Safely managed sanitation services in small towns: an analysis of knowledge and experiences from developing countries

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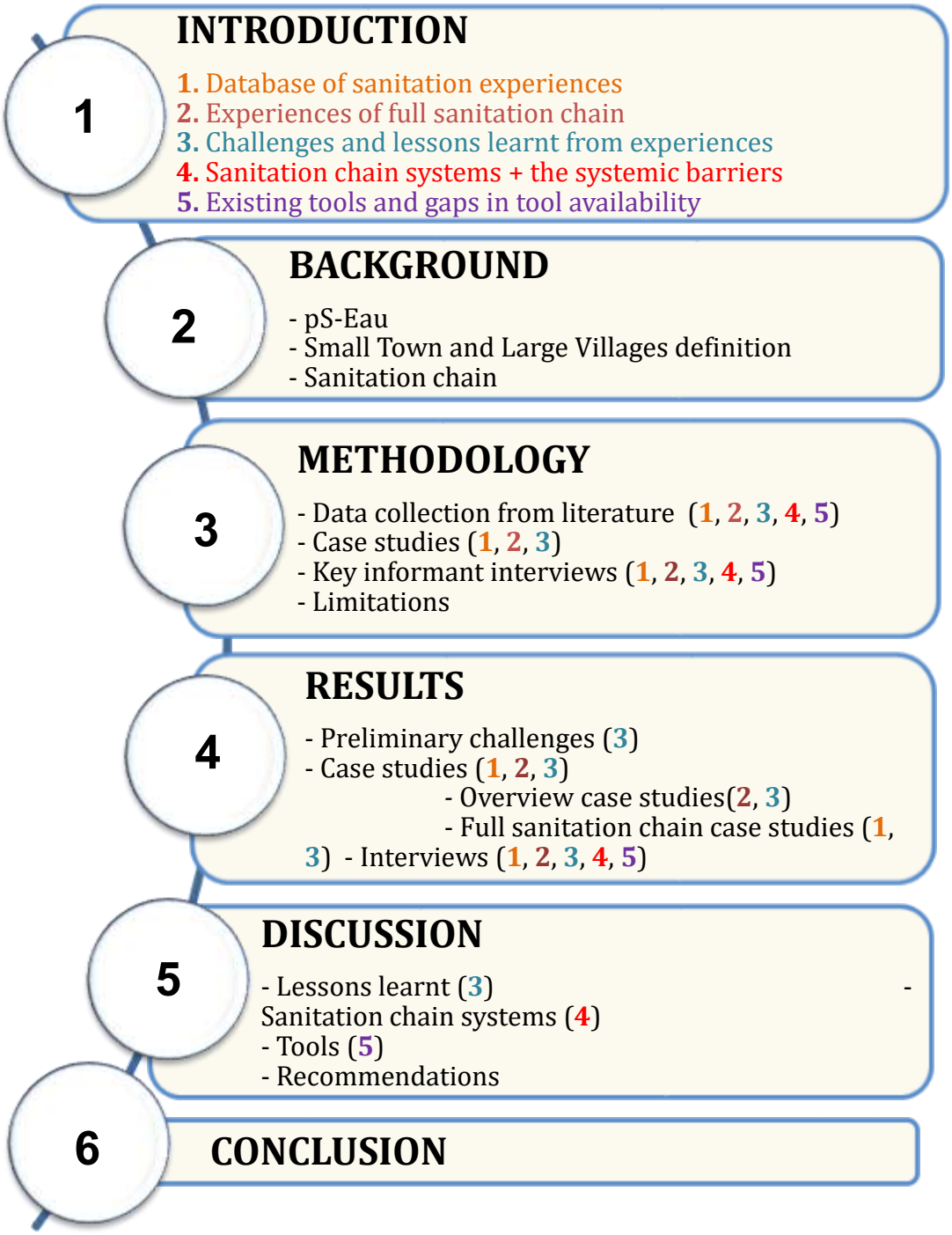
STRUCTURE OF THE REPORT



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EXECUTIVE SUMMARY

This study aims to contribute to understanding the factors of success and failure of sanitation affecting Small Towns Large Villages (STLV). Most development sanitation programmes in developing countries target either cities or rural areas. This has left STLV as a neglected area.

The study had five objectives which were to:

1. Compile a broad and diverse database of sanitation experiences focusing on improving the full sanitation chain in STLV in developing countries, to inform and make it available for further external research.
2. Analyse the database and use selection criteria to identify specific and relevant experiences of the full sanitation chain in STLV.
3. Identify and synthesise challenges and lessons learnt from experiences in STLV.
4. Identify and critically assess the sanitation chain systems that apply to STLV and the systemic barriers that prevent its functioning.
5. Identify existing tools and gaps in tool availability for managing sanitation in STLV.

46 case studies were identified which fitted this definition, and of those case studies, 11 were selected to be looked at in more detail as they covered the full sanitation chain and detailed on how was managed the sanitation chain. Nine interviews were conducted from a diverse panel of professionals: two university researchers, two consultants, three INGO staff, and two from local NGOs. The results and lessons learned from these can be categorised into:

- **Institutional:** related frameworks were considered to be more important than infrastructure, especially considering the lack of resources available. Capacity building is required to empower local stakeholders and to manage the sanitation chain on a technological, planning, management and administrative level.
- **Partnerships and stakeholders:** it is necessary that all the stakeholders involved know and fulfil their roles and responsibilities.
- **Financial:** STLVs currently do not have sufficient access to funding. The systems should operate in a way that ensures fees cover and maintenance. However, the current models are not viable. Tariffs and collection must be defined.
- **Technology:** must be appropriate and specific to the resources of the town. Step-by-step improvement of systems that build on existing infrastructure is the best option for scalable growth. No individual technology will be the best option for every scenario.

In conclusion, the overarching finding of this study is that sanitation in STLV is a relatively well-documented subject but with few examples of well managed and functioning full sanitation chains. The downstream steps of the chain were where technological, financial and management issues often exist. Coordination is essential for a successful sanitation chain. All components must be fully functioning and linked together.

To encourage more successful experiences of the full sanitation chain in STLV, tools for choosing the adequate financial model, the appropriate technology, and for monitoring sanitation chain constructed for the specific requirements of STLV need to be developed. Finally, efforts should be put in the quality and quantity of documentation related to sanitation in STLV to provide learning for further research.

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ACRONYMS

BoTT: Build Operate Train and Transfer
CapEx: Capital Expenditure
CLTS: Community Led Total Sanitation
CLUES: Community-Led Urban Environmental Sanitation Planning
CURES: Cranfield University Research Ethics System
DEWATS: Decentralised Wastewater Treatment Systems
FSM: Faecal Sludge Management
KI: Key Informants
M&E: Monitoring and Evaluation
N/A: Not Applicable
NGO: Non-Governmental Organisation
O&M: Operation and Maintenance
OpEx: Operational Expenditure
PE: Population Equivalents
PPE: Personal Protective Equipment
PPP: Public-Private Partnership
PPL: Proyecto Piloto en Pequeñas Localidades
PRADALIS: Projet de Recherche Action pour le Développement de l'Assainissement dans les Localités Intermédiaires
pS-Eau: Programme Solidarité Eau - Water Solidarity Programme
RAIL-Niger: Réseau d'Appui aux Initiatives Locales in Niger
SDG: Sustainable Development Goals
SFD: Shit Flow Diagram
STLV: Small Towns and Large Villages
TAF: Technology Applicability Framework
UK: United Kingdom
UN: United Nations
w/: with
WASH: Water, Sanitation and Hygiene
WHO: World Health Organisation
WSP: Water and Sanitation Program

GLOSSARY

Below are some definitions of concepts used throughout the report, they have been adapted from Oxford University Press (2018) and a discussion on the SuSanA forum (2015) to suit the sanitation scope of this study.

Centralised management: the sanitation service is regulated and managed at national level.

Centralised technology: the sanitation technology is run at town level.

Clustering: refers to the grouping of several STLV (cluster) for an element of the sanitation chain (for example; a common wastewater treatment) or the management of the sanitation service in nearby STLV by a single entity.

Collective: a service or an equipment which is not for only one household.

Community: users of the sanitation services, at any level.

Decentralised management: the sanitation service is regulated and managed at regional or town level.

Decentralised technology: the sanitation technology is (partially) run at household or neighbourhood level.

Developing country: a poor agricultural country seeking to become more advanced economically and socially. Global South, developing countries, low and middle income countries are used interchangeably in this report.

Economy of scale: for a sanitation service, proportionate saving in costs by increasing the size of the population served.

Local authority: the governing and administrative body of the STLV. Municipality and local authority are used interchangeably in this report.

NGO: non-governmental organisation that operates at either national or international level.

Public-Private Partnership (PPP): an arrangement where the public sector partners with a private company to jointly deliver sanitation services.

Public Sector: the municipality; in collaboration with the local and/or national government to implement or run sanitation services.

Private Sector: organisations run by private individuals (entrepreneurs) or groups (utilities), typically to generate profit.

Utility: a public or private organisation responsible for water and/or sanitation services.

1. INTRODUCTION

1.1. Context

Most development sanitation programmes in developing countries target either cities or rural areas. This has led to a severe lack of attention given to Small Towns and Large Villages (STLV) (see 2.2. STLV Definition), even though they host a significant part of the world population (UN, 2014).

Sanitation services were often found to be either non-functional or non-existent in STLV, despite public health issues raised by the lack of sanitation in settlements of this size and density. STLV are often too small to have viable full chain sanitation (see 2.3. Full sanitation chain), but are also too dense to benefit from the sanitation approaches used in rural areas such as digging new pits and moving latrines. They also face higher expectations from its population regarding services. Additionally, sanitation markets are fragmented and unregulated. Private sector involvement in sanitation services is minimal due to low economies of scale.

STLV represent a significant challenge for reaching SDG6, mainly targets 6.2 and 6.3 (UN, 2017) since they are neglected, and sanitation services for STLV require adapting to their singularities to design financially viable services that include the safe management of excreta.

Characterised by a high population growth rate, STLV are continually expanding and composed of socially diverse livelihoods. Also, due to a lack of skilled workers and to low financial capacity, STLV are not attractive and viable for private operators (UN-Habitat, 2006). All of these aspects represent challenges that STLV are facing and which make the management of sanitation services particularly complex (see 4.1. Preliminary challenges identified with respect to sanitation in STLV).

1.2. Objectives

The study aims to contribute to understanding the factors of success and failure of sanitation affecting STLV in the Global South.
The research question of this study is:

What factors make the sanitation chain in STLV in developing countries work?

The specific objectives of the study are:

1. Compile a broad and diverse database of sanitation experiences focusing on improving the full sanitation chain in STLV in developing countries, to inform and make it available for further external research.
2. Analyse the database and use selection criteria to identify specific and relevant experiences of the full sanitation chain in STLV.
3. Identify and synthesise challenges and lessons learnt from experiences in STLV.
4. Identify and critically assess the sanitation chain systems that apply to STLV and the systemic barriers that prevent its functioning.
5. Identify existing tools and gaps in tool availability for managing sanitation in STLV.

1.3. Outputs

The outputs of the study are:

- The definition of STLV in the context of this study.
- A database of 46 relevant sanitation experiences in STLV classified by types of governance (see Appendix 5).
- Fact Sheets of 11 selected case studies of full sanitation chain in STLV (see Appendix 6).
- Synthesis table presenting the results of 9 interviews with professionals of the sanitation sector in developing countries (see Appendix 7).
- Synthesis of lessons learnt from the literature, case studies and interviews related to sanitation in STLV.
- An analysis of existing tools and recommendations for identified gaps in tool availability for managing sanitation in STLV.

2. BACKGROUND

2.1. pS-Eau (Programme Solidarité Eau-Water Solidarity Programme)

pS-Eau is a French non-profit organisation created in 1984 with the aim of supporting and developing actors in the WASH (Water, Sanitation and Hygiene) sector in their efforts in providing the populations of developing countries with universal access to water and sanitation. To achieve this, pS-Eau have focused their efforts on three key areas: 'Research and Development', support to the actors of the international aid and cooperation of the WASH sector, in particular, the francophone cooperation, and finally '*promoting international solidarity mechanisms for water*' (pS-Eau, 2018). The latter is done through the facilitation of debates on specific sectors issues, lobbying for more funding, producing knowledge and sharing information on universal access to water and sanitation. Ultimately, *'pS-Eau is, and coordinates, an international and multi-stakeholders network that fosters the sharing of experiences and information between all stakeholders working within the water and sanitation and cooperation sectors'* (pS-Eau, 2018).

This study complements and feeds into PRADALIS programme (Projet de Recherche Action pour le Développement de l'Assainissement dans les Localités Intermédiaires), a 2-year programme (started in 2016) led by the pS-Eau and four other research partners and NGOs in Senegal (pS-Eau, 2018).

2.2. Small Town and Large Villages Definition

2.2.1. Process to elaborate the definition

The definition of 'small town' was developed and evolved throughout the project. Preliminary reviews of the literature shaped the design of the definition. As we worked, changes were made with the guidance of pS-Eau and opinions from Key Informants (KI).

There is no existing definition of 'small town', and individual governments determine their criteria for settlements to be considered a 'town' (see Appendix 1). The only available definition in the literature comes from the WASH sector (Roche, 2000) and this same definition has been

simplified further (Adank, 2013). Adanks' definition is the basis of that used in this report (see 2.2.2. Definition). In addition, some exclusion criteria have been set out to refine the case studies' selection criteria.

The population exclusion is deliberately broad, in order to capture towns in all continents (a village in India may have a population of an African town). Although population criteria related to each country's capital could be used (such as considering settlements with populations of two orders of magnitude less than that of the capital city as the lower threshold of 'towns'), absolute figures are used here as they are relevant to economies of scale issues (e.g. Population Equivalents (PE) for treatment, number of people served per vacuum truck).

We also found that during interviews, KI would have varying understanding of the word 'town' based on their experiences working in either Africa or Asia. To overcome this, we proposed the term 'Small Towns and Large Villages' (STLV) as this is deliberately more ambiguous and better illustrates the transitional nature of the settlements considered.

2.2.2. Definition

For the purpose of this study, we have defined STLV as: *Settlements with a sufficiently high density of people that would justify collectively managed water supply and excreta management systems. In turn, these systems would not be of interest to large city utilities to manage due to their size, and not being financially viable (*Adapted from Roche, 2000 and Adank, 2013).

Exclusions:

- A capital city
- Peri-urban area which benefits directly from services or infrastructures of a nearby city
- <2,000 or >100,000 resident population
- Settlements in 'high-income' countries

2.3. Full sanitation chain

Managing the sanitation services requires implementation of a wide range of processes and technologies starting at the user interface (toilets) and ending with reuse of the treated resources or with safe disposal. The 'sanitation value chain' defines the stages necessary to properly manage the human waste and prevent the population from health hazard, and is referred to in this report as 'the sanitation chain'. The sanitation chain components can vary slightly from one organisation to another. For this project, the Bill & Melinda Gates Foundation (2010) definition has been used, which is composed of the following scheme: containment, emptying, transport, treatment, and reuse or disposal (see Figure 1).

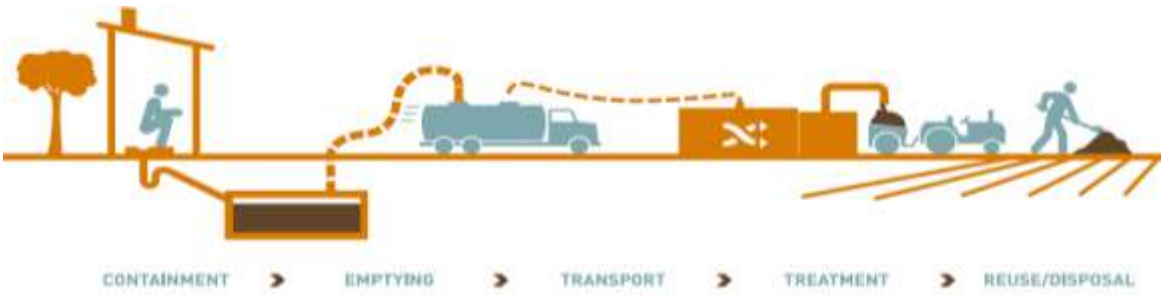

Figure 1: *Sanitation value chain (Bill & Melinda Gates Foundation, 2010)*

3. METHODOLOGY

The methodology used for this research project was comprised of three components: data collection from the literature, case studies identification the findings from KI interviews, and their analysis. CURES (Cranfield University Research Ethics System) has ethically approved the methodology.

The method used for data collection was adapted from the literature review processes described by Siddaway (no date) and Khan *et al.* (2003) resulting in five critical steps being outlined. The literature enabled the identification of the most relevant material, and information while the case studies provided a more in-depth understanding of the topic through some set examples in varying contexts. Finally, the report incorporated interviews which helped gain an understanding of the 'how' and 'why' of failures and successes identified in the case studies providing a broader understanding of sanitation within STLV.

3.1. Data collection, review and selection from the literature

The aim of the initial data collection from the literature enabled the authors to:

- Define STLV
- Identify key experiences and challenges of sanitation within STLV and the relevant lessons learnt from these

3.1.1. Framing the research question

A clear and structured research question was formulated. In this report, the research question defined was: *What factors make the sanitation chain in STLV in developing countries work?* This question remained untouched throughout the project.

3.1.2. Identification of relevant work

This consisted of breaking down the research question into individual concepts that resulted in the creation of key search terms. These allowed for the most relevant research papers and reports to be identified while searching through selected databases. In addition to using an initial database provided by the client (pS-Eau), other electronic databases such as Scopus and Google Scholar were used. To ensure nothing was missed, alternative keywords, terms and concepts were used such as: '*sanitation in small towns/urban centres/large villages*', '*safely managed sanitation*', '*full sanitation chain*', '*Faecal Sludge Management (FSM)*', '*on-site sanitation*', '*small wastewater treatment service/plant*'.

3.1.3. Assessing the quality of studies

Once the initial selection was completed, the documents found were matched up against the following set of specific criteria to ensure their relevance to the report in hand:

- Focused on a minimum of one of the initial concepts (see 3.1.2. Identifying relevant work).
- Added value to the research question.
- Allowed identified knowledge gaps to be filled.
- Described possible directions for future research.
- Presented a global vision (detailing links and interaction between different key concepts).

- Provided detailed real-life examples such as case studies.
- References used were of high quality.

3.1.4. Summarising the evidence

All the identified work that met the document selection criteria were uploaded to Mendeley, a reference manager which allowed to keep track of all the information while enabling simple online collaboration between the authors. Each piece of work was annotated to enable a new reader to access, at a glance, all the key information.

3.1.5. Interpreting the findings

Once step 1-4 were completed, the data was analysed to answer to the related objectives. The results were interpreted, with caution, in several ways: the findings related to challenges and lessons learnt were summed up by sections/types, and their relevance to STLV was discussed. How key experiences were interpreted is described in '3.2. Case studies'. Essentially, the amount and types of documents supporting findings was such that the results and the related discussions were of quality.

3.1.6. Secondary data collection from the literature

After a few weeks of working on the report, it transpired that further information was needed to answer unforeseen questions which had arisen through the initial steps of the methodology. This was resolved by the authors going back into the literature to conduct a second data collection. The aim was to find some new information that would help with:

- The identification of appropriate technology for STLV
- The identification of existing tools on planning, advocacy, technological, financing, managing, monitoring and evaluating sanitation in STLV

3.2. Case studies

Case study selection was divided into two steps; the first one being an inventory of case studies which provided a global overview of sanitation chain experiences in STLV along with their associated challenges and lessons learnt that could potentially be suitable for Sub-Saharan Africa. The second step refined these to a smaller number of case studies that formed the basis of more detailed 'Fact Sheets' which acted as another key pillar on which the discussion of the report was based.

