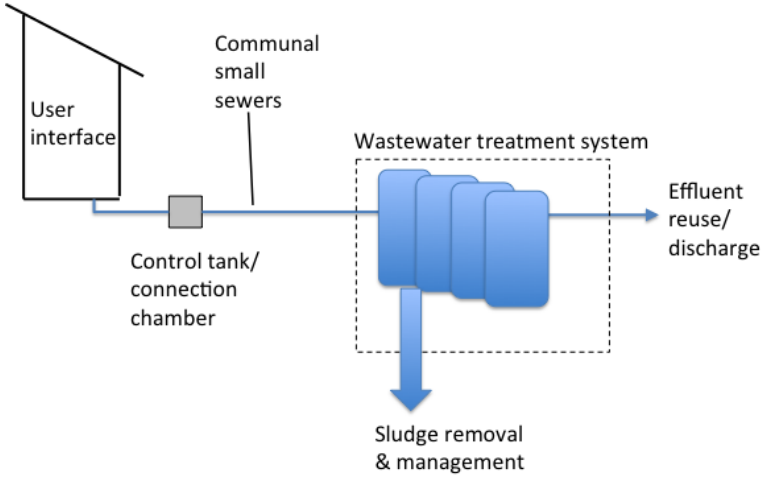
Results-based finance (RBF) is one of several innovative mechanisms, encompassing a range of financing instruments including Progress Linked Finance' (WSUP & ODI, 2011), Output-based Aid (OBA) (OECD, 2010), Performance-based Financing (PBF), Cash on delivery, and other variants (Trémolet, 2011). OBA is a financing tool that has been applied in a number of pilot projects where subsidies are paid upon demonstration of effective and measurable results – for example the Water Hibah program in Indonesia (IndII, 2013; ISF-UTS, 2011b). OBA transfers risk to the service provider, so access to this instrument is restricted to those service providers with relatively strong financial positions (WSUP & ODI, 2011). Progress Linked Finance (PLF), in contrast, is designed to provide payments before implementation but after verification that a pre-specified state of readiness has been reached, making finance more accessible (ibid).

Although RBF has high transaction costs with requirements for strong verification of results, and has had limited application in the sanitation sector thus far (Trémolet, 2011; WSUP & ODI, 2011), Jones et al. (2013) point out that this financing model has the potential to promote adaptation, experimentation and learning to tailor sanitation programs to the context "because they specify in advance the desired outputs of the programme but not the exact mechanisms used to achieve the results.

6.4 Functioning technology: Operation and maintenance of the physical system

The technology underpinning decentralised sanitation services within the scope of this project is represented schematically in Figure 3. The technologies are well documented and are briefly summarised to provide clarity in terminology used.

Figure 3: Generic elements of decentralised sanitation systems



The *user interface* may be individual household latrines and washing facilities, or communal sanitation centres. The user interface is connected to the sewer system at a *connection chamber* (also referred to as control tank, connection box and other terms) that includes an inspection port or manhole, and possibly grease trap and/or grit filter. The *communal small sewers* convey the wastewater from the user interface to the wastewater treatment system, and consist of sewerage pipework, connection chambers, manholes/inspection ports.

The *wastewater treatment system* could include a range of specific technologies including sedimentation tanks, septic tanks, digesters and biogas plant, baffled reactors, anaerobic filters, soil dispersal/gravel bed filters, ponds, constructed wetlands etc. (Gutterer et al., 2009). The treatment train produces treated effluent that may be re-used or discharged, and settled biosolids or sludge that needs to be removed periodically to maintain effective wastewater treatment. The sludge needs to be handled and managed appropriately to safeguard worker health, public health and the environment, and could potentially be put to productive re-use after sanitization.

Under different service models, system operator/s may be different actors/service providers with responsibility for the different elements of the system. In this section we present our findings without specifically identifying who is specifically responsible for what activity.

6.4.1 Technology Operational Responsibilities (ORs)

Important day-to day ORs, including training, coordination and education.

The following activities are required for maintaining the day-to-day functionality of the physical system at the different parts of the systems

Maintenance of user interface (latrines and communal sanitation centres) up to and including connection chambers

- User training is positively associated with higher levels of facility maintenance as well as satisfaction with its functionality (Roma et al., 2010). Visual and written rules for users - do's and don't such as the types of detergents to use (Ismawati 2007, cited by Sijbesma & Mozar, 2011) are helpful. Most users follow most of the operating and maintenance rules (WASPOLA, 2006).