3.2.1. Overview case studies

The overview case study selection was agreed with pS-Eau and included some case studies in which there were no results on the success at the end of the project. The inclusion and exclusion criteria below were used to identify acceptable case studies.

Inclusions:

- Fitted within the definition of STLV used in this report (see 2.2.2. Definition)
- Described a sanitation programme
- Clustering of STLV*

Exclusions:

- Only included containment part of the sanitation chain and which didn't allow for economy of scale (Urine-Diverting Dry Toilet, Ecological Sanitation)*
- Only piloted in targeted neighbourhoods of the STLV
- Documents published before the year 2000

**requested by pS-Eau*

Acceptable case studies were compiled into a database which contains case studies from low and middle-income countries. These were spread between Asia, Africa and South/Central America.

For better identification, the case studies were classified into six categories of actors (defined in the glossary) representing the key institutions and organisations involved in sanitation services. NGOs were considered only when they were involved beyond implementation (e.g. support and funding or capacity building and follow up). The categories are the following:

- Public sector
- Private sector
- PPP
- Public sector & NGO
- Public sector (w/ Community)
- Public sector & NGO (w/ Community)

The database is presented according to the following parameters: Country, STLV Name, Population, Step of the sanitation chain covered, Technology, Governance, Lessons learnt and Management. Lessons learnt from the case studies were split into the following categories based on the information provided: institutional, financial, economic, partnership and stakeholders, technology, education, advocacy, beyond the sanitation sector, and transport. The 'management' category reflects whether the project was: 'well managed', 'improvements required' or was 'poorly managed/non-functioning' (see 4.2.1. Overview case studies). This classification was based on the amount of data available even though it varied extensively from one case study to another. Therefore, this classification method cannot be used to draw broad conclusions on sanitation management in STLV.

3.2.2. Specific case studies: Full sanitation chain experiences

The specific case studies were selected from the overview table according to a colour coding and ranking scheme. The colour coding reflected the quality and quantity of data available in the literature and interviews for each category of information and for each case study (see Table 1). The case studies that were highlighted entirely in green were analysed further. However, as a limited number of studies were selected through this process, a scoring was added. This was simply done by attributing numbers to colours with the highest score being 12 where all categories were highlighted in green. The scoring meant that the classification of case studies was more nuanced. The highest ranked case studies were selected for each of the different categories of actors involved (see 4.2.1. Overview case studies).

***Table 1**: Grading and colour-coding of overview case studies*

Colours	Criteria rules				Score
	General information	**Sanitation facilities and services**	**Governance**	**Funding**	
Green	Size of the population and either density or area	Detailed information	List of actors involved, their roles and details (dates, etc.)	Details: name of the funders, amount, dates, involvement	3
Yellow	Size of the population	Partial information	List of actors involved and their roles	Name of the funders and amount	2
Red	N/A	Little information	List of actors involved	Name of the funders or no information	1

Ultimately pS-Eau had the final word on the selection; their main criteria was that the full sanitation chain was described and one cluster of STLV be included. The full sanitation chain case studies were selected on how detailed and appropriate the technology used was. Some of the case studies from the initial list were rejected due to lack of information available, if they were pilot projects, or if the data was outdated. Finally, two case studies were added on the recommendation of pS-Eau which were not in the overview.

This final list of case studies was further analysed with the help of Fact Sheets to provide more detailed examples of full sanitation chains in STLV. The sample was representative of the different scenarios that existed throughout the Global South and covered different types of institutional framework, technologies and partnership in terms of sanitation management. KI interviews and further research informed these case studies.

3.3. Key Informant Interviews

For this research, the KI chosen were consultants, NGO staff, or researchers who possess specialist knowledge on sanitation management in STLV. The interview's results were used to highlight some key findings of the case studies, illustrate lessons learnt and confirm challenges identified during the data collection from the literature. The optimum sample size of KI was reached when new interviews did not bring additional findings, colloquially known as saturation point (Ritchie and Lewis, 2003).

3.3.1. Preparation of the interviews

KI were selected amongst a list of pS-Eau contacts and UK based academics for their unique insight into the case studies or related experiences to the research question. The appointment scheduling established the 'contract' between KI and the authors (see Appendix 2). It provided a clear presentation of the project and details on the matters addressed during the interview.

Research on the interviewees, their enterprise and job were investigated before the interviews to increase the pertinence of the exchange.

3.3.2. Conducting the interviews

Interviews were led in English or French, recorded and required three persons: two interviewers and one person taking minutes. The type of interview used was semi-structured, consisting of open questions following a general order that was adapted to match the interviewee's train of thought, thus ensuring a flowing conversation. The presence of a structure enabled cross-case comparability between each interview (Bryman, 2012). Close-ended questions were used only for clarification or to get the conversation back on track. The interviewer also synthesised or reformulated ideas from the interviewee to increase understanding and the validity of the method. Transparency was necessary and achieved by allowing room for questions from the interviewee on the group project research. The follow-up questions evolved throughout the interviews according to findings, as well as the interviewee's responsiveness and knowledge.

3.3.3. Minutes and qualitative analysis of the content

Detailed notes were taken during the interview. The interviewers used a list of prepared questions to ensure that all the data were collected (see Appendix 3). A debriefing was carried out by the three authors involved to get an overall impression and consensus. Recordings, for which consent was given at the start of each interview, were analysed along with the scribe's notes to produce a document summarising the exchange. This was done within the 24 hours following the interview to avoid any omissions. Coding was used to reveal the overlapping responses and outstanding elements enabling the authors to sum up the key findings and themes. The different interviews were then reported in a table summarising the information extracted on main recurrent topics enabling comparisons. Coding was also used to refer to the interviews anonymously (KI1 to KI9).

3.3.4. Validity of the method

This was ensured by recording and debriefing the interviews which increased the authenticity of the collected data. All the recordings were listened to for a second time, and this was done collectively. This limited interviewees being misinterpreted and allowed for the authors to agree on the meaning of relevant statements. All the interview minutes were annotated accordingly. Moreover, triangulation was made with data from the existing literature and those provided by interviewees to cross-check facts and figures.

3.4. Limitations of methodology

There were several limitations to the methodology used. With regards to collection of data, only a limited number of documents relevant to the research question were available regardless of their source (electronic databases and journals) and due to a multitude of reasons (unpublished or project reports lacking references). Of those documents found, a lot of the time the information contained was incomplete according to the set criteria (see 3.1.4. Summarising the evidence and 3.1.5. Interpreting the findings).

For the case studies, the inclusions and exclusions (see 3.2.1. Overview case studies) limited the number of case studies picked which may have caused a bias in the results as certain methods are more widely reported while some countries have been researched more than others. The case studies found may have lacked a level of impartiality as they were often written by the implementers of the project while little follow-up reports were available which meant that it was difficult to qualify the sustainability of a certain project.

The main constraint for the interviews was the use of a voice call (Skype) instead of face to face approach possibly resulting in loss, or misunderstanding, of information due to poor line connection and a language barrier when English was not the interviewee/er or minute taker's mother tongue. The quality of the information collected during each interview depended on the time that was made available by the interviewee, their objectivity, as well as the capacity of the interviewer to facilitate the conversation without the use of leading questions. The amount of information that would be amassed was not foreseen, neither was the fact that different interviewees would interpret same pieces of information differently. To resolve this and ensure homogeneity of the results, a secondary review was conducted of all the interview content.

4. RESULTS

Using the existing literature, the case studies database created, including full sanitation examples and the key informant interviews, challenges and lessons learnt have been drawn. Correlations were also looked for in the data.

There were several limitations to the results presented in this section. The methodology and its limitations resulted in a limited sample size which in turn meant that any statistical analysis could not be generalised. A much larger number of case studies would have been needed to be able to draw conclusive trends. Also, the ranking for the case studies was based on the limited information found in the data collection that was at times complemented by one or more of the small number of interviews carried out. The varying levels of information would have led to a bias in the ranking system. With this in mind we have summarised the findings in three principal sections below: the challenges faced by STLV to manage sanitation, the overview and full sanitation chain case studies, and finally a summary of the interviews. These results are further interpreted in the report (see 5. Discussion).

4.1. Preliminary challenges identified with respect to sanitation in STLV

The following challenges were identified during the early stages of this research project when reviewing the grey literature provided by pS-Eau. This allowed the authors to: familiarise themselves with the specificities and difficulties faced in STLV concerning sanitation, orientate the analysis of case studies, and provide guidance for the interviews. These challenges solely formed a baseline for the report whilst new ones were gathered from interviews and the detailed analysis discussed later in the report. This section feeds the third objective which is to identify and synthesise challenges from experiences in STLV.

Changing communities: STLV lack the infrastructure and resilience to deal with rapid population growth. This new population is often comprised of people with low or unsteady incomes which can significantly affect public services. Permanent and seasonal migration (e.g. linked to agriculture) results in socially diverse livelihoods (Adank, 2013). The irregularity of income may affect bill payments which in turn may prevent long-term sustainability of public services (Caplan and Harvey, 2010).

Attractiveness of STLV to utility providers: The rural nature of STLV means their economies are partially cashless (e.g. subsidence farming, in-kind payments). The lack of physical cash available within the town is a potential barrier to any future utility bill payments (Caplan and Harvey, 2010). Additionally, STLV are often not large enough to achieve economies of scale due to their size and density. This makes them an unattractive market for utilities despite the fact that the volume of waste to be treated is too large for community initiatives to manage, operate and maintain (Lüthi *et al.*, 2017a).

Lack of knowledge, skilled staff and strategic planning: Remoteness from cities means there is a limited number of skilled utility staff and reduced awareness of available sanitation products and suppliers (Thomas and Alvestegui, 2015; WaterAid, 2017). This is compounded by the lower quality of life and living wages which makes retention of staff even more problematic. In turn, training of available staff is costlier and time-consuming while lack of knowledge can lead to an absence of strategic planning (Lüthi *et al.*, 2017b).

Scale of local government: In STLV there are fewer funding opportunities, less financial capacity and often sanitation issues are seen to be the responsibility of individuals and not that of public/local officials. Management of sanitation services is also challenging due to weak institutions (UN-Habitat, 2006).

Application of appropriate technology: Finding tailored sanitation technologies in STLV to create financially viable and sustainable infrastructure, while ensuring maximum population coverage regardless of one's livelihood, has been shown to be very challenging (UN-Habitat, 2006).

4.2. Case studies

4.2.1. Case studies overview

46 case studies were identified, stemming from 21 different developing countries of which 13 were from Asia, 14 from Latin America and 19 from Africa (see map in Appendix 4). All of the case studies fitted the criteria for STLV and were tabulated for ease of analysis (see Appendix 5). These results aimed to fulfil the first objective of the study: having a database of sanitation experiences in developing countries.

- Steps of the sanitation chain

There are five steps to the sanitation chain: containment, emptying, transport, treatment, and reuse/disposal (see 2.3. Full sanitation chain). When representing the results, projects covering either four or five steps were paired together. This decision was made as many of the documents did not mention the last step (reuse/disposal).

- 8 projects only covered a single step on the sanitation chain.
- 12 projects covered two steps.
- 11 projects covered three steps.
- 13 projects covered four or five steps.

Two case studies did not directly cover any steps of the sanitation chain. Instead, the projects were aiming to cover the governance and the management aspect of the service. Therefore, projects classified under 'governance' are ones which were not aiming to build or install any infrastructure but instead aimed at other improvements around sanitation such as: engaging new (public or private) operators, defining responsibilities, improving the laws, improving communication, and educating staff, operators or the public. A further 13 projects included a governance aspect but were still addressing some step of the sanitation chain.

➢ Management of the sanitation service

Each case study was classified into the following management status: 'well managed', 'improvements required', 'poorly managed/non-functioning'.

- 'Well managed' projects were those reported as running successfully with no serious issues. For instance, Dumaguete, Philippines was ranked as being 'well managed' as the document stated that '*The program has resulted in measurable improvements to the environment and significant economic development'* (Robbins and Antonio, 2017). This status also includes projects where the majority of the population benefited from the service. In total, 18 case studies were ranked as 'well managed'. These projects were found to be evenly spread when looking at their distribution by continent with six in Asia, five in Latin America and seven in Africa.
- 'Improvements required' were operational projects that contained significant dysfunctional elements but also aspects needing further development. This status was attributed to case studies by finding positive and negative points stated in the documents and then comparing both. Out of the database, 19 experiences were ranked as 'improvements required'.
- 'Poorly managed/non-functioning' projects were those failing to meet basic sanitation needs of the population or were no longer running. When categorising a project as 'poorly managed/non-functioning' there had to be significant evidence in the documents stating that it was the case. For example, Maimun, Egypt was classified as 'poorly managed/non-functioning' as in the text it stated '*The visit of the WWTP showed a highly dysfunctional status, with an anaerobic effluent coming out of the supposedly 'aerated biofilter'. This initiative is a good example of what should not be done when dealing with small- scale sanitation'* (Reymond, 2013). Six were ranked as 'poorly managed/non-functioning'.

Three case studies could not be ranked as they were ongoing and with no available outcomes.

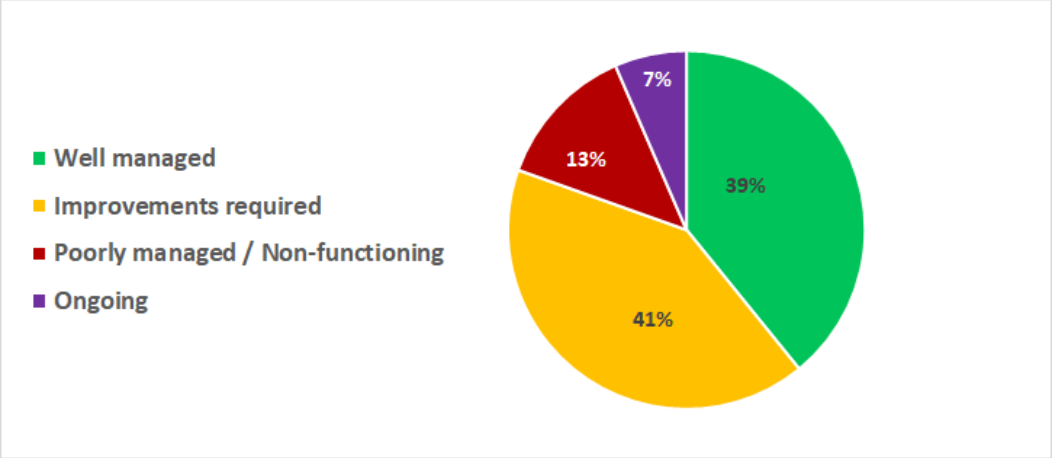

Figure 2: *Proportion of case studies 'well managed', 'improvements required', 'poorly managed /non-functioning' and 'ongoing'.*

Although the percentages detailed in Figure 2 above cannot be generalised, it reflects the trends of this database by revealing that most of the sanitation projects in STLV need further enhancements in managing sanitation services (41%). In addition, the proportion of case studies that have 'well managed' sanitation services is significant (39%).

- Management per type of actors

Figure 3 describes how the projects were managed according to the type of actors involved (see 3.2.1. Overview case studies).

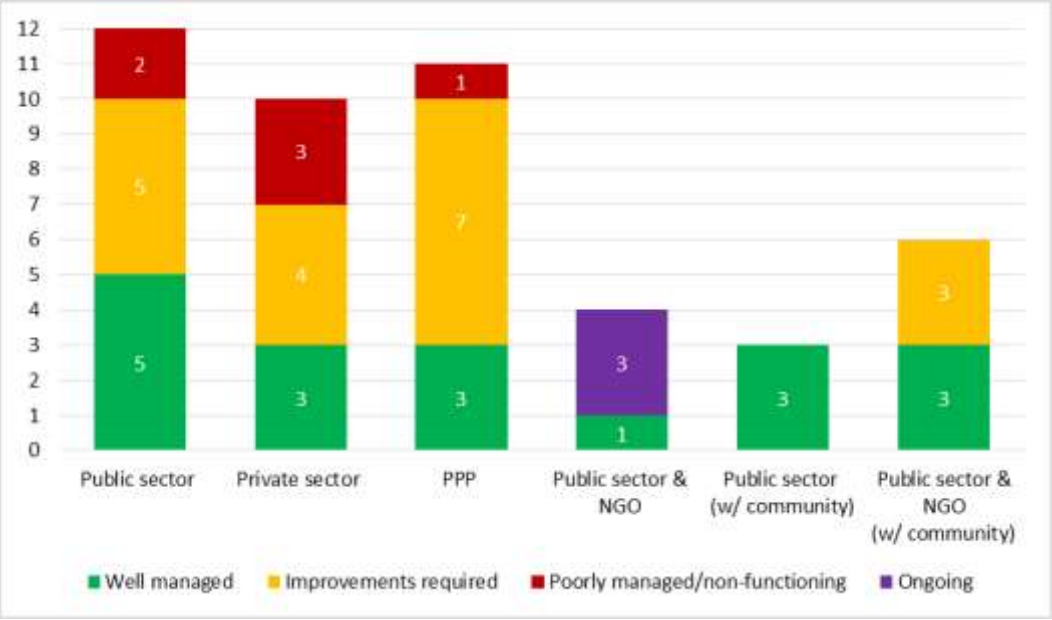

Figure 3: *Number of case studies 'well managed', 'improvements required', 'poorly managed /non-functioning' and 'ongoing' case studies split by the actors*

Figure 3 shows that each group of actors are capable of delivering 'well managed' projects. This indicates that actors are not a defining characteristic to a 'well managed' project. Hence, factors resulting in projects being 'poorly managed/non-functioning' are not purely linked to the actors involved.

- Management per population size

Smaller towns had the most variability with a high proportion of either 'well managed' or 'poorly managed/non-functioning' projects as seen in Figure 4.

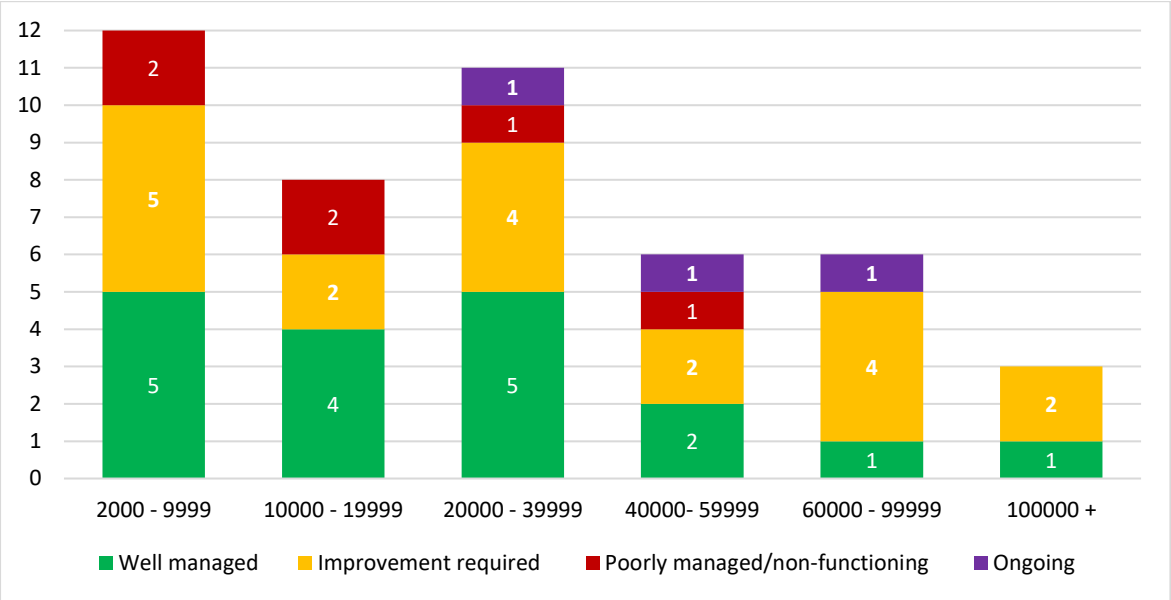

Figure 4: *Case studies split into STLV population brackets showing the number of 'well managed', 'improvements required', 'poorly managed/non-functioning' and 'ongoing' projects*

From the case studies, there does not seem to be a trend that correlates project success to either actor or continent. This shows currently there is not one solution to the issue of STLV sanitation throughout the developing world. There are a variety of different methods and actors which can be successful. From all the categories listed or described throughout 4.2 Case studies, the public sector and community partnership programs are the only ones to have a majority (55%) of their projects classified as 'well managed'. Considering there are only three examples of this, further research would be needed to determine whether this was a viable option, and still true on a larger scale.

- Lessons learnt

A mixture of positive and negative lessons were learnt. Considering each case study had its own specific results, no one conclusion could be drawn. However, the results were used to illustrate general lessons learnt in the discussion section. From the lessons learnt, 'technology' was the most mentioned category throughout the case study overviews. It was mentioned 14 times both positively and negatively. 'Institutional', 'partnerships and stakeholders', and 'financial' were all also mentioned frequently (between 10 and 13 times). This indicates that these are the most critical factors in sanitation systems in STLV.

4.2.2. Full sanitation chain case studies

A total of 11 full sanitation case studies were selected out of the overview case studies according to a set of criteria (see 3.2.2. Specific case studies: Full sanitation experiences). The full sanitation chain case studies provided more details on the technological aspect of each section of the sanitation chain, whereas overview case studies provided a broader perspective. Among these 11 experiences, five were from Asia (Chilaw in Sri Lanka,

Lakshmipur in Bangladesh, Tikapur in Nepal, Hin Heup in Laos and Dumaguete in the Philippines), three from Latin America (Marinilla in Colombia, Sechura and Tumbes in Peru) and three from Africa (Rosso in Mauritania, Filingué in Niger and Kasungu in Malawi) of which one is a cluster (Tumbes, Peru).

- Fact Sheets

Fact Sheets were made for each of the full sanitation chain case studies (see Appendix 6), summarising the information found in different documents and included critical evaluations of experiences of the full sanitation chain in STLV. Management of each component of the chain was described, along with the actors involved and the different roles played by these. Along with the associated key lessons learnt, these findings helped achieve both objectives two and three. Table 2 is an example of a full sanitation chain case study: Tikapur in Nepal.

Table 2: *Fact Sheet for the town of Tikapur, Nepal*

Fact Sheet 4: Tikapur, Nepal	**Population: 56,136 (2011 census)**
Baseline: High existing on-site sanitation coverage but total lack of sanitation service chain (emptying, transport and treatment).	
Summary of the project: **Number of beneficiaries/coverage:** 98% of household sanitation coverage (2016). **What and how:** As part of the programme Sanitation Planning for Small Towns in Nepal (start in 2016): Testing of planning tools, data collection exercise, utilising smartphone apps (Kobo Toolbox survey), SFD, GIS database. **Follow up:** Allows for better planning and advocacy of sanitation.	
Sanitation chain: **Containment**: On-site sanitation technologies (60% of single pit latrine, 7% of double pit latrines, 19% Flush toilet connected to septic tank, 12% biogas digester) (SFD). **Emptying:** Manual emptying (38% emptied by family member, 65% by Informal manual emptying providers, 44% of latrines have never been emptied yet). **Transport:** Manual emptiers. **Treatment:** No centralised treatment. **Disposal/Reuse:** Waste dumped into the environment (86%) or buried in adjacent pits (14%).	
Actors -Include funders	*Roles*
Asian Development Bank	Funder (as part of the Third Small Towns Programme for 26 towns in Nepal)
Eawag-Sandec	Technical support
UN-Habitat	Funding
Private sector	Informal manual emptying
The Water and Sanitation Users Committee (WSUC)	Local body responsible for water and sanitation services
Lessons: Mass awareness was needed to disseminate the concept of citywide sanitation planning. Need of more hands-on guidance material, lack of know-how in FSM at all levels (national, district, municipal, private sector).	
Results: 30% of the faecal sludge is appropriately managed (SFD)	
References: Eawag-Sandec, GIZ, Gret, pS-Eau, SuSanA, WaterAid. and the World Bank (2017) 'Safely Managed Sanitation In Small Towns', in Minutes of the tandem sessions, World Water Week. Sunday 27th August, from 2:00-3:30pm and 4:00-5:30pm, Stockholm. pp.1-17. Eawag-Sandec (2018) SFD Promotion Initiative: Tikapur Nepal. Kathmandu/Tikapur: EAWAG-SANDEC. Available at: http://www.susana.org/_resources/documents/default/3-2361-7-1447766816.pdf. Lüthi, C., Reymond, P., Renggli, S., Reynaert, E., Klinger, M., Sherpa, A., Sherpa, M., Mtika, W., (2017a) 'Small Towns: Research on Solutions for the Sanitation (Planning) Gap', Sandec News, 18. Available at: http://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/schwerpunkte/sesp/Sanitation_Planning_in_Small_Towns/small_towns.pdf (Accessed: 14 April 2018) Lüthi, C., Mitka, W., Renggli, S., Reymond, P., Montangero, A., Sherpa, A.M., Sherpa, M., (2017b) Research for policy 5: Sanitation Planning for Small Towns: Good data for good planning. Eawag	

- Summary of the full sanitation chain case studies

Figure 5 represents a summary of the main results that were classified by actors. As previously explained (see 4.2.1. Overview case studies), case studies have been sorted by the most common combination of actors involved in the sanitation chain.

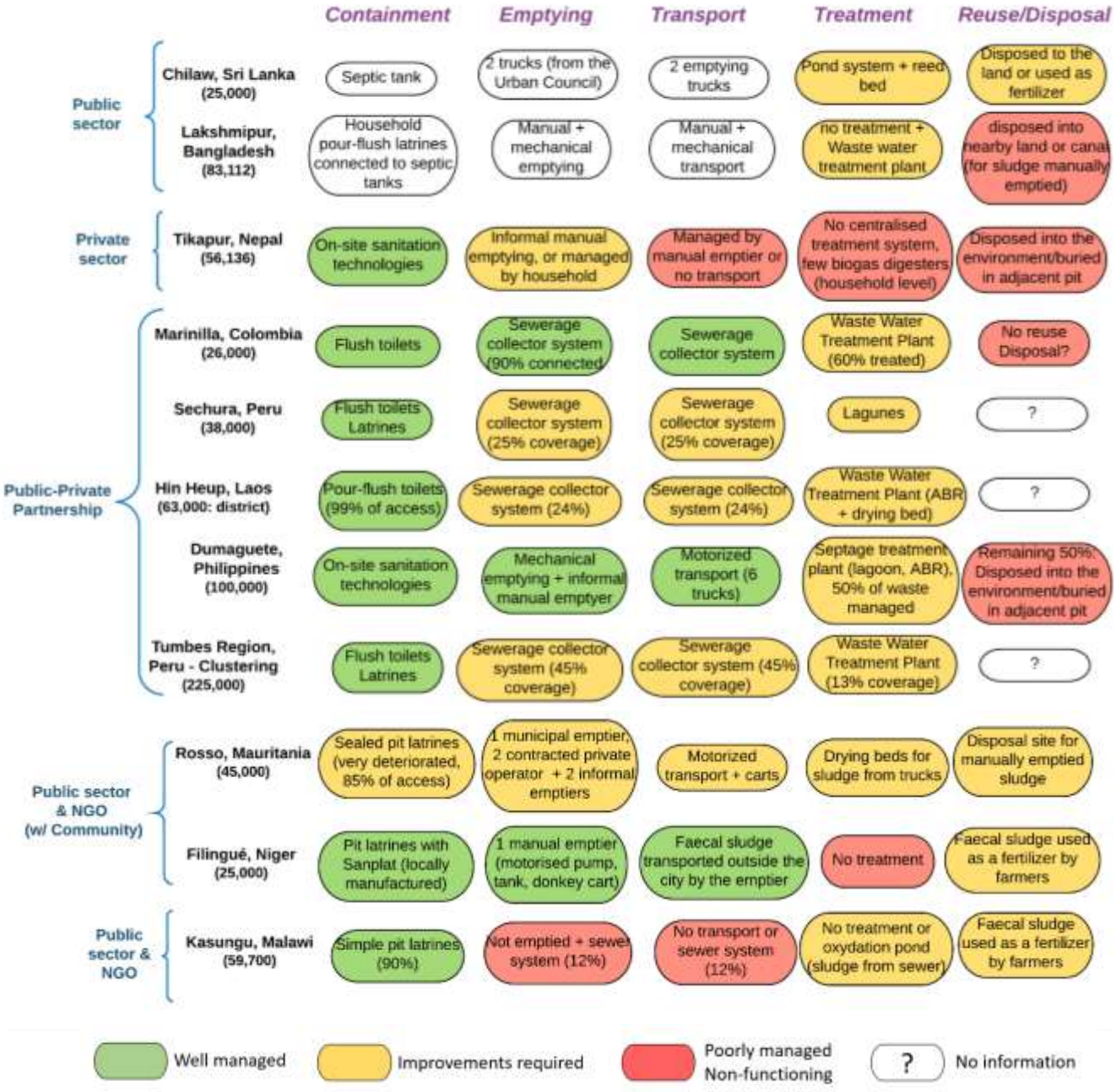

Figure 5: *Pattern representing the options in place for each section of the sanitation chain for the 11 full sanitation chain case studies sorted out by actors*

Properly managed services from which the majority of the community can benefit from have been highlighted in green. Those that still require improvements to reach the whole town but showed an interesting approach are shown in yellow. Finally, red was chosen when the town received no service delivery or that the one in place was inappropriate due to health risks. Finally, for the captions with questions marks; no information was found while for those in

white there was no coverage information detailing the proportion of the town which benefits from the service.

Regarding the containment aspect of the chain, access to sanitation facilities was usually achieved in STLV with 8 out of the 11 case studies being properly managed, hence the tendency for green boxes towards the left-hand side of Figure 5. Difficulties faced by STLV began after containment where emptying and transport services were only managed in a minority of towns (3 out of 11). Regarding the treatment, none of the towns studied properly managed the treatment aspect of the chain. Although most of the STLV possessed a centralised treatment facility (2 out of 11 case studies did not have any form of treatment in place), the treatment coverage was generally very low. Reuse and disposal have been highly neglected (5 out of 10 were 'poorly managed' or not occurring, and 3 had no information).

4.3. Interviews' summary

The interviews were conducted to: contribute to the overview database (Objective 1), complement certain full sanitation chain case studies (Objective 2 and 3), identify systemic barriers preventing the sanitation chain from functioning (Objective 4) and identify potential functioning or missing tools for STLV (Objective 5). These results were further analysed and used to highlight findings in the discussion. A table summarising interviewees' main statements on recurring key themes can be found in Appendix 7.

Nine interviews were conducted from a diverse panel of professionals: two university researchers, two consultants, three international NGOs staff and two from local NGOs. Overall, the information collected reinforced what was found in the data collected from the literature, the main outcomes have been summarised below.

Firstly, lack of management capacity to handle sanitation issues was seen to be a recurring challenge for STLV municipalities and utility staff (all KI). This challenge can be overcome with more focus on soft skills through capacity building on the long term, staff training and support, skills transfer and strong leadership. Institutional engagement and political willingness are factors of success (KI5 and KI6), and according to KI1 that is to a more significant extent than the choice of the technology. Concerning responsibilities, it was recommended that roles be defined clearly at an early stage (KI1, KI2, KI4, and KI8).

Two consultants (KI7 and KI9) agreed on the division of roles where containment should be the user's responsibility while emptying and transport should fall under the private sectors and treatment be the public sector's duty. However, they disagreed on where investment should be focused. While one argued that subsidies must be given in priority for household containment, the other stated that public money should be dedicated to downstream treatment as users were not willing to pay for that part of the sanitation chain.

The lack of financial resources, especially for Operational Expenditure (OpEx) (in particular; salaries) and Capital Expenditure (CapEx) was one of the leading issues highlighted (all KIs except number 6). Several strategies exist to overcome this challenge: service subscription, subsidies, sanitation tax, better fees collection, bonding fees with the water sector or funder's donation. KI1 considered cross-subsidies with the water sector as a possible solution. On the contrary, some were concerned with the resulting increase in water bills and the complexity to

manage accountancy between the two sectors (KI3, KI4, and KI5). In most of the cases, the market of sanitation service provision was unattractive for private service providers because of lack of demand from the population (KI7, KI8, KI9). However, by setting market rules, giving guidelines (KI1, KI9) and creating demand, private operators could be attracted in operating in STLV (KI3, KI6, KI7, KI9).

For most of the key informants, the size of STLV meant they could not reach economies of scale. A population of less than 60-80 thousand is not viable for most operators (KI7), around 50 thousand might work if there is tourism and a hotel industry with a good client base (KI7 and KI3). For KI2, KI8, and KI9, the population size was less significant than willingness and ability to pay. Interviewees were also asked their opinion on clustering as it has been considered as one, or the solution in reaching economies of scale. However, KI5 was concerned by the political complexity and public accountability it would imply while others were sceptical about the economic viability. The latter was especially true in cases where the extension of the service increases the operational costs and therefore the tariffs (KI6 and KI8).

The need for a simple (low-tech) and affordable technology adapted to the context, building on what is already existing, was raised nearly in all the interviews (KI2, KI4, KI5, KI6, KI8, KI9). It is enabled by a good baseline database, i.e. an analysis of the context which maps existing sanitation facilities and services, as well as the income levels in the population of the STLV (KI2, KI3, and KI6). According to KI2 and KI3, the local community should be able to take charge of Operation and Maintenance (O&M) of the system. The two university researchers (KI1 and KI4) mentioned behavioural change and how it was more of a challenge in STLV as people who had migrated from rural areas were used to very basic living conditions. The service must, therefore, be prepared to drive behavioural change.

Having a global vision (KI2, KI7, KI8, and KI9) and long-term planning (KI1, KI3, and KI4) were identified as being mandatory as long as they were carried out in a step by step approach (KI1, KI2, KI3, KI5, and KI6) taking in consideration what the STLV could sustain. This could be facilitated by giving guidance to STLV on the way to full sanitation chain, especially for the first steps. Sanitation was rarely seen as a priority for local authorities (KI2, KI3, and KI5); therefore it would be beneficial to coordinate with other sectors like water, rainwater, and solid waste management while implementing sanitation projects (KI1, KI2, KI8).

Figure 6 shows the main recurrent themes which were mentioned or discussed in depth during the interviews. Box-sizing is proportional to the number of interviewees talking about a specific subject. Numbers were deliberately not included as this representation is subjective. Moreover, these themes were evoked more or less spontaneously and discussed in varying depth. Subjects answering leading questions were excluded from the diagram (which is why clustering does not appear for example). Financial resources were represented in green and stakeholders related subjects in dark blue.

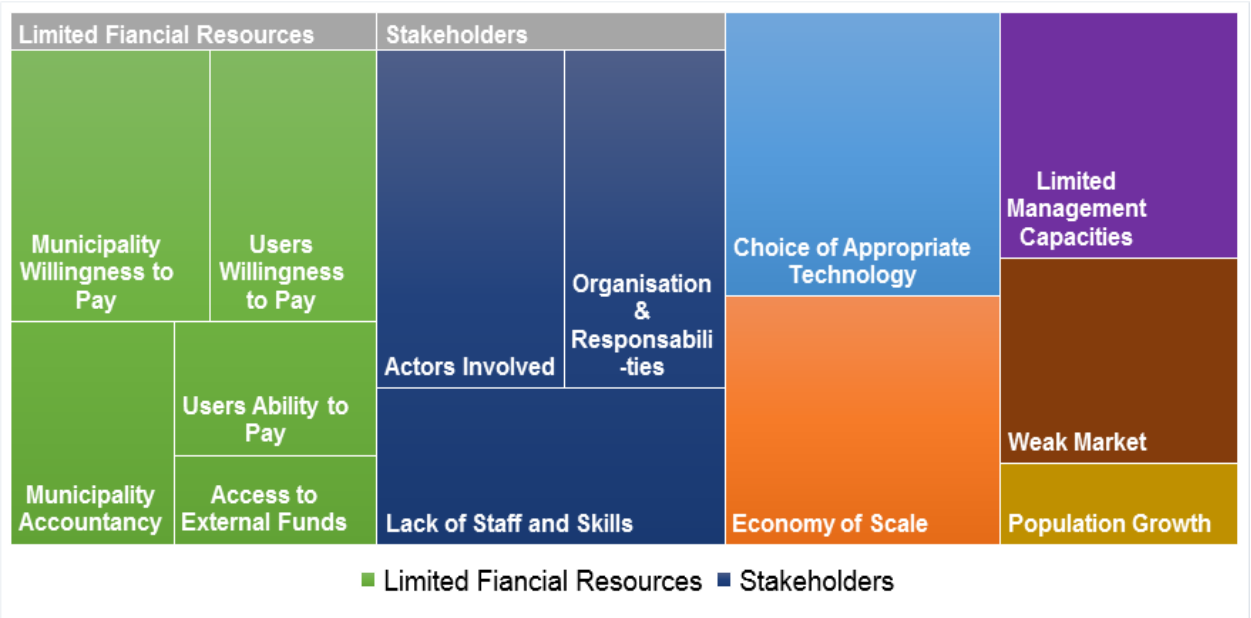

Figure 6: *Interview themes: sized in proportion to mentions*

5. DISCUSSION

This discussion section was based on all the previously stated results, namely the key findings of the data collection, the case study overview (see Appendix 5), the Fact Sheets of full sanitation chain case studies (see Appendix 6) and the interviews (see Appendix 7). The aims of this section were multiple. Firstly, through the combination of data gathered, to answer the research question while gaining an in-depth understanding of the topic at hand. Secondly, allowing for recommendations to be made and finally raising further research questions. Even though interpretations were evidence-based (lessons learnt produced by findings from the literature and illustrated by case studies and/or interviewee's experiences), combining the data proved to be challenging.

5.1. Limitations

Limitations for data collection were discussed in '3.4. Limitations of the methodology'. There were limitations and risks in discussing the research question with missing or misunderstood data (see 4. Results). However, a process of triangulation between the authors and the client was used to validate the data and use it for interpretation.

This research was based on literature, case studies, and interviews that were understood with (unavoidable) subjectivity as it was impossible to be neutral during the data analysis and interpretation. Another limitation was the prevailing tendency, while analysing the data, to focus on elements which reinforced previous findings and personal beliefs. There was also a risk of bias in the discussion by focusing on initial statements (Dumez, 2013).

Recommendations depend on the author's perspectives; if other researchers had conducted this study, conclusions would likely be different. Therefore, this study had limited external reliability (Ritchie and Lewis, 2003). Finally, to overcome these limitations, it was essential to

try and take a step back from the data analysis and to try and have an objective look at the findings.

5.2. Lessons learnt

This section aimed to answer the third objective of the study and more broadly, to analyse the lessons that could be learnt from a range of past experiences. These could help to overcome the initially identified challenges of sanitation in STLV (see 4.1. Preliminary challenges identified with respect to sanitation in STLV) as well as new ones stemming from the interviews and detailed analysis. The lessons learnt were split into six different sections: Stakeholders, Institutional, Capacity building, Financial, Technological, and Clustering.