- Keeping latrines and communal toilets clean and in good condition (Crous, Haarhoff, & Buckley, 2012; Washcost, 2012). This requires expenditure for cleaning products and consumables, which is often lower than required (ibid).

- Proper disposal of menstrual hygiene products (Truyens et al. 2013). Menstrual hygiene products (MHP) that are flushed down toilets are a frequent cause of blocked pipes that can be costly to rectify (Truyens et al., 2013; WSP, 2013b). Truyens et al. note that poor definition and instructions about the 'proper' disposal for MHP, and the absence of appropriate waste bins in communal toilets for women, are causes of improper disposal. This issue will become more urgent as women's access to disposable sanitary products increases with growing interventions to improve dignity for women (Betteridge, 2013; Truyens et al., 2013).

- Arrangements for collection of solid waste (including MHP) within facilities, safe handling and disposal (Truyens et al. 2013)

Maintenance of connection chamber

- Connection chambers placed where house pipes are connected to the street sewer collect silt and debris that need clearing (Nema, 2013). The connection box may include a grease trap (Sijbesma & Mozar, 2011) or they may be separate.

- Grease traps, required at every house/communal facility connection to intercept grease and solids that get washed into the system, need regular cleaning. This will allow wastewater to flow freely into the small sewers without stagnating. Odours from grease traps are amongst the most commonly reported problems (Eales et al., 2013).

- Information and training on proper disposal of grease and sludge from traps and connection chambers is required. In his case study, Nema (2013) observes that the community has no knowledge about appropriate disposal, and sludge removed from connection chambers was frequently left on the footpath. While signage and posters used in Indonesian SANIMAS systems advise cleaning grease traps every 3 days (Sijbesma & Mozar, 2011 citing Ismawati 2007), there is a gap in guidance on safe handling and disposal.

Maintenance of the sewerage system

- Blocked sewer pipes are the most commonly reported problem, and requires regular collective pipe flushing (Eales et al., 2013). Operators require information and training to diagnose and clear blockages and perform minor repairs (Gutterer et al., 2009; Sijbesma & Mozar, 2011).

- Manholes in the sewer network as well as the treatment system are frequently jammed (Kerstens et al., 2012). Manholes need to be maintained, and monitored for infiltration and inflow during rains. Slight modifications to manhole covers may be required to reduce excessive inflows that can potentially reduce the effectiveness of the treatment system (Kerstens et al. 2012).

- In relatively informal communities, with very poor roads, broken pipes are likely as a result of other informal construction, occasional heavy vehicle movement, poor quality material choices initially, inadequate depth of installation, etc, (pers. comm).

Maintenance of the treatment system

- Kersten et al. (2012) observed a very rapid build-up of scum in settling chambers, requiring removal as frequently as twice per month. They ascribe it to particles attaching to biogas bubbles, and propose that regular desludging could address the problem.

- Regular inspection and effluent sampling and analysis is recommended every six months by Gutterer et al. (2009). This will enable treatment shortcomings to be identified and rectified.

Longer term ORs are often forgotten during planning, but are essential.

Desludging is required at intervals as sludge buildup can reduce the effectiveness of treatment systems. There is a knowledge gap in how frequently desludging is required, as sludge build up rates vary widely and depend on an array of factors that are not fully understood (Mills, 2013). Capital maintenance, or renewal and replacement of assets (including pumps) should ideally occur at the point where the system is still functioning well (so service levels are not compromised), but just before it might fail (Ferguson et al., 2003). Recognising the right time requires expert judgement that will be more likely to be available with professional management (ibid).

On-going monitoring of system performance is an essential, but often missing element of O&M.

Ongoing monitoring of system performance can help minimise crisis maintenance and unplanned emergency breakdowns, and enable timely preventative maintenance (Mukheibir, 2000). Regular sampling and monitoring effluent quality is recommended by Kerstens et al. (2012), who stress that reporting back to the community should be part of the process, to improve "understanding of impacts and system performance". The important aspects of monitoring are training, ordering, documentation, schedule of maintenance (Mukheibir, 2000). Collaborative approaches from all stakeholders in setting the indicators, and support from NGOs and Local government in assessing indicators, increase the likelihood of continued monitoring (Mukheibir, 2000).

Members of the community can play an important role in monitoring and reporting faults.

While the municipality takes full responsibility for O&M of the SSS system described by Nema (2013), the reports of faults and major issues made by residents via the helpline supports their system monitoring, and plans are afoot to improve resident training to scale up this form of monitoring. A self-monitoring system has been put in place by the DWA community of practice of German wastewater system operators, based on members collecting performance data that is shared nationally (Lohaus, 2012). Plant operators receive training in monitoring and documenting performance. Annual comparison of data has made an important contribution to improvement of performance and effluent quality. Keeping the public informed has increased public confidence in the system, which supports public acceptance of wastewater fees (ibid).