5.2.1. Stakeholders

- Local authorities

The very first lesson learnt from the case studies regarding the management of the sanitation chain was that involvement of local authorities plays a key role in achieving successful sanitation projects as was the case in Filingué, Niger (detailed in Box 1) (KI6).

Box 1: Involvement of the local authority in the sanitation project in Filingué, Niger

The role of the municipality of Filingué has been central to the success of the sanitation project conducted by the NGO RAIL (Réseau d'Appui aux Initiatives Locales) Niger. The municipality contracted an experimented emptier already operating in Filingué. Then, during a general assembly attended by the emptier and then population, they facilitated the discussion of what tariffs should be agreed upon. These had to be affordable for the population while financially viable for the emptier. Across the project, the local authority also:

- Provided subsidies to the lowest-income households to build pit latrines with SanPlat. This generated a positive dynamic with most of the dwellers of Filingué to buy and use a SanPlat.
- Promoted the role of the emptier within the town.
- Facilitated the transfer of knowledge by communicating through posters and the use of town criers.

The primary challenge for the elected members of the local authority was to fulfil the needs of the population, especially concerning sanitation, which was a sector that needed to be considered as a priority.

This example shows the importance of the willingness and involvement of the local authority to make a sanitation project successful.

(Gabert *et al.*, 2018; KI6)

The role of local authorities in STLV is essential in creating the enabling environment for utilities to be successful. For example, support can be provided directly like in the case of Tansen, Nepal, where the municipality provided public land for wastewater treatment plants (Bright-Davies, 2013). However, local authorities are not always the ones providing support as seen in Cayambe, Ecuador where the municipal utility was successfully created with technical and financial assistance from a national institution (Drees-Gross, Andrade and Schippner, 2015).

Strong municipal leadership with willingness to draw attention to enlist development agencies, as seen in the case of San Fernando in the Philippines, helped to overcome the lack of enabling environment at national level (WaterAid, 2016b). Finally, local authorities that successfully manage their sanitation services can become models for other towns such as Dumaguete in the Philippines which became the country's first publicly-financed septage management system when implemented in 2013 (Robbins and Antonio, 2017) (see Appendix 7, Fact Sheet 5).

- Private sector / Utilities

Large utilities are unlikely to accept small contracts to provide services in STLV, and the local authorities in STLV often lack the capacity to handle contracts with large utilities (UN-Habitat, 2006). However, as mentioned by KI4, KI7, and KI9, municipalities were likely to contract small private operators or entrepreneurs to overcome the challenges associated to the management and operation of the emptying and transport steps of the chain - steps where there is usually a gap in skills. The municipality should only be responsible for giving guidelines and monitoring the operation of the private sector (KI1). KI4 mentioned an approach that could be used by STLV municipalities: Build, Operate, Train and Transfer (BoTT) as a form of public-private initiative. BoTT facilitate the implementation of projects through the use of management contracts and by combining the skills and resources of the private sector with the vision and financial strength of the public sector (DWAF, 2000).

As not all private operators are good sanitation service providers, training entrepreneurs is a way to achieve quality sanitation in STLV. This was demonstrated in the case of Filingué, Niger where an emptier was contracted and trained by the municipality to spread his scope of action (Gabert *et al.*, 2018) (see Appendix 7, Fact Sheet 1). The case of Marinilla, Colombia showed that when a private operator serves several STLV, a reasonable level of professionalism and economies of scale was reached which in turn allowed for a reduction in operational costs (Rivera, 2001) (see Appendix 7, Fact Sheet 7).

- Public-Private Partnership (PPP)

From KI3's experiences in Africa in the 90s, PPP did not work in STLV as they were highly indebted, especially to other public institutions (like energy supply and social security) and unable to pay back these debts. KI4 is cautious regarding PPP as private involvement means that the percentage of profit is higher compared to public provision which can be a sensitive issue when serving poor people. On the other hand, PPP is a way to share the financial burden when building new infrastructures.

PPP has been very popular in Latin America as can be seen in the case study overview (see Appendix 5), specifically those examples in Peru, Colombia and Ecuador as well as some less formal contracts in Africa and Asia. No generalisation was made on the success of these kinds of contracts as they were all implemented differently and had their own context. The case of Sechura (see Box 2) shows what can happen to PPP when the involvement of all stakeholders does not remain constant.

Box 2: Management contract in Sechura, Peru

A 10 years renewable management contract was established between the municipality and an independent specialised operator. This contract was created through the PPPL 'Proyecto Piloto en pequeñas localidades' (Pilot Project for Improving Water and Sanitation Services in Small Towns) with the help of Water and Sanitation Program (WSP). The municipality, government and population engagement were determining factors for this type of contract to be put in place. The sanitation service quality and coverage improved under this contract, unfortunately, the lack of coordination between the operator, the municipality and the community prevented the contract from being renewed.

(Tapia Gamarra, 2013).

KI9 saw the private sector as weak and unregulated in STLV but when there is a strong local government to provide guidelines and some tariffs regulation like in Filingué (see Box 1) its involvement ensures success and PPP would be seen as the solution. KI7 and KI9 saw PPP as a way to share responsibilities in the sanitation chains: the private sector should be involved in the emptying and transport while the municipality should organise the treatment/reuse aspect.

- Community involvement

Community involvement is essential to guarantee the success of the sanitation chain in STLV and make sure that service provision meets everyone's needs. The scale of projects is often appropriate to involve the community in the planning, the choice of the technology and the delivery of the service (UN-Habitat, 2006). For example in the town of Sechura, Peru the local community had a central role, along with the other actors, in the coordination of the service management having previously created a supervision board (Tapia Gamarra, 2013) (see Appendix 6, Fact Sheet 8). Moreover, as confirmed by KI2 and KI3, the community can manage the sanitation system where the lack of economy of scale dissuades the private sector. Also, the lack of complex management of sanitation service gives space to the community to influence the local authorities.

Community involvement often underpins better service provision as seen in the case of Nala, Nepal where the project was initiated due to the strong demand from the community for better service provision and their willingness to participate in the sanitation planning process (Sherpa A, Sherpa M, Lüthi, 2013). Community involvement has other advantages such as improving the living conditions of vulnerable groups, and fostering gender equity as demonstrated in the case of Kyotera, Uganda (SNV, 2011).

- Partnerships - Responsibilities and collaboration

KI1, K2, and KI8 were of the opinion that all the partners should assign and agree on clear roles, responsibilities and tasks straight from the beginning of projects. As seen in the case of Kasungu, Malawi defining which actor has what role was essential in making sure responsibilities did not overlap with each other and that all tasks are managed by someone (Eales and Gibson, 2017) (see Appendix 7, Fact Sheet 2). This was successfully achieved through the use of general assembly in the town of Filingué, Niger (see Box 1). Once made, the responsibilities should be reviewed with necessary adaptations made roughly every five years (KI4). KI7 and KI9 agreed on the division of roles where containment is the user's

responsibility while emptying and transport falls under the private sector and treatment is the public sector's duty.

In the case of Marinilla, Colombia, maintaining a good relationship between all the actors involved led to agreements and improvements in the management of the sanitation chain (Rivera, 2001) (see Appendix 7, Fact Sheet 7). In Nala, Nepal, collaboration between the actors of the projects allowed sustainable planning, implementation, capacity building, and O&M of the project (Sherpa A., Sherpa M., Lüthi, 2013). However, as seen in the town of Sechura, Peru, as soon as the community committee ceased to meet, the coordination between the actors of the project was compromised and precipitated the failure of the sanitation service chain (Tapia Gamarra, 2013) (Box 2).

In the process of dynamic population and economic growth, STLV are shifting from community managed to centrally managed services. This transition requires coordination between the actors (KI1). UN-Habitat (2006) supported that the relationship between users and the local authorities in STLV was easier than in cities and that local authorities were more willing to partner with local organisations and receive support from NGOs. For example, in Tansen Nepal, the NGO acted as an intermediary between the government and the local communities to ensure a working sanitation chain (Bright-Davis, 2013).

5.2.2. Institutional

- Growth

STLV have been known to grow faster than the institutions supporting them. STLV identified were often unable to control for this growth but should be able to redirect people to areas they have planned for (KI1). Planning for population growth needs to be taken into account as some treatment systems require a considerable amount of space.

- Human capital

Retention of skilled workers and management staff has proven to be difficult due to the improved quality of life and access to amenities in cities. Lack of career options in STLV and the inability of the utility to implement projects also played a part. Retention may be increased by incentivisation, training and strong leadership - as these are typically lacking in STLV (KI3). Training and good leadership are required to provide the human resources capacity building to deliver better services (KI3).

- Regulatory and enforcement policies

Institution involvement was singled out as being more important than infrastructure (KI1), and seen by some as an essential part of the solution (KI4). KI7 saw regulation as essential in controlling the downstream segment in order to avoid unregulated emptying, resulting in pollution and health issues. Lakshmipur's case study highlights that the absence of a specific FSM regulatory framework is a significant impediment in the planning and implementation of successful FSM initiatives (Dasgupta *et al.,* 2016) (see Appendix 6, Fact Sheet 10).

- Lack of involvement and support from central government

STLV often lack strong political leadership along with the capacity and commitment required in improving sanitation provision and attracting investment. This was partly attributed to a lack of political weight and visibility to national governments (UN-Habitat 2006), unless there is a strong, well-connected local champion, as seen in Dumaguete (see Appendix 7, Fact Sheet 5). SFDs are simple to compose for STLV and can be a useful tool to raise awareness and political will (KI5) (see 5.4.2. Advocacy and Awareness tools).

The Water and Sanitation in the World's Cities series found that rural and urban sanitation often came under the responsibility of different government institutions (UN-Habitat 2006). STLV were at times missed altogether as they fell outside of sector strategies and were unable to fight for their share of funding. Policymaking was often made in a distant capital city, and not implemented in STLV due to lack of regulatory capacity (UN-Habitat 2006).

- Decentralisation

Decentralisation was a common trend in South and Central America (Rosensweig and Perez, 1999), seen by the national governments as a way to modernise the water and sanitation sector. Decentralisation was supposed to enable small authorities to adapt to local conditions and demands, but often STLV are delegated additional responsibilities without increased authority or capacity to fulfil them (UN-Habitat 2006). For example in Marinilla, when the regional agency shut down, sanitation services responsibility was handed over to the municipality which was not capable of maintaining it. There were a very few sewerage connexions and no wastewater treatment. In this case, the water and sanitation services were handed to a competent private operator (see Appendix 6, Fact Sheet 7).

Instead, national or regional programs, institutions or centralised support structures can be implemented to support local authorities in the transition (UN-Habitat, 2006), particularly for planning (KI3). For instance, The National Sewerage and Septage Management Program in the Philippines accelerated the progress made by the STLV of Dumaguete by *'providing technical assistance and targeting training to build capacity of local officials to undertake FSM programmes*' (Peal *et al.*, 2015) (see Appendix 6, Fact Sheet 5).

Similarly, in this context of decentralisation, the municipality of Filingué in Niger, had to face new sanitation responsibilities but was supported by the decentralised cooperation (with the municipality of Athis-Mons in France) through the NGO RAIL-Niger (RAIL-Niger, 2008). Filingué's municipality did not have the skills nor resources to manage the service, but the new organisation of the sanitation service provided the population with a functioning pit emptying organisation (KI6) (see Box 7 in 5.2.5. Technological).

NGOs have been trying to fill the vacuum left by the national governments during decentralisation programs by facilitating capacity building of local authorities (see 5.2.3. Capacity building) and institutional reorganisation such as PPP (see Box 2 in 5.2.1. Stakeholders).

5.2.3. Capacity building

The first challenge mentioned for sanitation service in STLV by KI1 and KI3 was the lack of technical, planning and managerial capacities of both utilities and local authorities. It can be explained by the maladapted approach towards sanitation management in STLV due to their shifting nature from rural to urban characteristics. The skills required exceed rural approaches while urban utility approach is unachievable because of the lack of revenues generated by sanitation services (UN-Habitat, 2006). There is no full cost recovery and an inability to remunerate and retain competent staff (KI3), who are already difficult to attract in STLV (UN-Habitat, 2006). Unfortunately, there is still a focus in the sanitation sector on improving technologies and infrastructures rather than developing soft skills (UN-Habitat, 2006; KI1).

Responsibilities have often been handed to local authorities through decentralisation without the adequate resources and capacity development (see 5.2.6. Decentralisation). Regional or municipal level action (perhaps centralised training (KI8)), is required (KI3) to improve operational, technical, and financial management capacities as well as administrative skills to plan, implement and sustain sanitation services (UN-Habitat, 2006; KI1). The case of Kyotera, Uganda in Box 3 illustrates a multi-stakeholder capacity development process within the framework of a regional program.

Box 3: A participative capacity building project in Kyotera, Uganda

As part of a regional capacity building program, namely the Lake Victoria region Water and Sanitation initiative, 2,990 people were trained on a wide range of topics ranging from water, sanitation and environment to pro-poor governance and local economic development. Those trained included people from local governments, water and sanitation providers, local entrepreneurs, NGO, community-based organisations, users and vulnerable groups. The stakeholders had ownership of the capacity development process as they identified the problems, their capability to address them, and the solutions. Communication and collaboration mechanisms between stakeholders was developed leading to shared objectives and approach. The resulting consortium was able to develop an integral and successful '*program of town-wide capacity development interventions*'.

(SNV, 2011)

STLV lack trained staff with capacities on forward and participatory planning. They also lack the capacity to raise income through local taxation or to access national budgets (UN-Habitat 2006). Box 4 gives an example of what were the triggers and outputs of building capacities of the local authorities.

Box 4: Permanent capacity building of local authority in Rosso, Mauritania

Knowledge development of the local authority is critical to make informed decisions and be capable of conducting the process of planning.
In Rosso, capacity building for local authorities was enabled by key factors:

- Accountability
- Participatory planning
- Financial management and follow up

Institutional capacity building allowed better regulation of the sanitation service. Desludging into the street was prohibited, and a public service delegation agreement for emptiers (manual and mechanical) was implemented.

(GRET, 2015; Santi, 2017)

Building capacities on what is existing is a way for local authorities to overcome those issues and ensure their role of leader in the case of the manager of sanitation service provider. In the case of Rapale and Ribaué described in Box 5, stakeholder's capacity was developed as a discrete project instead of the long-term capacity development programmes with specific outcomes, impacts and indicators as recommended by UN-Habitat (2006) and KI2.

Box 5: Capacity strengthening in Rapale and Ribaué, Mozambique

Mentoring and coaching was proposed to local government staff during the implementation of the Sanitation Master Plan. Also, a focus was made on disabled person needs through participatory design workshops. It enabled the development of entrepreneurs and local authority capacity to support and adapt services to families with special needs.

(Thomas and Alvestegui, 2015)

Similarly, utilities require specific training to involve all stakeholders, identify technical options, and select the appropriate strategy (UN-Habitat, 2006). Local technical skills should be developed, especially regarding O&M. In Rosso, Mauritania (GRET, 2015) as well as in Filingué, Niger, (KI6) the manual emptier received training, developing its capacity to work safely. Knowledge should be made more accessible to all levels of staff, and international knowledge should be shared and adapted to local contexts (UN-Habitat, 2006).

In some cases, there is also a lack of FSM knowledge at all institutional levels and in all sectors as in the case of Tikapur, Nepal where both the public and private sectors lacked know-how (Eawag-Sandec, 2018) (see Appendix 6, Fact Sheet 4). Therefore, local municipalities are often faced with difficult decisions on technology choices (KI5), and they may struggle to choose the most appropriate technology that is scalable beyond household level but cannot be supported by the private sector which is not more competent.

Water Operator Partnership is an emerging methodology (KI5) that can help to build capacity. Similarly, twinning local authorities to share knowledge and experiences should be looked at (UN-Habitat, 2006). Community's capacity to be responsible for some sanitation services could be encouraged and also facilitated by community organisations best practices transfers (ibid).

As a conclusion, it is essential to develop all of the local stakeholders' capabilities (KI2) from the municipality to the operator without forgetting to involve the community. In Kyotera, a broad multi-stakeholders approach has been adopted (see Box 3), in Rosso both local authorities and operators capacities have been addressed (see Box 4) and in Rapale and RIibaué, the local government and entrepreneurs have been formed to answer the needs of vulnerable groups (see Box 5).

5.2.4. Financial

Many different types of financial models for faecal sludge management have previously been identified (Steiner *et al.*, 2003) and no one type has been shown to be universally applicable. The research carried out in this report has demonstrated that for STLV to have a full and viable sanitation chain, strong sustainable and constant financial support was required. Summarised below are key financial lessons obtained from the research carried out.

- Service Payment/Tariffs

Application of a tariff has been shown to be the most straightforward way of ensuring funds were available for administration, O&M of services used in the emptying, transport and treatment of sludge. Tariffs were either applied solely at household level as an emptying fee or in parallel with discharge fees (from a desludging organisation) and purchase fees (from end-use industry). Alternatively, attaching a sanitation tax as seen in Dumaguete, to the water bill where it covered debt service on plant and trucks as well as enabling scheduled septic tank desludging on rotating 5-years plan, was shown to be a feasible model (see Appendix 6, Fact Sheet 5). Again concerning Dumaguete, to ensure the tariffs were affordable even to the poor who consumed less than 10 m^3 per month compared to the average 22 m^3, a 'low minimum payment' was created which allowed for greater coverage (Robbins and Antonio, 2017).

When emptying and discharge servicing fees were combined, for example in the PPP model in San Lorenzo, Peru, their sustainability was compromised when fares were too low and thus services were not covered (Tapia Gamarra, 2012). Willingness to pay for faecal sludge management was usually not an issue, the problem being there was not always the ability to do so (KI9). In many STLV, poverty of population meant that there was no money to pay for expensive sanitation services (KI2). It was found that when there was room for some negotiation between the service provider and poorest households (KI6), there was a higher use of the service. Finally, STLV were shown to be cohesive communities with stronger community organisations. This meant that when a new management model that enabled better billing was implemented it resulted in more investment and a better service coverage as seen in Sechura, Peru (Appendix 6, Fact Sheet 8).

- Financial Resources

Capital may be available from central government (KI9), but there was a lack of knowledge to access it in STLV. This resulted in not enough funds available to pay staff and CapEx (KI3). There was also a lack of political influence to access public funds. Funding to STLV was also limited by the lack of 'municipality' status (UN-Habitat, 2006). Cross subsidising to help low-income households was less feasible as STLV generally have fewer high-income households

and commercial users (UN-Habitat, 2006). When there was no capacity to provide CapEx, foreign investment and technical advice were able to kick-start sustainable solutions as in Hin Heup, Laos PDR (WASA, DHUP and URI, 2002) (refer to Appendix 6, Fact Sheet 6). Subsidies were essential for sanitation infrastructure and often for services (KI2 and KI6). The lack of financing mechanisms in place in STLV, where users were the main financial actor (household paid both the running costs and emptying fees) was a big issue especially considering there was no or very little public money (KI7).

The municipalities' ability to invest and work on the downstream segment of chain came from collecting some of the tax levies which then flowed into their budget. This allowed them to start the 'pump' in turns of financing but considering they already struggled with tax collection, to start a new one for sanitation would be difficult. Therefore the easier way to do it is to slightly increase the water bills to partially cover sanitation (KI7 and KI1). This is easy in large cities with existing formal utilities (public or private) but for STLV there exist very few examples where small operators/utilities collect money for sanitation on the water bill (KI7).