Regulatory monitoring regimes and frequency may be based on risk level.

Inventories of decentralised sanitation systems are maintained and managed by local governments in New Zealand (Ferguson et al., 2003). As the agencies with statutory responsibility for sanitation, local governments have initiated a risk based inspection regime for the physical systems, with monitoring every 1-3 years for high risk classes of systems, relaxed to inspections every 3-5 years for low risk classes. Inspections could involve "emptying pre-treatment units via pump-outs of septage and then evaluating the physical condition of the unit; …(detailed inspections of land application systems)…; sampling and analysing pre-treatment effluent quality; and undertaking environmental effects assessment (including groundwater and surface water monitoring within and beyond the site, as well as checking soil condition and plant health in the vicinity" (ibid).

6.4.2 Technology Institutional Arrangements (IAs)

Capacity building is necessary and involves training, skills development, knowledge sharing processes.

Capacity building is often necessary to ensure that local actors can effectively carry out O&M responsibilities (J. Parkinson & Tayler, 2003; Roma & Jeffrey, 2010; Sansom, 2011). This may target actors including: CBOs with a willingness to take on O&M responsibilities; private enterprises that may be able to take on tasks such as sludge management or routine maintenance; and local governments that may be willing to take on monitoring or other responsibilities pertaining to incentivising effective O&M. Knowledge must be disseminated using locally appropriate language and communicated through mediums that are relevant to the local audience. National level capacity development strategies, such as that in Indonesia can help to guide 'all parties to collaborate to ensure that personnel are available in sufficient numbers and with appropriate competence (WSP, 2009). Indonesia's strategy seeks to (1) improve the appeal of sanitation jobs (2) institutionalise competence advancement schemes (3) revitilise competence development programs (4) stimulate knowledge exchange (WSP, 2009).

Clearly define roles and responsibilities support service delivery.

O&M roles and responsibilities must be clearly defined, communicated and accepted by all participating actors (including formal or contractual recognition where appropriate) (Montgomery et al., 2009; Oosterveer & Spaargaren, 2010; J. Parkinson & Tayler, 2003; Roma & Jeffrey, 2010). Where community based organisations (CBOs) are responsible for specific O&M tasks, they must be compatible with the skills available at the community level. Coordination and formalised partnerships with other actors such as contractors and service providers may be required to maintain effective O&M longer-term.

Scheduled monitoring and maintenance protocols need be developed and adopted to each context.

Preventative maintenance is a key factor that can separate operational systems from failing systems. Long-term sustainability is supported by scheduled protocols or service contracts to cover both desludging and routine maintenance checks, with repairs as necessary. Ensuring that ongoing finance is available for scheduled monitoring and maintenance is fundamental to this important institutional process (Murray et al., 2011). Diagnosing issues with maintenance and mechanisms for improving can also be analysed according the environment of the decentralised system. Indonesia, these challenging environments are: swamp, riverine, estuary and flooding landscapes (Dionoputro, et. al., 2010).

Technical assistance can be provided in a variety of ways.

All systems need a back-up technical or referral service (Dionoputro, et. al.), 2010, such as help lines, guides and onsite resources. Continual training for operators and professional associations are also beneficial (PT. Qipra Galang Kualita, 2012).

Access to externally provided services, such as those relating to sludge services and local, transparent supply chains, can be crucial.

Some operational responsibilities to ensure sustainable sanitation are dependent on availability of externally provided services, such as sludge removal, that include safe handling practices, sludge treatment and reuse/disposal arrangements, and efficient supply chains for materials and spare parts etc. An inability to source spare parts locally can hold up the process of maintaining and repairing malfunctioning systems. Facilities that are able to deal with repairs efficiently are more likely to operate effectively (Murray & Drechsel, 2011)**.** Dynamic operations and maintenance may require establishing local spare parts supply chains (Montgomery et al., 2009). Transparency and flexibility in the provision of materials is crucial, especially if they are being delivered by a third party (contractor) (WASPOLA, 2006). These externally provided services are ongoing areas of research and development (for e.g., see (Johnson et al., 2011; Tayler, Siregar, Darmawan, Blackett, & Giltner, 2013; Verhagen & Carrasco, 2013).

Accountability for routine operations and maintenance can be facilitated through incentives and implementation partners.

Failing to perform routine operations & maintenance tasks can lead to short-term technical faults and longer-term system failures, although this can be attributed to a number of factors, one of these can be a lack of accountability to ensure that the systems are maintained and serviced by skilled operators. In developing countries this may also be linked to a lack of incentives for ensuring that systems function properly, including low enforcement of environmental and health regulations (Murray et al., 2011). Implementation partners should be accountable for working with communities to establish functional institutional processes, such as planned maintenance protocols, that will support long-term community management. The implementation partner should also be responsible for documenting this process. (Montgomery et al., 2009).

Standards and regulation can drive long-term success, but need to be achievable and equitable.

Developing and enforcing standards and regulations (relating to the construction, operation and maintenance of decentralised wastewater treatment systems) can be an important institutional driver for effective long-term operation (Parkinson & Tayler, 2003; Nelson & Murray, 2008). Enforceable standards for the design, construction and maintenance of systems, and for wastewater, drainage, and solid waste disposal can assist decentralised systems by providing objective benchmarks for assessing progress (WSP, 2009). It should be also recognised that in developing countries, initially setting standards too high may impede the expansion of service provision and restrict the scope of applicable technological options (Gutterer et al., 2009). As standards and regulation may increase transaction costs and diminish operating flexibility, the capacity of small-scale independent providers to service the urban poor may be reduced (Nelson & Murray, 2008). Regulators in developing countries must work with local communities to design achievable and enforceable standards that enable rather than constrain decentralised service provision (Parkinson, 2013).

Enabling legislation may allow cities to set standard according to capacities and to facilitate an incremental approach (WSP, 2009). The impacts of standards and their enforcement are seldom considered, but can have unintended consequences of burdening the poorest people. There is often more political pressure to advocate high standards of sanitation than the means to fund their achievement, particularly in informal settlements (McGranahan, 2013). Amongst other effects, it can lead to affordable services for the poor not being provided – for example, communal toilets that don't meet the standard for the Millennium Development Goals (ibid). A pragmatic approach by South Africa's Water Act supports contextually differentiated treatment and disposal standards that match health and ecological risk, allowing lower standards where risks are less (Gutterer et al.,2009).

There is a gap in relation to nutrient pollution impacts

Much of the discussion of effluent quality standards is focused on BOD, COD and microbial quality - there could be a gap in the community sanitation literature about the need to limit inorganic compounds in discharged effluents, including nitrates and phosphates, an important issue because it causes nutrient pollution and eutrophication of receiving water bodies.

6.5 Roles of Sector Stakeholders

We have been guided by the findings from the global practice scan to identify potential roles for sector stakeholders, which has revealed complexity because many different groups are involved, and each has potential to take on quite different roles. For now, the main distinction in these roles seems to be the ORs versus IAs, and there appears to be less distinction between the domains. Our views on this will likely change as we engage with on-ground practices. For now, in the table below, we sought to classify the range of possible roles for each stakeholder using the four classes created by Checkland (1999) as thinking tools for complex 'soft' situations. These are:

- **Clients**: the customers or users of the system or process;
- **Actors**: those who take the actions; who implement or cause the system or process to happen
- **Owners**: those who have power to make decisions about the system or process, who can stop it or allow it to go ahead.
- **Guardians**: those who will raise their voice if the system is not working as it is intended to

	Users	**CBOs**	**Private sector**	**Contractors**	**Local Govt.**	**Regional Govt.**	**National Govt.**	**NGOs**	**Donors and Lending Institutions (International development sector)**
Operational Responsibilities	Clients Owners Guardians	Actors Owners	Actors	Actors	Actors Owners Guardians			Actors Owners	Owners
Institutional Arrangements	Clients	Clients Actors Owners	Actors Guardians	Actors Guardians	Actors Owners Guardians	Owners Guardians	Owners Guardians	Actors Owners Guardians	Owners Guardians

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APPENDIX : Methodology

Research partner input

We sought input from our research partners in two ways: firstly, directly from our partners themselves, and secondly, through IWA specialist groups and individuals.

Literature practice search and scan

A formal search of both 'black' and 'grey' literature was undertaken. Search strings for 'black' literature and key web sources of 'grey' literature are provided in the tables below.

Content mapping

There are many dimensions to this area of inquiry: such as ownership structure (Public/private/community/CBO/coop/NGO); geographical/cultural; types of ORs and IAs. Rather than pre-determining the structure, based on the findings of the initial exploratory research, we mapped the critical content areas for the Global Practice Scan in order to develop an outline for the primary synthesis document, and to classify resources as more or less important.

Deep reads and synthesis

For each of the more significant resources, a template was completed and themes captured in an annotated bibliography of over 70 documents.