Local governments were unable to access domestic capital markets and lack the capability to use debt instruments (UN-Habitat, 2006). Central governments were also tasked with the challenge of dispersing cash appropriately knowing that for every large town there may be ten small ones. STLV often grew faster than their borders or official status, which impacted their funding allocation. Bilateral donors were not able to dictate to the recipient countries where to allocate funding and STLV were often a low priority.

- Financial Viability

STLV were often too small in population size, specifically the number of paying customers to make the entire sanitation chain financially viable (KI2). According to a report commissioned by pS-Eau (Collignon, 2002) for STLV in Sub-Saharan Africa when the population were lower than 50,000 PE the FSM was not viable for most operators (KI7). Having the containment part of the chain designed in a modular fashion, which allowed for it to be easily upgraded, would facilitate any future push for economy of scale (KI9). A barrier to this was the need for a high upfront level of financing especially considering that funding for sanitation in STLV, in general, is problematic (KI9). A solution for this is clustering or association with a big city (KI3).

5.2.5. Technological

This discussion is partially based on Figure 5 (see 4.2.2. Full sanitation chain case studies).

- Containment

A key point raised by interviewees and that was further highlighted in the literature was the importance of putting effort into the existing sanitation facility with the view of upscaling it, instead of imposing a replacement system (KI1 and KI9). Implementing a simple and affordable solution rather than a complex technology, which would require high investment and O&M costs and high level of expertise, was also recommended (KI2 and KI6). Models cannot be copied internationally due to the varying demographics and economies from one STLV to another. For instance, a study in South Africa found that the most affordable technology were VIP latrines while a single-pit pour flush toilet were the cheapest sanitation

facility in India (UN-Habitat, 2006). Thus, it is essential to support local options to achieve a sustainable impact rather than imposing external solutions.

The case study of Tikapur in Nepal, detailed in Box 6, revealed that no one-size-fits-all solution exists and that different kinds of technologies can be implemented, from rudimentary to more advanced, to achieve quasi-total coverage.

Box 6: A wide range of sanitation technologies in Tikapur, Nepal

Tikapur is a STLV of about 60,000 inhabitants located in the Terai district, south western region of Nepal. Only 2% of the population still practice open defecation, whilst the remaining 98% have access to on-site sanitation facilities through varying kinds of technologies such as single pit latrines (60%), double pit latrines (7%), pour-flush toilets connected to septic tank (19%) and latrines equipped with biogas digesters (12%). This wide range of technologies reflects the different socio-economic classes of the town and has allowed for near full coverage. This example shows that choosing the appropriate sanitation option depends on a country's resources (material available, living costs) and on the capacity of households to afford it.

(Eawag-Sandec, 2018).

To summarise, the success of the sanitation access is not dependent on the type of technology, but its appropriateness within the local context as well as having all relevant actors involved (KI7 and KI8). However, the first part of the sanitation chain is not the one causing failure in the sanitation management. Typically, there is near total access coverage to some type of sanitation technology (see Figure 5). People value having access to their own latrines, in part for social acceptance as well as for their well-being.

➢ Emptying & Transport

Emptying and transport are two intertwined aspects of the sanitation chain. Transport of excreta matter must be managed by the same operator responsible for emptying. This is particularly challenging when emptying is managed manually because workers do not have the capacity to transport the waste over long distances.

o Mechanical/Manual emptying

Manual emptying service providers are known to be stigmatised, most of the time, within their communities and families due to the nature of their job. However, in STLV, to contract a mechanical emptier is often not affordable for low-income households nor is it financially viable for the provider (cost of fuel). Also, vacuum trucks may not be able to access all areas within the towns, especially small informal settlements with narrow access channels. For these situations, service users may resort to paying manual emptiers which can be deemed an appropriate solution if safety measures for the workers are implemented (training and (PPE)). An example of a successful manual emptying service in STLV is described in Box 7.

Box 7: Properly managed manual emptying in Filingué, Niger

In Filingué, a town of about 25,000 inhabitants, the municipality contracted an emptier that was already operating in the town. Studies were conducted and showed that one emptier was sufficient (activity not viable for more than one emptier). Subsidies financed a tank, a motorised pump, a cart and PPE (gloves, boots, protection glasses, shovel) for the emptier. He attended a workshop about health risks related to sanitation. A General Assembly was set up with the emptier, the population and local authorities to define the emptying tariffs affordable for the population and viable for the emptier. This programme has been implemented in 2006 and is still used (KI6).

The approach implemented has to be adapted to the local context (for the whole chain). This example shows how important it is to select the sanitation actors thoroughly and that the success is depending on the management and willingness within the town.

(Gabert *et al.*, 2018; KI6).

Moreover, contracted trucks from nearby cities for emptying services seems to be not feasible for STLV; the transport costs of the provider make the tariffs unaffordable for the majority of households (KI6). This has been demonstrated in the town of Sheno in Ethiopia where the municipality occasionally arranges to bring a vacuum truck from the nearby city Addis Ababa, although the service was utilised by businesses (IRC, 2015b). Thus there is no proper transport facility in Sheno, and it is assumed that emptying coverage is low. Even if the town were to own and operate the truck, finding spare parts for maintenance would prove difficult (KI2).

- Sewer system

Generally, sewerage systems are not the most suitable solution in STLV because they require technical design capabilities and are too expensive, both for the user and the operator (KI2), especially in Africa. However, there have been some successes with non-conventional sewerage systems in South America and promising work in India with simplified spinal systems that are easily scalable (KI4). Non-conventional sewerage systems (including simplified sewerage, solid free sewerage, condominial sewer and small-bore sewers) have been implemented in some low and middle-income countries and can be an alternative if there is sufficient population density (KI9) and water consumption per capita.

Studies conducted in Brazil revealed that from a certain population density, simplified sewers are more affordable than on-site sanitation, at around 150 people per hectare (see Figure 7) (UN-Habitat, 2006). The same figure shows that conventional sewers are always more expensive than on-site sanitation for the density range presented, and so are not viable for most STLV. To summarise, small-scale sewer system is the most suitable sewer system for STLV and can represent a better and cheaper option (Tilley *et al.*, 2014).

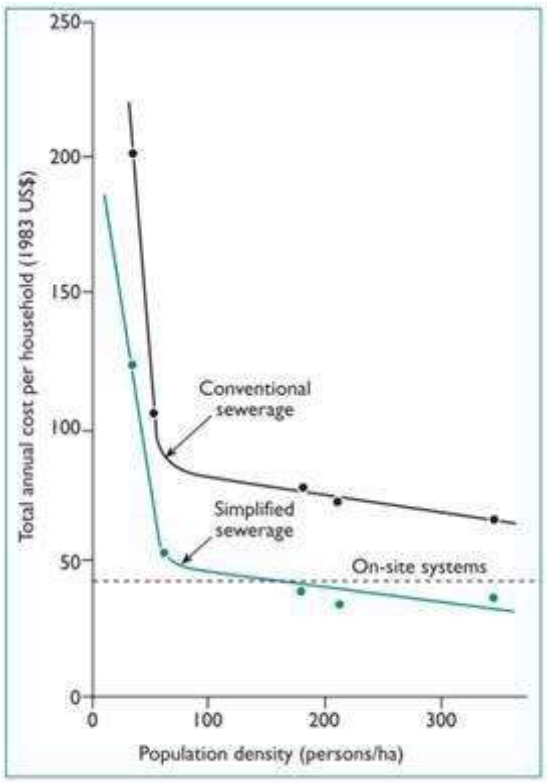

Figure 7: *Annual costs per household for conventional sewerage, simplified sewerage and on-site sanitation in low-income areas of Natal, northeast Brazil, in 1983 (Sinnatamby, 1986)*

➢ Treatment

STLV are transitioning from purely on-site storage and treatment to semi or even fully-centralised treatment, which make this aspect particularly challenging. As a result, the treatment aspect is often neglected in STLV, leading to untreated waste ending up in the environment as seen in Filingué (KI6), Tikapur (Eawag-Sandec, 2018), Dumaguete (Robbins and Antonio, 2017), Ouahigouya (Blunier, 2004), and Lakshmipur (Mujibur Rahman *et al.*, 2015).

To overcome this issue, it is recommended to implement basic technical solutions that are understandable, manageable and affordable such as decentralised wastewater systems (DEWATS) (KI2). It is an approach based on a set of treatment principles that do not require sophisticated control and maintenance (Sasse, 1998). This is the reason why it could be applied in STLV (Asian Development Bank, 2016). This type of system has been implemented successfully in Kolachel, India (see Box 8), and can be cited as an example of good practice. Other exemplary cases of DEWATS have been implemented in Hin Heup (see Appendix 6, Fact Sheet 6), septic tank and small-scale sewer system and Dumaguete; Anaerobic Baffled Reactor System (see Appendix 6, Fact Sheet 5).

Box 8: Decentralised primary treatment in Kolachel, India

In Kolachel, the treatment is partly decentralised with a primary treatment on-site (septic tanks) and a centralised off-site secondary treatment. The effluents are conducted from the septic tanks to the wastewater treatment plant through a pipe system. This pipework is smaller and less costly than a traditional sewerage system. It is a solid-free sewerage system, which presents the advantage of reducing maintenance costs. Also, the system is self-regulating with no dependence on mechanical/electrical equipment.
This case study demonstrates that technological decentralisation can be beneficial as it reduces the costs and maintenance burden.

(Dhinadhayalan and Murugesan, 2012)

To conclude, particular attention should be given in the selection of wastewater treatment processes in STLV, as in many cases the one selected is inappropriate, leading to unsafely managed waste (KI1).

- Reuse/Disposal

All steps of the sanitation are interlinked and dependent from one another. As per Figure 5, the latter links of the sanitation chain are often neglected which may imply that issues lay upstream. Many STLV grew from, and still depend upon, agricultural markets and so have potential agricultural use of nutrient-rich wastewater, which represents an opportunity for waste management (KI4). STLV also produce more agricultural waste which could be coupled with sanitation via anaerobic digestion (ibid.). Among the case studies found, the one describing a properly managed disposal or reuse of human waste are scarce. When reuse is not considered as a solution, waste should be disposed of safely. However, this research revealed that uncontrolled dumping of waste into the natural environment is common. For instance, in Filingué, Niger, faecal sludge is directly applied to agricultural land as a fertiliser without any form of treatment (Gabert *et al.*, 2018). Nevertheless, the case study of Chilaw, Sri Lanka shows an example of treatment for agricultural reuse (Box 9) (see Appendix 6, Fact Sheet 11).

Box 9: Treatment for agricultural reuse in Chilaw, Sri Lanka

In Chilaw, sludge was treated using drying beds. The pathogens content of the sludge is periodically tested and the drying period can be extended if the levels of pathogens are too high. It is then be disposed of safely in reed beds or on the coconut plantations, to be fertiliser, free of charge at the request of the owner.

(Dasgupta *et al.*, 2006; SMEC Consultants, 2012)

5.2.6. Clustering

Clustering enables cross-financing and pooling of resources between small urban centres. In general, clustering is considered as a solution to overcome the economy of scale challenge (KI3, KI4) and to complete the full sanitation chain (KI9) but under certain conditions. STLV have to be close enough to each other (KI8) and the service managed by a private operator (KI7). The economic viability should nonetheless be verified through costs modelling (KI1).

Some interviewees were sceptical of the benefits to pooling vacuum trucks as the service costs rise with the distance (KI6 and KI9). For KI2 it should only be an emergency solution. Also, clustering may have unexpected political constraints and consequences, as it implies a new level of bureaucracy (KI5, KI2).

The grouping of STLV can be made either for the technological part, for example with a joint emptying service or treatment plant, or for the management part like in Tumbes, Peru (see Box 10) (see Appendix 6, Fact Sheet 9).

Box 10: Cluster of 14 STLV in Tumbes, Peru

The municipalities handed over Water and Sanitation services to a single private company. The main factor of failure was the lack of organisation amongst the local authorities. The municipalities' coordination unit was not operational and prevented good governance. It illustrates the point made earlier on the administrative complexity caused by this type of grouping.
Moreover, this case study shows that clustering does not guarantee an equal level of sanitation coverage and service quality for all the STLV in the cluster. Despite the overall improvement of the service, Zorritos, for example, is still facing unsolved treatment plant issues lagging behind the other STLV of the cluster.

(Tapia Gamarra, 2013)

5.3. Sanitation chain systems

This section will identify and discuss the 'barriers' that negatively impact the FSM in STLV by preventing excreta reaching the next step in the sanitation chain. This will feed into Objective 4 by identifying systemic barriers and the dependent links they impact.

There are a number of recognised functional sanitation chains, such as those laid out by Tilley *et al.* (2014). For any settlement, the system may vary between neighbourhoods. For example, there may be sewers in central areas and pit latrines on the town limits. Those systems seen in the full sanitation chain case studies (see Appendix 6) are discussed, as they are relevant to STLV. STLV typically have barriers between steps in these idealised chains that prevent the functionality of the system. The barriers are from the findings of the case studies and KI interviews, and are plotted on these idealised systems at the point where they impact the functioning of the system. Barriers are shown as numbered red hexagons in Figures 8 to 11. The arrows in the diagrams represent the flow of excreta and wastewater. Arrows with dotted lines highlight where barriers have impacted this flow. This visual mapping highlights where common failures are occurring, demonstrates the consequences of some of the issues described in earlier sections, and allows for comparison between different systems. No account is taken of the frequency of occurrence, or severity; but the subsections below will aid in understanding the systems found in STLV, how they should function, and in what ways they are failing.

For each link of the sanitation chain, there is a wide range of technologies that can be implemented. One of the major lessons from this study is that the success of sanitation services delivery is not primarily dependent on the technology selected, but on coordination between each link in the chain. Indeed, for the same technological schemes set up in two

STLV, one could deliver a safe and functioning service while the other could lead to a complete failure. This can be seen when comparing the functional pit latrine emptying service in Filingué, Niger to that in Tikapur, Nepal where manual emptying is conducted by informal workers, leading to low coverage of the service (see Appendix 6, Fact Sheets 1 and 4).

This report focuses on domestic sanitation inputs. Where industries do exist, these should have separate treatment, as they may form a significant proportion of flow for STLV and so present an increased contamination risk (SOGREAH Consultants, 2011).

5.3.1. Biogas system

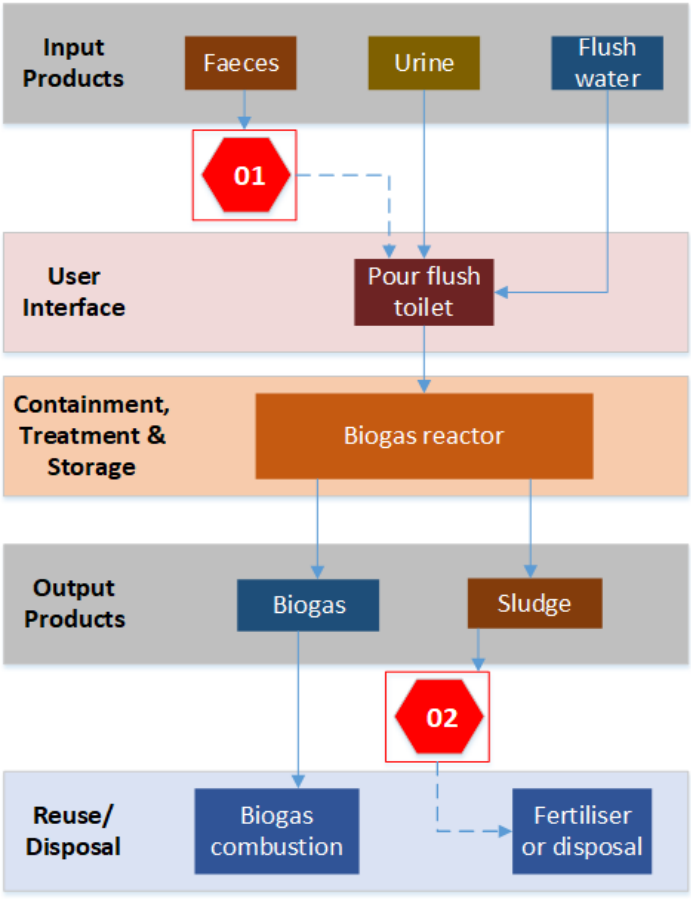

Figure 8: *Biogas system (adapted from Tilley et al., 2014)*

The system presented in Figure 8 uses a biogas reactor, which acts as containment while also treating blackwater while it is in storage. This local treatment removes the dependency on transport. This system is seen in full sanitation chain case studies in Dumaguete and a limited number of households in Tikapur. Only two barriers have been identified, but limited information was available on this system from case studies and interviews.

Barrier **01** is due to an issue identified by KI4; rural practices and attitudes continue in STLV settings, which results in open defecation. Since the faeces do not even end up in the toilet, this is a barrier to the functioning of the system. This barrier is not dependent on the type of system used so is common to all of them.

Barrier **02** prevents sludge from being reused or disposed of properly because it fails to meet national quality standards. This was seen in Kafr El Hammon (Reymond, 2013), Sechura and Zorritos (from the cluster of STLV case study in Peru) (Tapia Gamarra, 2013).

5.3.2. Blackwater transport to (semi-)centralised treatment system

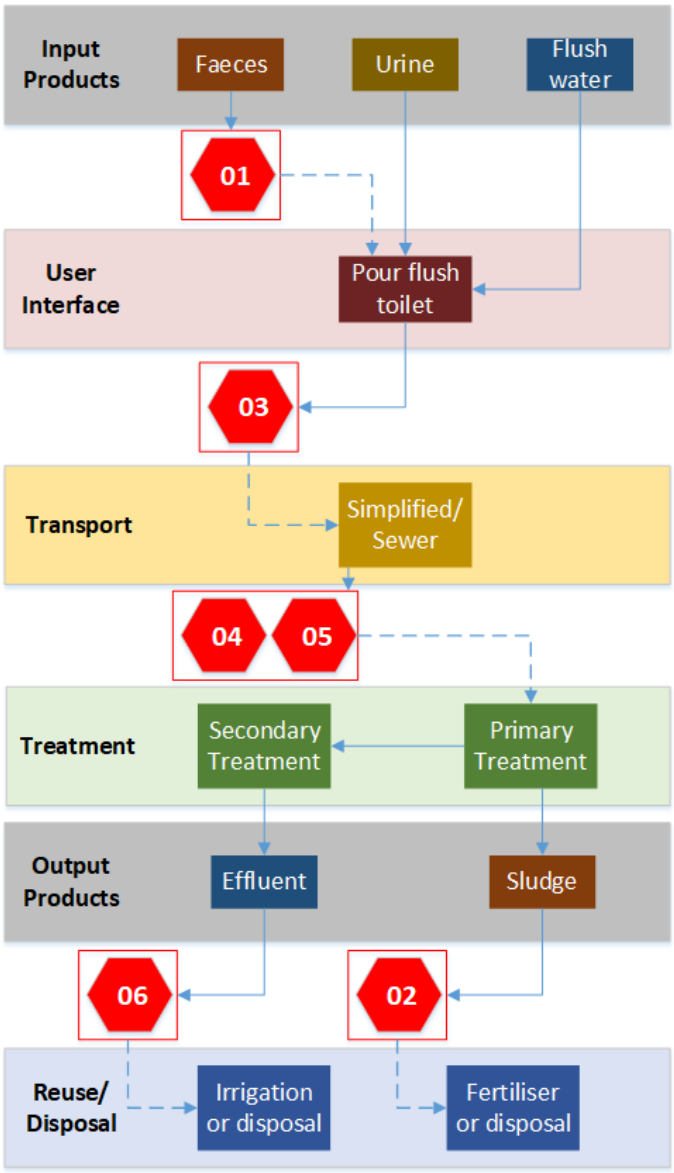

Figure 9: *Blackwater transport to (semi-)centralised treatment system (adapted from Tilley et al., 2014)*

Small bore sewers are critical to the system presented in Figure 9 and is unlikely to be viable for all but the densest of STLV neighbourhoods (see 5.2.5. Technological). This system is seen in full sanitation chain case studies Hin Heup, Marinilla, Sechura and the 14 town cluster in Peru. Six barriers have been identified, although Barrier 01 and 02 are common with the Biogas system described in '5.3.1. Biogas system' above and will not be repeated here.

Barrier **03** is due to any reason pour flush toilets cannot be connected to sewers. As discussed in '5.2.5. Technological' and by KI4, sewer systems are too expensive for most STLV. KI4 also raised the issue that the design of sewers can require technical knowledge not available in STLV.

Even if these are overcome and sewers are installed, two barriers preventing waste from treatment have been identified; Barrier **04** is that waste transported in the sewer network does not make it to treatment, as seen in Marinilla (Rivera, 2001) where part of the wastewater was still discharged into a creek. Barrier **05** is the sewers themselves failing which can also break the link between the sewer and treatment. This can be due to lack of O&M as seen in San Jeronimo, San Vicente (WSP, Proconsul and Hydroconseil, 2001) and Samaha (Reymond, 2013).

Barrier **06** is effluent not making it to proper reuse or safe disposal because it is of poor quality. This was seen in Marinilla and Sechura from the final case studies (Tapia Gamarra, 2013).

5.3.3. Blackwater treatment system with infiltration

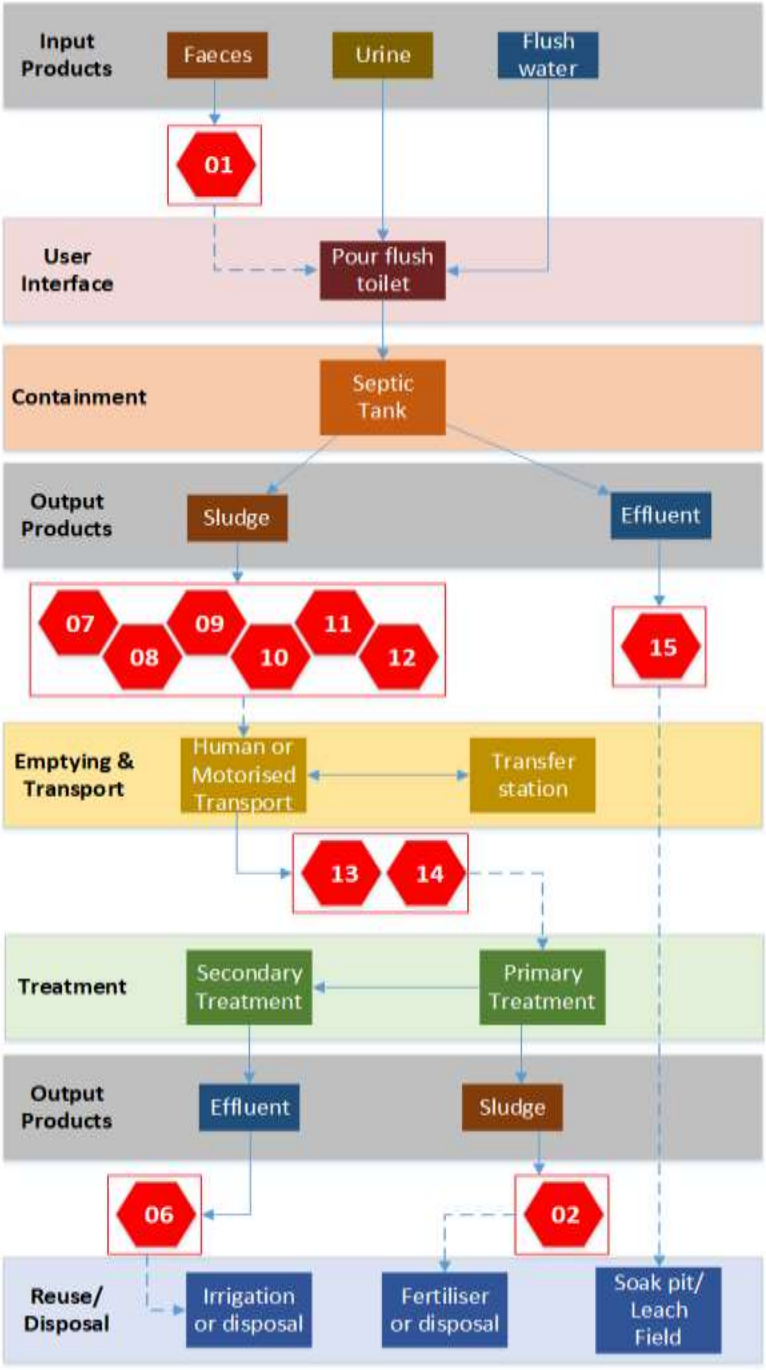

Figure 10: *Blackwater treatment system with infiltration (adapted from Tilley et al., 2014)*

The system presented in Figure 10 uses septic tanks for collection, which then require mechanical or manual emptying. This system is very common in Africa (KI1) and can be seen in the full sanitation chain case studies of Dumaguete, Lakshmipur, Chilaw, and some neighbourhoods in Tikapur. Twelve barriers have been identified, although some have been described already: 01 and 02 in '5.3.1. Biogas system' and barrier 06 in '5.3.2. Blackwater transport to (semi-)centralised treatment system'.

The sludge contained in septic tanks encounters a significant number of barriers to being emptied and transported: households may be unable to pay for collection (Barrier **07**) (KI1), lack of standard designs makes sludge extraction difficult (Barrier **08**) (KI9), large vacuum trucks may not be appropriate for STLV (Barrier **09**) (KI2), and as seen in Maksegnit (IRC, 2015a) and Sheno (IRC, 2015b) provision of these trucks from neighbouring settlements cannot be relied upon (Barrier **10**). Even where emptying services exist there is a lack of regulation to control the emptiers (price, PPE, and coverage) (Barrier **11**) (KI7). Barrier **12** was seen in Dumaguete and applies to septic tanks connected directly to drains or other outlets, and removes the incentive for emptying to happen so they overflow (Robbins and Antonio, 2017).

Once collected, the waste is often dumped before reaching treatment (Barrier **13**) - as seen in Filingué (KI6), Tikapur (Eawag-Sandec, 2018), Dumaguete (Robbins and Antonio, 2017), Ouahigouya (Blunier, 2004), Lakshmipur (Mujibur Rahman *et al.*, 2015), or the treatment plant may be poorly designed and managed and so unable to accept sludge (Barrier **14**) (KI1).

It was seen in Lakshmipur (Mujibur Rahman *et al.*, 2015) that septic tank overflows were not always connected to soakaways, resulting in effluent not being disposed of properly (Barrier **15**).

5.3.4. Single pit system

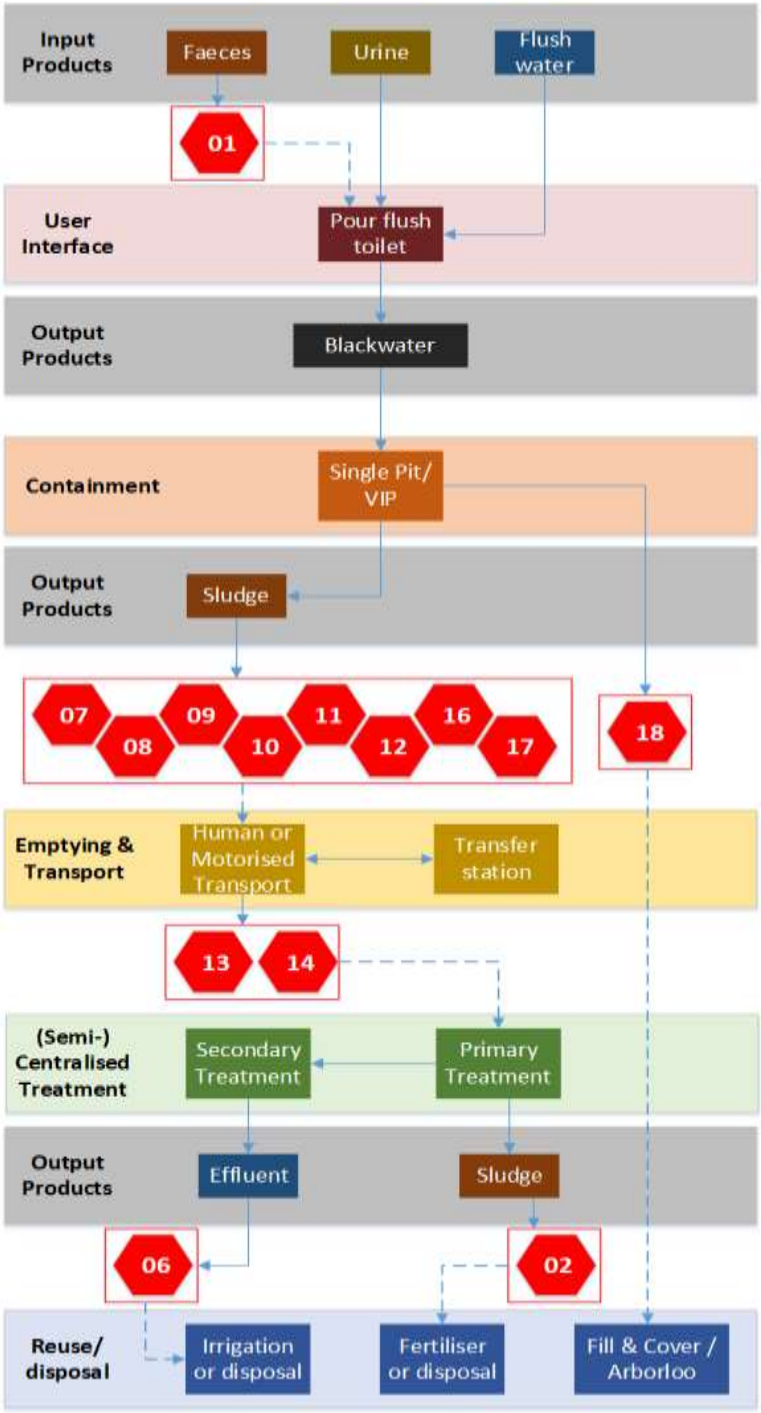

Figure 11: *Single pit system (adapted from Tilley et al., 2014)*

The system presented in Figure 11 is seen in full sanitation chain case studies Filingué, Kasungu, Rosso and the majority of neighbourhoods in Tikapur. This system was found to have the highest number of barriers identified (13), although only three are unique to this type of system.

The pit system requires emptying, encountering all the same related barriers (07 to 12) as for septic tanks (see 5.3.3. Blackwater treatment system with infiltration). However, the pit system was seen in Rosso (GRET, 2015) to be unlined resulting in sludge seeping into the ground which is a barrier (**16**) and KI1 identified pit collapse as another barrier (**17**) - both are barriers to proper emptying and transport.

On the right hand side of the idealised system shown in Figure 11 offers an alternative to emptying - the pit can be covered, and another pit dug. However, KI1 described this solution as more appropriate to rural settings as STLV typically lack the space to do this (Barrier **18**).

5.3.5. Summary of encountered systems

Some barriers identified in the case studies and KI interviews apply to all of the systems; these are at the beginning (user interface: 01) and the end (use/disposal: 02 and 06). As this section considers barriers with respect to the functioning of sanitation systems, many of the barriers encountered were due to the design, construction, and building control of infrastructure (03, 04, 05, 08, 12, 13, 15, 16, 17, 18). However, many of the barriers are related to the O&M of the systems (05, 06, 09, 14) and regulatory control or monitoring (02, 06, 11, 13).

These barriers are consequences of the underlying issues described in 5.2. 'Lessons Learnt', and show how they impact FSM in STLV. In particular, systems that produce untreated sludge, such as septic tanks or single pit latrines, have many barriers to collection. Sections '5.3.3. Blackwater treatment system with infiltration' and '5.3.4. Single pit system' show that reliance on human or mechanical emptying and transport is particularly problematic. This should steer sanitation interventions in STLV towards supporting steps beyond the containment phase, and consider systems that do not rely on transport, such as the biogas system discussed in 5.3.1.

The findings show the importance of viewing how the steps in the sanitation chain connect; rather than as separate, discrete, steps. This pairing of idealised models with real-world findings could have applications beyond this report, and is discussed further in '5.4.5. Recommendations for developing tools to manage sanitation in STLV'.

5.4. Tools

Based on the lessons learnt and the understanding of the requirements for functionality of the full sanitation chain, the necessity for tools specific for sanitation in STLV emerged. As explained in the methodology, the tools described and discussed in this section come from the secondary data collection from the literature, combined with results from interviews and case studies that identified tools related to sanitation in STLV. The aim of this section is to feed Objective 5 of the study. Therefore, all the tools described in this section for planning, making advocacy, choosing a financial model, and monitoring sanitation apply to STLV.

5.4.1. Planning tools

Planning is a challenge in fast-growing STLV; therefore city planning is essential (KI1 and KI4) and should take at least one year (KI2). Dynamic participatory planning including all stakeholders reduces costs and ensures consumers are provided with an appropriate sanitation service they can afford (UN-Habitat, 2006; KI2). A business plan can be used as a tool to match management and investments. Participatory planning, as used to implement a new sanitation service in Rosso, Mauritania requires political willingness and a trained local authority, willing to assume their role of leader. The case is described in Box 11.

Box 11: Participatory planning in Rosso, Mauritania

Support from GRET was given to the local authority in charge of sanitation to conduct participatory planning. Dialogue to diagnose the situation included every major stakeholder; local authority, private operators, manual emptiers, and the population. Together, they defined the level of service that the local authority was obliged to provide, with support from the NGO. The purpose of the planning was also to make agreements on permanent capacity building for the local authority and training and health protection (PPE) for manual emptiers. Participatory planning is key to ensure projects start successfully but it also raises challenges: actors must compromise and not deviate from the plan.

(Santi, 2017; Gabert *et al.*, 2018)

Concerted Municipal Strategy for Water and Sanitation (CMS n°1) was written by the pS-Eau to guide the local contracting authorities to develop services for a population greater than 30,000 people. This guidebook helps in developing a municipal diagnosis taking into account existing services and stakeholders' expectations. It also sets out steps to coordinate and define objectives shared by every stakeholder. Finally, it details how to develop an action plan by prioritising operations according to objectives (Le Jallé *et al.*, 2012).

Community Led Urban Environmental Sanitation (CLUES) includes water, solid waste management and storm drainage in addition to sanitation. The fact that rainwater and solid waste is evaluated with sanitation during the planning phase is important (KI2). The 7-step approach is a consultation process designed to be adapted to the context (WaterAid, 2016c). In Tansen, Nepal it was used as a baseline assessment to raise and discuss issues with the community for planning (Bright-Davis, 2013). In Nala, Nepal the CLUES planning approach led to successful implementation of the community's preferred sanitation system (Sherpa A, Sherpa C, Lüthi, 2013). The approach is detailed in Box 12.

Box 12: The purpose of CLUES planning in Nala, Nepal

The main aim of the CLUES planning approach is to ensure long-term sustainability of the sanitation system. In Nala, Nepal it was used to identify local challenges and improve environmental sanitation of the most underserved part of the population. Community mapping, surveys, users' needs identification and prioritisation enabled the community to make an informed choice leading to strong community participation and ownership. Therefore, this approach allowed the users' community in Nala to choose their preferred sanitation system: a simplified sewerage system with a decentralised wastewater treatment system.

(Sherpa A, Sherpa C, Lüthi, 2013).

City Sanitation Planning, including citywide sanitation services planning, are used to address both technical (e.g. services) and non-technical (e.g. institutional capacity) aspects of urban sanitation resulting in guidelines and strategies (WaterAid, 2016c). Its implementation in Tikapur, Nepal revealed that mass awareness was needed to diffuse the concept. A toolbox was implemented and validated by Eawag in Tikapur, containing; GIS tools, SFDs, Household survey, City Sanitation Planning Format and Workshops (Lüthi *et al.*, 2017b).

Most of the current planning tools and toolboxes have been developed and implemented by NGOs. However, they can sometimes be too keen on planning, which is not necessarily what makes a project successful (KI5) as illustrated by the case of San Fernando, Philippines, shown in Box 13.

Box 13: Sanitation planning, not the driver of success in San Fernando, Philippines

In San Fernando, Philippines, planning was not the primary driver for a clean town. Even though a Sanitation Strategic Plan was developed for nine years, it had low influence on the success of the project, which was mainly due to the institutional enabling environment and the development agenda. The Sanitation Strategic Plan rapidly became irrelevant as San Fernando was shifting from decentralised to centralised faecal sludge management.
(WaterAid, 2016b).

Tools for planning should always have realistic aims with incremental steps (KI2, KI3, KI5, and KI6) not to discourage stakeholders in the process towards full sanitation chain and universal coverage. It was sensibly thought through in Rosso - aims were set at 60% coverage in 2015 and 100% in 2020 (Gabert *et al.,* 2018) (see Appendix 6, Fact Sheet 3).

5.4.2. Advocacy and awareness tools

Public advocacy on the sanitation challenge needs to be made in STLV (KI4), particularly towards deciders as their involvement is crucial for a project to work (Gabert *et al.*, 2018; KI1 and KI6).

Shit Flow Diagrams (SFD) can be used to demonstrate the need for improved sanitation service delivery. SFD shows for every part of the sanitation chain if excreta are safely managed or not and in which proportion. Although a complex tool to implement in a big city, it is relatively quick and straightforward to implement in STLV (KI5). WaterAid used it in STLV in Ethiopia, and it was helpful to identify the critical points to address first, the points of blockages and to mobilise decision makers (KI5). It was also successfully used in Tikapur, Nepal (Lüthi *et al.*, 2017a). The visual nature of the SFD makes it appropriate for advocacy and decision making.

Raising public awareness is key in STLV due to their transitional nature from rural to urban settlements. It is illustrated by the case of Rapale and Ribaué in Box 14. As mentioned in two interviews (KI1 and KI4), behavioural change is critical, the migrating rural population is used to basic living conditions where open defecation or non-emptied pit latrines is less of an issue than in densely populated urban areas. Many tools can be used such as drama, project visits, radio, and newspapers. The selection must be made according to the cultural practices and characteristics of the public.

Box 14: Awareness creation in Rapale and Ribaué, Mozambique

UNICEF sensibly chose to use two different approaches for the two faces of the cities. They used PHAST (Participatory Hygiene and Sanitation Transformation) in the areas with more urban characteristics and CLTS (Community Led Total Sanitation) in rural areas. Sanitation competitions were also organised, the winning neighbourhoods being the one with the more improved latrines, this way public awareness and local leaders' approval was achieved through a single action. Furthermore, one person was elected within the municipal sanitation group to be the supervisor of the Sanitation Master Plan and advocate for funding.

(Thomas and Alvestegui, 2015).

5.4.3. Financing and managing

There are many different types of financial models for faecal sludge management, and no one type has been shown to be universally applicable to all situations. Bassan *et al.*, (2014) summarise the pros and cons of five different financial models which are commonly found. For this report, selected models have been used as a template and tool to analyse the financial viability of the full sanitation chain case studies. The first step is to identify each part of the sanitation chain, in a STLV, along with the responsible actors for each one and what financial transactions are in place if any at all. Findings are then matched against existing models allowing identification of missing financial components or where improvements are required.