Formal search for 'black' literature: *Scopus*, *Web of Science* and *Google Scholar* were selected as the journal databases to search for 'black literature'. Search results were sorted *by relevance* and filtered by *social science* and *environmental science* journals, when the returned results were greater than 500 articles. Our search strings were:		
Base String:	AND	AND
(decentralized OR decentralised OR satellite OR distributed OR "on-site" OR onsite OR "small-scale" OR community)	(sanitat* OR wastewater OR "wastewater treatment" OR "wastewater treatment systems" OR sewage)	
(decentralized OR decentralised OR satellite OR distributed OR "on-site" OR onsite OR "small-scale" OR community)	(sanitat* OR wastewater OR "wastewater treatment" OR "wastewater treatment systems" OR sewage)	(governance)
(decentralized OR decentralised OR satellite OR distributed OR "on-site" OR onsite OR "small-scale" OR community)	(sanitat* OR wastewater OR "wastewater treatment" OR "wastewater treatment systems" OR sewage)	(operation* OR maintain* OR manage*)

(decentralized OR decentralised OR satellite OR distributed OR "on-site" OR onsite OR "small-scale" OR community)	(sanitat* OR wastewater OR "wastewater treatment" OR "wastewater treatment systems" OR sewage)	(developing OR developed)
(decentralized OR decentralised OR satellite OR distributed OR "on-site" OR onsite OR "small-scale" OR community)	(sanitat* OR wastewater OR "wastewater treatment" OR "wastewater treatment systems" OR sewage)	(sustainability)
(decentralized OR decentralised OR satellite OR distributed OR "on-site" OR onsite OR "small-scale" OR community)	(sanitat* OR wastewater OR "wastewater treatment" OR "wastewater treatment systems" OR sewage)	(institution* OR "government support" OR regulation* OR policy OR financing OR partnership* OR guidelines)
(decentralized OR decentralised OR satellite OR distributed OR "on-site" OR onsite OR "small-scale" OR community)	(sanitat* OR wastewater OR "wastewater treatment" OR "wastewater treatment systems" OR sewage)	(enabl* OR “enabling factors” OR monitor* OR "co-operative" OR cooperation OR "best practice" OR "scale-up" OR "up-scaling" OR implementation OR "capacity building" OR "improv* OR performance" OR challenges OR evaluation OR planning OR “social change”)
(decentralized OR decentralised OR satellite OR distributed OR "on-site" OR onsite OR "small-scale" OR community)	(sanitat* OR wastewater OR "wastewater treatment" OR "wastewater treatment systems" OR sewage)	(“social context” OR "case studies" OR "knowledge transfer" OR development OR investment OR drivers OR optimisation OR training OR teaching OR learning “long-term” OR support OR responsibilities OR engagement OR consultation OR "social inclusion")

Note: for search strings, it was important to check for ‘decentralized’, using both a ‘z’ and ‘s’.

Grey literature

The following websites were also investigated for relevant grey literature.

Name	URL
CSE – Centre for Science and Environment	http://www.cseindia.org/taxonomy/term/20123/menu
Decentralized Water Resource Collaborative - WERF	http://www.ndwrcdp.org
International Water Management Institute	http://www.iwmi.cgiar.org
IRC International Water and Sanitation Centre	http://www.irc.nl/
IWA Water Wiki	http://www.iwawaterwiki.org/xwiki/bin/view/Articles/WebHome
Research Triangle Institute (RTI)	http://www.rti.org
Sanitation and Water for All (partnership)	http://www.sanitationandwaterforall.org/
Sanitation Updates (IRC)	http://sanitationupdates.wordpress.com/
Share (Sanitation and Hygiene Applied Research for Equity) – DFID funded 5year initiative	http://www.shareresearch.org/NewsAndEvents/Detail/city-widesanitation
SuSana – Sustainable Sanitation Alliance (sent by ODI)	http://www.susana.org
UN Documentation Centre on Water and Sanitation (UNDCSW)	http://unwaterlibrary.org
UNESCO: Institute for Water Education: Water Management & Governance Research Theme	http://www.unesco-ihe.org/node/5655
Wastewater Solutions for Development: Decentralizing wastewater treatment for simplicity and sustainability	http://watsanexp.ning.com
WaterAid	http://www.wateraid.org/uk/what-we-do/our-approach/research-and-publications
WERF's decentralized research	http://www.decentralizedwater.org/
WSSCC- Water Supply and Sanitation Collaborative Council	http://www.wsscc.org/
WSUP – Water & Sanitation for the Urban Poor	http://www.wsup.com/index.htm