- Model 1 - Discrete collection & transport and treatment

This model has previously been identified and is known as the '*Discrete Collection & Transport and Treatment Model*' (Bassan *et al*., 2014).Three towns from the full sanitation chain case studies fall under this model. All have the upstream section of the chain function similarly but differ slightly from the start of the treatment step. Filingué and Tikapur are lacking an actual treatment system or a tool to manage treated sewage and the relevant fees incurred (see Appendix 6, Fact Sheet 1 and 4). Rosso does have a basic facility (drying beds) but the discharge fee has proved to be a barrier to appropriate treatment, and private enterprises (de-sludgers) prefer to dump outside of town (see Appendix 6, Fact Sheet 3).

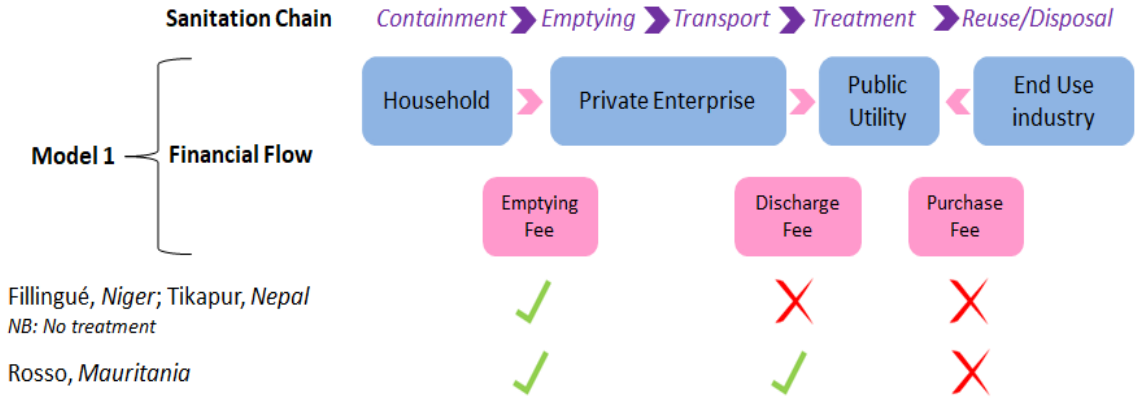

Figure 12: *Model 1 - Discrete Collection & Transport and Treatment Model*

Pros: This is a 'disconnected' financial model where every part of sanitation value chain is managed by different stakeholders (emptying and transport are grouped together). Here the public utility operates independently from the government authority who in turn can use this model as a way to secure budgetary support. For the system to be sustainable, it is essential that there is good communication between all stakeholders. This is case in Filingué where affordable and financially viable emptying tariffs were agreed through a general assembly (see Box 7).

Cons: The high discharge fees which are either passed on to customers by private enterprises which the poorest can't afford, or the private enterprise simply doesn't pay the discharge fee and instead illegally dumps the collected waste. Treatment quality will also most likely be affected due to the fact the utility gets no financial support from the government authority to support supervision and monitoring.

- Model 2 - Integrated collection & transport and treatment

As can be seen in Figure 13, half of the full sanitation chain case studies fall within this model, albeit none of them were entirely functioning as none possess any reuse/disposal tool/facilities.

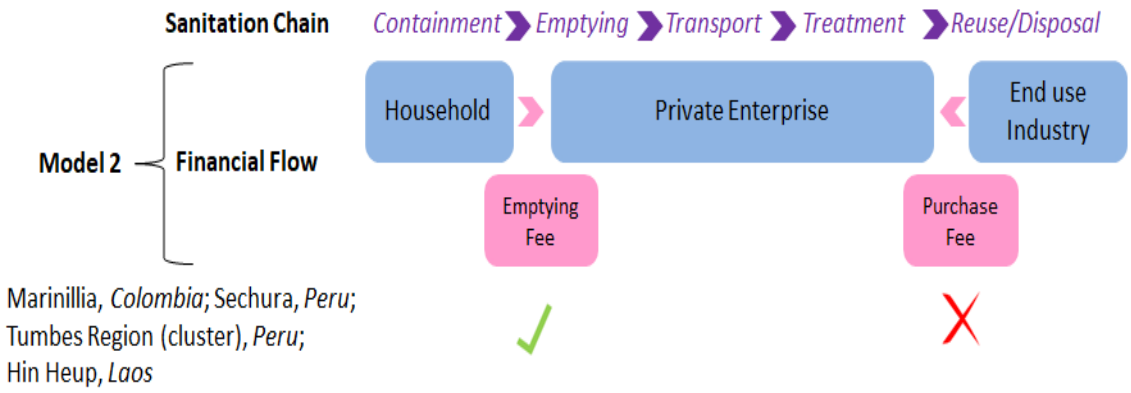

Figure 13: *Model 2 - Integrated Collection & Transport and Treatment Model*

Pros: Here emptying, transport and treatment are all the responsibility of private enterprises which means there is no need for a discharge fee, and the emptying fee will be significantly cheaper than in model 1.

Cons: This model relies heavily on fees from households, which can be high and unaffordable for some. In the case of Marinilla, the fees were too low which meant that investment capacity was limited and relied on external funders (see Appendix 6, Fact Sheet 7). This model might encourage private operators entering the market which results in choice and better price for each household, but this could lead to treatment or disposal being neglected.

➢ Model 3a - Municipality owned and run

This model (see Figure 14) is not based on any of those described by Strande *et al.*, 2017. Instead, this presents a unique case of the Philippines' first government-financed septage management system in Dumaguete that became a model for other cities and towns who were motivated to initiate their own systems (see Appendix 6, Fact Sheet 5).

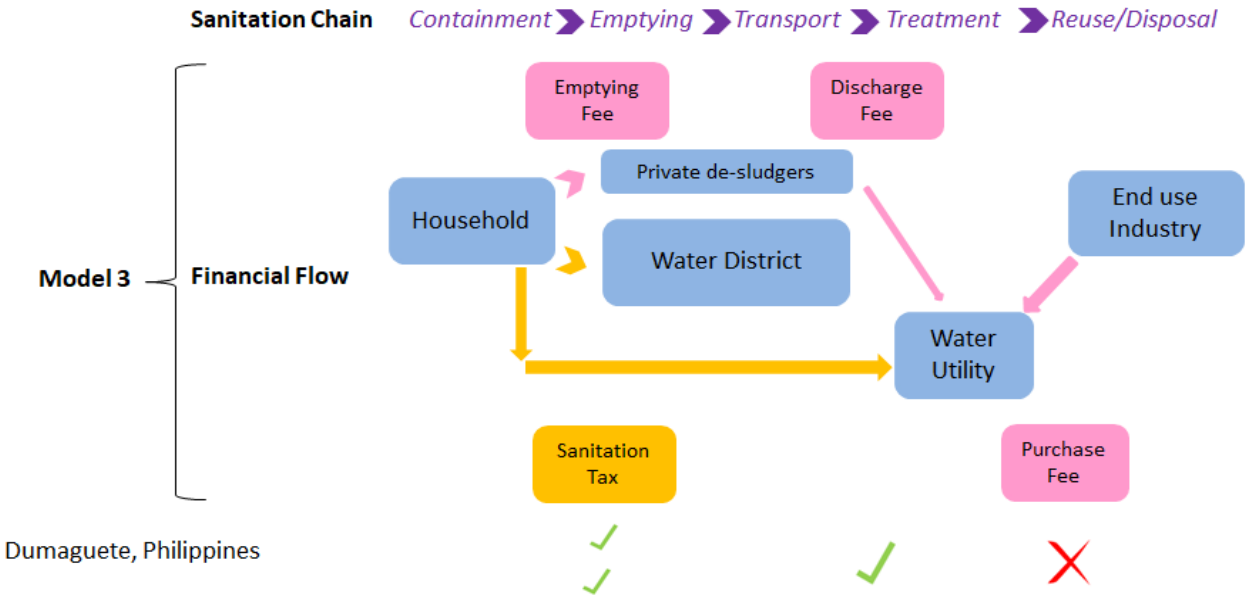

Figure 14: *Model 3a - Municipality owned and run*

Pros: Sanitation tax covers plant and truck costs and enables septic tank desludging on a rotating 5-year plan. In this case, the sanitation tax was set at $0.05 per cubic meter of water consumed with the average monthly septage bill was $1.00. Private de-sludgers, which previously indiscriminately disposed of septage, now dispose of collected sludge into the city's treatment plant for a nominal fee.

Cons: Promotional initiatives provide an important reminder of the benefits of continuing the service. When the promotion campaigns tapered off, so did the participation rate, which resulted in the programme going from a 'door to door' model to a 'call for service' model. This current program is working, but not everyone calls even though they are paying for the service. The net result is less septage being collected and treated than anticipated, resulting in lower operating expenses.

➢ Model 3b - Demand-led municipality owned and run (open market)

This model, as seen in Lakshmipur, Bangladesh (see Figure 15), is a variation of Model 3a but crucially with no sanitation tax and where private de-sludgers have no formal place to dispose of their waste (see Appendix 6, Fact Sheet 10).

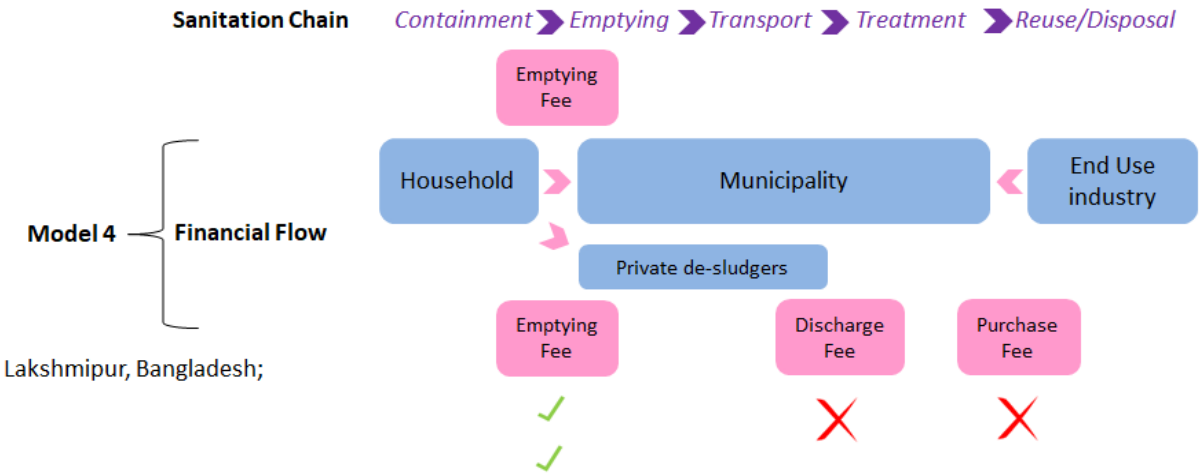

Figure 15: *Model 3b - Demand-led municipality owned and run (open market)*

Pros: Money is generated through emptying fees. There is more choice for users, as anyone can enter the market resulting in better coverage for emptying.

Cons: With no sanitation tax, it is harder to recoup costs for emptying, transport and treatment. Emptying fee process needs to be simple and timely for the households as otherwise it might not be taken up. This is not the case in Lakshmipur where the local authority requires an application to be filled out alongside the fee payment with the services available within the following three days. There is also no financial incentive for private de-sludgers to empty waste in controlled and safe manner.

- Model 3c - Demand-led municipality owned and run (closed market)

This model (see Figure 16) is again a variation of Model 3a but crucially with no sanitation tax, and where private de-sludgers have no formal place to get rid of their waste. It was used in Chilaw, Sri Lanka (see Appendix 6, Fact Sheet 11).

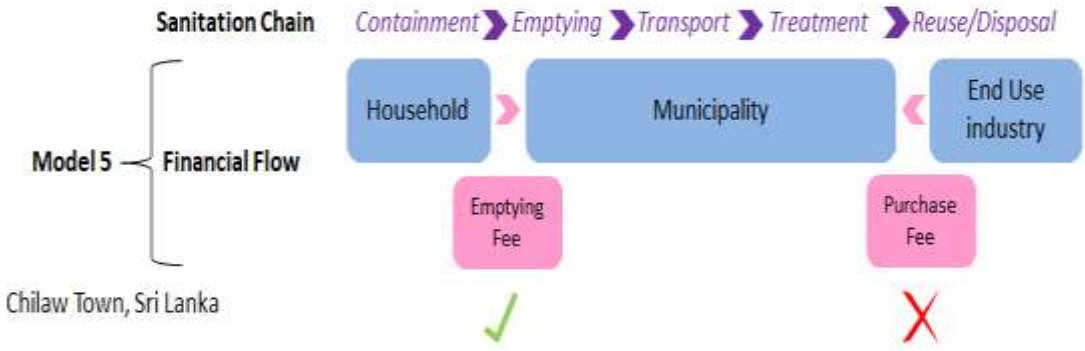

Figure 16: *Model 3c - Demand-led municipality owned and run (closed market)*

Pros: The municipality can dictate tariffs and thus its income and is in total control the sanitation chain, with no reliance on the private sector. There is no sanitation tax but this is compensated by the high emptying fees which are essential in recouping the cost for emptying, transport and treatment especially considering the infrastructure cost of $1,300,000.

Cons: No choice for users regarding emptying services which may affect coverage. Most revenue is reliant on emptying fees. Hence the cost of desludging is high. In this specific case, the service is only provided upon request, and tariff varies from $18 to $43 depending on if the household is within the Urban Council limits or not.

The above financial models confirm that each STLV has their own unique characteristics and that it is difficult to create broad templates which can be easily be applied. However, once an appropriate model is found then barriers and areas for improvement are easily identified. Therefore the critical element in using such a tool is having the access to all information related to the sanitation chain (actors involved, financial transactions and contracts).

5.4.4. Monitoring and evaluation

Monitoring and Evaluation (M&E) are essential to maintaining the system and program improvements. Effective monitoring can identify strengths, weaknesses and links throughout a program. The responsibility for the monitoring should be at a high management level to ensure it happens and should use data collected at the community level (KI3). Once the M&E has occurred, the local government must accept it and use it to make the necessary changes.

The SDG target 6.2 states that every country should aim *'by 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation'* (UN, 2017). The indicators used to measure progress is the percentage of the population using 'safely managed sanitation services'. Monitoring for the SDG can be done through household surveys to determine access and methods of sanitation used. Treatment of the faecal sludge must also be monitored as well as the methods of emptying and transport as if any step of the sanitation chain is not safely managed then people using those facilities will be classed as having a basic sanitation service (SDG 1.4) (WHO, 2018).

There are some examples of M&E in the case study overviews. Several have a baseline and post-project surveys of access to sanitation at a household level. In Samaha, Egypt, the treatment plant was subject to monthly effluent quality monitoring, from independent companies, to confirm they met national standards (Reymond, 2013). Every country will also have different regulations for effluent quality, and the disposal of sludge, which should be followed by quality tests at the treatment plant and monitoring of dumping practices can measure compliance.

There are currently no toolkits that have been found specifically for M&E sanitation at STLV level. There are however toolkits designed for rural areas and standardised testing for urban and utility treatment facilities. These can be adapted to be specific to STLV. There is a big difference in monitoring under 10,000 and monitoring 100,000+ populations. UNICEF has a toolkit for monitoring rural areas sanitation, and WSP has launched benchmarking programs in several countries including India. In an urban scenario, this should lead to more accountability for service providers (Kumar and Singh, 2010).

5.4.5. Recommendations for developing tools to manage sanitation in STLV

Based on the analysis of the existing sanitation management tools available to STLV, gaps have been identified along with recommendations on new ones which could be developed. The aim of this section is to feed Objective 5.

- Sanitation planning tool

There are existing tools adapted to STLV. However, whatever tool is used, it is essential to pay attention to several elements such as having a long-term view on the sanitation system planning - advised a minimum of five years (KI4). Also, planning should be pragmatic, especially at the beginning and it can be completed with more thorough planning exercises over the expansion phase of the town. WaterAid (2016a) describes sanitation planning as an iterative process: lessons learnt throughout the execution of the plan and during the M&E should be captured in manageable knowledge and then used in further iterations. (WaterAid, 2016a).

- Adapted financial model tool

Financial models can be found in the literature. However, there is a lack of tools for deciding which financial model should be used according to the context. The potential tool described in '5.4.3. Financing and managing' would aim to ensure that the chosen financial model will support the STLV in budgeting, ensure accountability, and be financially sustainable. For this tool to work, a workshop including all actors involved within the sanitation chain would have to be set up to identify the existing services in place along with any related financial transactions as well as technologies in place. From there, an action plan for developing a sustainable sanitation chain would be put together, based on the most suited financial model for the town.

- Context based appropriate technology selection tool

The existing technologies used in STLV sanitation are already well understood. However, to ensure the most appropriate choice of technology, a simple tool that takes account of the characteristics of the town (density, water supply, capacity for CapEx and OpEx, water table) could be developed. There are existing tools such as from Monvois *et al*. (2010) (see Appendix 8) but STLV are more dependent on on-site sanitation, and these output options could be expanded.

- Monitoring and evaluation tool

There is no proper existing tool for M&E for sanitation in STLV. To set up a M&E program, indicators must be selected to act as a proxy. These indicators can be adapted from local or national standards and guidelines. These must be measurable, reliable with available data, sensitive to changes and with a direct correlation to the issue. Finally, these indicators can differ between towns as long as they fit the criteria above (Schwemlein, Cronk and Bartram, 2016).

- Sanitation chain system failure mapping tool

Various models of viable sanitation chain systems have been described by Tilley *et al.* (2014), and those relevant to this study are used in '5.3. Sanitation chain systems' as tools to understand the common failures in a systematic way. It is a visual tool which enables the identification of the weakest links in the sanitation chain. These could be used by STLV to choose a sanitation system according to the barriers they feel capable of overcoming. It could also help in anticipating problems in newly implemented sanitation chains. And ultimately, improve existing systems according to dependencies in functional sanitation chains. To a certain extent, it could be used as an advocacy tool along with, or instead of, SFD as it goes further into the identification of causes and consequences of poor management of the sanitation chain system.

5.5. Recommendations on further research questions

Based on the lessons learnt and on the discussion section of the study, recommendations for further research work related to the topic of sanitation in STLV can be stated:

- Management of the sanitation chain: tools for choosing the appropriate technology, the appropriate financial model, assisting system-level thinking, and ensure proper M&E could and should be developed.
- Governance: regional governance of sanitation can be considered as a potential new level of management or an alternative to all the existing models.
- Partnership: standard contracting processes, supported by regulations and clearly defined criteria to operate in the market can be a way to address issues of contracting external operators (KI1).
- Technology: upgradable technologies for STLV already exist, but should be more developed (KI9) in an institutional environment that enables the implementation of new technologies. Alternatively, standardised technologies adapted to STLV should be investigated (KI5).
- Finance: looking at potentially adapting the Technology Applicability Framework (TAF) tool and specifically its methodology of the group between different stakeholders in determining what financial models are appropriate (RWSN, 2018).
- As a final recommendation, more efforts should be put in the level of detail and the quantity of information when putting together documents related to sanitation projects in STLV. A way to overcome this is for organisations to agree on standard templates for reporting sanitation experiences in STLV.

6. CONCLUSION

This study allowed to draw the following conclusions regarding the set objectives:

1. **Compile a broad and diverse database of sanitation experiences focusing on improving the full sanitation chain in STLV in developing countries, to inform and make it available for further external research.**

46 experiences of sanitation in STLV were identified and compiled into a database (see Appendix 5). However, all the examples are not relevant in the context of the analysis of the full sanitation chain. Some experiences are under documented with a lack of details on the current and/or post-project situations. The fact that many of the studies were 'pilot projects' shows that STLV sanitation is an area still being developed and investigated by experts.

2. **Analyse the database and use selection criteria to identify specific and relevant experiences of the full sanitation chain in STLV.**

The compiled database only contains a small number of experiences dealing with the full sanitation chain. Out of the 46 identified experiences, 11 were selected as they each presented a full or nearly completed sanitation chain and were well documented. However, not all those experiences were successful. Also, the downstream steps of the chain were where technological, financial and management issues often exist.

3. **Identify and synthesise challenges and lessons learnt from experiences in STLV.**

STLV are facing a range of challenges. First of all, their size makes them unattractive to utility providers which, when they are present, are lacking knowledge, skilled staff and strategic planning. The local government, is missing these same characteristics. Moreover, the transitional nature of STLV between rural and urban makes it difficult to find appropriate technologies for changing communities.

The lessons that can be drawn from this study are the following.

- **Partnership:** it is supported that all the stakeholders involved in the sanitation chain should know and assume their roles and responsibilities - especially in the context of STLV where the scale of projects allow balance in the involvement of them all.
- **Institutional:** although local and national institutions have weak capacities and low involvement in the sanitation chain, the institutional framework is considered as more important than the infrastructure, especially considering the lack of resources available in STLV.
- **Capacity building:** authorities and utilities lack capacities in technological, planning, management and administrative skills. Based on what the population needs and what is already known, capacity building is required to empower local stakeholders and allow them to manage their sanitation chain.
- **Financial:** there is a need for defining tariffs and collection systems, as well as identifying sources such as collection from emptying, dumping or treatment service fees. Also, the fees must cover maintenance and services, as the most of the identified models are not financially sustainable. Upfront money (CapEx) is required, which is unlikely to be provided by the private sector. Finally, it has been shown that access to funding is limited because STLV are out of sight and that there are higher investment risks.

- **Technological:** the technology needs to be appropriate to the context and build upon what already exists. Also, when a new technology is introduced, it has to be implemented step by step and be scalable according to the growth of the town. The level of technology must match the ability of the institutions and the population to pay, the needs of the population, and the capacities of the operator (either public or private). Also, considering the technological, financial or management aspects, the focus needs to be done on the downstream parts of the chain.
- **Decentralisation:** according to experiences, decentralisation triggers positive results regarding technology although this is not true from an institutional and management perspective where it can cause ambiguity over roles and responsibilities.
- **Clustering:** in theory, clustering is a good idea but in practice it is much harder to achieve. It is seen as a solution for technological, financial and capacity building aspects but it is challenging when looking at the management of the system (organisation of institutions and stakeholders involved).

Overall, the lessons learnt from KI interviews and the in-depth analysis of case studies reaffirmed the STLV challenges found in the preliminary data collection. These challenges have been shown to be common across the Global South. However, the ways to overcome them are multiple and context specific.

4. **Identify and critically assess the sanitation chain systems that apply to STLV and the systemic barriers that prevent its functioning.**

Particularly, but not exclusively, in STLV, the challenge is to manage the whole sanitation chain and guarantee solid linkages between all the steps. The reliance on emptying and transport of sludge is particularly an issue for STLV, impacting those systems that rely on it. Sanitation interventions should look beyond containment and/or support systems that do not depend on transport.

5. **Identify existing tools and gaps in tool availability for managing sanitation in STLV.**

Existing tools for planning, advocacy and awareness are easily adapted and widely used in STLV. To see more successful experiences of full sanitation chain in STLV, tools for choosing the adequate financial model, the appropriate technology and for monitoring sanitation chain need to be developed.

All experiences prove that linkages are essential: all components must be fully functioning and linked together to get a successful sanitation chain. This starts with strong institutional leadership along with sound financial management and stakeholders involvements. Together, they will agree on what technology should be used or implemented and on what are the gaps that need to be fulfilled to make the system work.

The overarching finding of this study is that sanitation in STLV is a relatively well-documented topic but where the quality and detail of information is often lacking. From this, it would seem that few examples of a well managed and functioning full sanitation chain exist - or they have not been documented. Moving forward and to enable future learning, any research on STLV sanitation should put more effort into the collection of quality, detailed data, and conducting follow-up studies to ensure the sustainability of implemented programmes.

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APPENDICES

Appendix 1: Income level and National definition of towns for all case studies

(N/A: Individually determined by central government)

	Country	Income Level*	Town definition**
ASIA	Bangladesh	Lower-middle	N/A
	India	Lower-middle	All places having 5 000 or more inhabitants, a density of not less than 1 000 persons per square mile or 400 per square kilometre, pronounced urban characteristics and at least three-fourths of the adult male population employed in pursuits other than agriculture.
	Lao PDR	Lower-middle	Areas or villages that satisfy at least three of the following five conditions: located in metropolitan areas of district or province, there is access to road in dry and rainy seasons, about 70 percent or 2/3 of the population has access to piped water, about 70 percent or 2/3 of the population has access to public electricity, there is a market operating every day.
	Nepal	Low-income	As declared by the government municipalities.
	Philippines	Lower-middle	Population density of at least 500 persons per square km. Urban areas are considered other districts regardless of population size that have streets, at least six establishments (commercial, manufacturing, recreational and/or personal services), and at least three public structures such as town hall, church, public park, school, hospital, library, etc.
	Thailand	Upper-middle	Municipal areas
	Viet Nam	Lower-middle	N/A
AFRICA	Burkina Faso	Low-income	N/A
	Ethiopia	Low-income	Localities of 2 000 or more inhabitants.
	Egypt	Lower-middle	N/A
	Madagascar	Low-income	N/A
	Malawi	Low-income	N/A
	Mozambique	Low-income	N/A
	Namibia	Upper-middle	N/A
	Niger	Low-income	N/A
	Senegal	Low-income	Agglomerations of 10 000 or more inhabitants.
	Uganda	Low-income	N/A
LATIN AMERICA	Columbia	Upper-middle	N/A
	Ecuador	Upper-middle	N/A
	Jamaica	Upper-middle	N/A
	Peru	Upper-middle	Populated centres with 100 or more dwellings.

**World Bank data*
https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups
***Demographic Yearbook 2016*
https://unstats.un.org/unsd/demographic-social/products/dyb/dybsets/2016.pdf

Appendix 2: One-page summary sent to contacts

SAFELY MANAGED SANITATION SERVICES IN SMALL TOWNS: AN ANALYSIS OF KNOWLEDGE AND EXPERIENCES FROM DEVELOPING COUNTRIES

As part of our MSc at Cranfield University, we are conducting a group project in partnership with pS-Eau on **small towns** in developing countries and the **challenges** they face throughout the whole **sanitation service chain**. We are looking for **case studies** of current examples of both **successful** and **unsuccessful** projects.

The major questions we aim to answer are:

- What **experiences** of full **sanitation chain** in small towns do we know?
- What are the **specificities** and the **constraints** do small towns face regarding their sanitation services?
- Which **lessons** can we learn from the identified experiences?

SMALL TOWN DEFINITION (work in progress):
"*An area that is sufficiently large and dense in concentration of both people and enterprises with water and sanitation needs that may be served and benefit from the economies of scale offered through some kind of centrally managed water supply and wastewater management system*."

Exclusions:

- A capital city
- Peri-urban areas - benefits from services or infrastructures of nearby city
- Population range outside of **2,000** and **100,000**

HOW YOU CAN HELP?

We are looking for additional case studies as well as interviewees who are sanitation specialists or experiences working with sanitation in small towns. Ideally, we are after case studies which contain the following criteria:

- Population size (see definition)
- Type of sanitation services implemented
- Funding information (who, how much? Etc.)
- Management of sanitation services (who and how)
- Success rate of sanitation programme implemented
- Lessons learnt

If you have relevant case studies or willing to be interviewed please either contact pS-Eau (Colette Génevaux at genevaux@pseau.org, Christophe Le Jallé at le-jalle@pseau.org) or us directly via email at s.neumand@cranfield.ac.uk **no later than 27th March 2018**. We look forward in discussing this topic with you.

Team Group Members
Laura Bachelier; Annette Butty; Dave Haddock; James Dornan; Serge Neumand; Lise Nousse

Appendix 3: Interviews' questions

- What is your experience of sanitation management in small towns?
- Did you have any specific role in this project?
- Which small town?
- Who were the actors involved and what kind of management was it?
    - Was the community involved and to which extent?
    - What type of contract (if PPP)?
- What part of the sanitation chain is concerned?
- When was this project implemented? Is it still on-going?
- How was it funded?
- Was it successful?
    - If yes, what were the factors of success? If no, what failed?
    - If yes: in your opinion, would it be replicable in a different context / a sub-Saharan country?
    - What could have been done better?
- What are the main challenges in managing the sanitation chain in small towns?
- How can some of them be overcome?
- What are the lessons learnt from this (or these) experience(s)?
- In your opinion, what are the key/critical elements to implement a sustainable sanitation chain in a small town?

[For researchers only] What is your opinion on this definition: "*a small town is an area that is sufficiently large and dense in concentration of both people and enterprises with water and sanitation needs that may be served and benefit from the economies of scale offered through some kind of centrally managed water supply and wastewater management system*"?

Do you have any additional question about the project?

Optional questions:

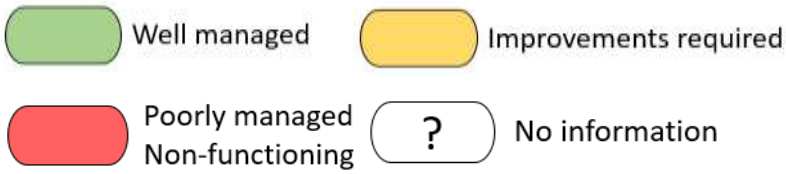
Are you aware of any cluster of small towns to manage sanitation?
What is the ideal population size for the sanitation chain to work? Economy of scale?

Appendix 4: World map showing case studies location

Appendix 5: Case study overview

Some case studies did not directly cover any technological step of the sanitation chain. Instead, the projects were aiming to cover the governance and the management aspect of the service, which is indicated throughout the 'G*overnance'* row.

Colour coding legend:



Legend for referencing:
A list of references can be find at the end of this Appendix. Referencing for the full sanitation case studies is included in the Fact Sheets (Appendix 6) with the remaining documents as detailed below.
'Name of STLV'*: References detailed in Appendix 6: Full sanitation chain case studies
'Name of STLV'[1]: Additional references

➢ ***Public sector***

Continent	Country	STLV Name	Population	Step of the chain covered	Technology	Governance	Lessons Learnt	Manage-ment
Latin America	Colombia	San Vicente[1]	4359	Emptying Transport Treatment	Sewerage, Waste Water Treatment Plant (WWTP)	Yes	N/A	
	Colombia	Hispania[1]	2511	Emptying Transport	Sewerage	Yes	N/A	
	Ecuador	Cayambe[2]	34000	N/A	N/A	Yes (environmental sanitation program)	**Institutional:** Creation of municipal utility is successful with technical and financial assistance from an institution.	
	Colombia	Amaga[1]	11324	Emptying Transport	Sewerage	Yes		
Africa	Ethiopia	Adishihu[3]	10771	Containment	Latrines	No	**Partnerships and Stakeholders:** Only the first part of the sanitation chain is complete due to a lack of involvement and interest in sanitation from the municipality.	
	Egypt	Mashal/Kom el Naggar[4]	6000	Treatment	WWTP	No	**Technology**: Treatment system (activated sludge) is not suitable as it is too expensive and complex for STLV.	
	Ethiopia	Maksegnit[5]	14240	Emptying Transport	Vacuum trucks	No	**Transport:** Towns cannot rely only on vacuum trucks coming from the biggest town/capital nearby for emptying household latrines.	

Continent	Country	STLV Name	Population	Step of the chain covered	Technology	Gover-nance	Lessons Learnt	Manage-ment
Asia	Thailand	Uttaradit[6]	58313	N/A	N/A	Yes	**Beyond Sanitation Sector:** Sanitation benefits can come from outside the WASH sector. Often lack of tenure is a critical blockage to any sanitation investment.	
	India	Kolachel (Colachel)[7]	23227	Emptying Transport Treatment	Sewerage and Decentralized system (include septic tank, waste stabilisation ponds and maturation ponds)	No	**Technology:** If space allows, decentralised treatment can reduce cost and maintenance burden.	
	Bangladesh	Lakshmipur *	83112	Containment Emptying Transport Treatment Disposal	Latrines connected to septic tanks and pour flush toilets. Transportation to Faecal sludge treatment system using Vacutug. Manual collection	No	**Institutional:** The interest and capacity of Municipality are important factors for the success of FSM services, including treatment. An absence of specific FSM regulatory framework is a major impediment to planning and implementation of successful FSM initiatives in the urban areas of Bangladesh. Information campaign required to get the population to understand the benefits and get buy-in. **Financial:** It is essential that the programmes and initiatives to improve sanitation in Bangladesh realise the importance of the successful operation of the facility at Lakshmipur and make available adequate support to the city in this initiative.	
	Sri Lanka	Chilaw*	25000	Containment Emptying Transport Treatment Reuse/Disposal	Latrines connected to septic tanks. Vacuum Trucks. The treatment system consists of a flow-through pond system with an anaerobic, facultative and maturation ponds.	No	**Technology:** Utilise existing technology (septic tanks, vacuum trucks) and framework (Town council) to complete the sanitation chain. **Institutional:** Well thought plan & proposal (including perceived potential impacts on physical, environmental, economic, social/cultural resources).	
	Philippines	San Fernando[8,9]	115000	Containment Transport Treatment	Flush toilets connected to a tank + WWTP	No	**Institutional:** Strong political champion, which can enlist help from development agencies, can overcome lack of enabling environment from central government.	

➢ ***Private sector***

Continent	Country	Town Name	Population	Step of the chain covered	Technology	Gover-nance	Lessons Learnt	Manage-ment
Asia	Nepal	Tikapur*	56136	Containment Emptying Transport Treatment Disposal	Pit latrine. Flush toilet connected to a septic tank Biogas digester Manual emptying	No	**Institutional:** Mass awareness needed to disseminate the concept of citywide sanitation planning. A need for more hands-on guidance material, lack of know-how in FSM at all level (national, district, municipal, private sector).	
Latin America	Colombia	San Jeronimo[1]	3094	Emptying Transport	Sewerage network	Yes	N/A	
	Colombia	La Ceja[1]	32097	Emptying Transport	Sewerage network	Yes	N/A	
	Colombia	Apartado[1]	75522	Emptying Transport	Sewerage network	Yes	**Partnerships and Stakeholders:** external private operator is contracted when there is low coverage.	
Africa	Egypt	Kafr El Hammam[4]	2000	Emptying Transport Treatment	Shallow sewer, settling and oxidation tanks	No	**Technology:** Technology suitable for Egypt, making this successful so far, however, in the long run, toxic sludge could be a big issue and could face challenges when they start trying to collect fees.	
	Egypt	Samaha, Dakahlia[4]	6500	Treatment	Constructed wetlands	No	**Technology:** A suitable technology was chosen for this town, which is why it is successful.	
	Egypt	Maimun, Beni Suef[4]	7000	Emptying Transport Treatment	Conventional sewer system, aerated bio-filter	No	**Technology:** The technology used must be appropriate, and the staff must be given sufficient training to run the system otherwise it will fail.	
	Ethiopia	Sheno, Oromia Region[10]	16534	Containment Emptying Transport	Latrines Vacuum trucks	No	**Transport:** Towns cannot rely only on vacuum trucks coming from the biggest town/capital nearby for emptying household latrines.	
	Ethiopia	Abomsa, [11,12,13]	20517	Emptying Transport	Pit Latrines, manual and vacuum truck emptying	No	**Institutional:** If the municipality is in charge of the solid waste collection, then there needs to be proper management, appropriate waste extraction technologies and to adequate budget and logistics allocated. Public latrines management requires performance agreements with operators and improved monitoring to be well managed. **Financial:** There can be a functioning liquid waste collection thanks to subsidies but no sustainable solid waste collection.	
	Egypt	El Moufty[4]	2750	Emptying Transport Treatment	Small-bore sewer system and anaerobic ponds with drying beds	No	**Technology:** No longer complies with Egyptian standards. However, this shows with the right management sanitation in STLV can have full cost recovery.	

- ***Public-Private Partnership***

Continent	Country	Town Name	Population	Step of the chain covered	Technology	Gover-nance	Type of contract	Lessons Learnt	Manage-ment
Asia	Philippin-es	Duma-guete*	100000	Containment Emptying Transport Treatment Disposal	On-site Sanitation Desludging trucks + manual emptying, partial Septage Treatment Plant	No	N/A	**Institutional:** Home to the Philippines' first government-financed septage management system that became a model for other cities and towns who were motivated to initiate their own systems in their respective communities. Strong local leader was instrumental here.	
	Laos PDR	Hin Heup*	63091	Containment Emptying Transport Treatment	Pour flush toilets Sewerage Anaerobic Baffled Reactor+ sludge drying beds	No	N/A	**Financial:** Where there is a willingness to pay for a service, but no ability to provide CapEx, foreign investment and technical advice can kick-start sustainable solutions.	
Africa	Burkina Faso	Ouahi-gouya [14]	66700	Containment Emptying Disposal	Autonomous toilets Trucks	No	Lack of clear contracts	**Partnerships and stakeholders:** A clear renting contract should be defined between the municipality and the operator to clarify responsibilities and enable better maintenance. Optimisation of the truck emptying is possible through better organisation and planning. **Financial:** The treatment of the excreta cannot be financed by the emptying fees (low willingness to pay versus depreciation of the truck), different investment strategies are possible to enable a fully managed sanitation chain.	
	Madaga-scar	Foulpo-inte[15]	5000	Containment Emptying Treatment Disposal		No	Delegation agreement	**Institutional:** Political willingness is critical and participatory planning takes a trained local authority who is willing to assume its role of leader. Once running the authority must then act as a monitoring body. Compromises between actors is required. **Financial & Technology:** Low-cost technology can provide a sustainable and hygienic sanitation service in small cities.	

Contin-ent	Country	Town Name	Popul-ation	Step of the chain covered	Technolo-gy	Gover-nance	Type of contract	Lessons Learnt	Manage-ment
Latin America	Peru	San Lorenzo [16,17]	2400	Emptying Transport	Sewerage	Yes	Management contract. (delegation of duties contract, two years renewable)	**Financial:** The sustainability of the model is compromised by the low fares which cannot cover the costs of administration, operation and maintenance.	
		Vice[16,17]	15000	Emptying Transport Treatment	Sewerage & WWTP	Yes	Agreement to cede use (8 years renewable)	**Financial:** Household metering helped to reduce the non-revenue water and to cover the service costs. It also enabled the population to see the difference with the old management model. "When the market does not respond, the organised population can manage the services, by creating a legal corporate entity independent from the municipality, such as a Board of Users."	
		Sechura *	32000	Containment Emptying Transport Treatment	Flush toilets Sewerage & WWTP (lagoons)	Yes	Management contract (10 years renewable)	**Partnerships and Stakeholders:** The municipality, government and population engagement were determining factors for this type of contract to be put in place. The lack of coordination between the operator, the municipality and the Community might have been the main reason for failure. **Financial:** The better billing enabled by the new management model allowed more investment and better service coverage.	
		Cluster of 13 towns in Tumbes *	225000	Containment Emptying Transport Treatment	Sewerage & some treatment	Yes	Co-financed concession contract (30 years renewable).	**Partnerships and Stakeholders:** An agreement between local political and social forces ensure continuity in policies necessary to the sustainability of the utility. "The specialised operator must take over the administration of the services after having verified that billing revenues and an improved level of collections can feasibly enable it to fully cover operation and maintenance costs". A continuous information flow (communication strategy towards the public) is required to introduce a new sanitation operator or model (smooth transition and empowerment) Participation of the population should be encouraged, the process of selection of the utility should be didactic and transparent. "Technical Unit in the municipality should be created" in charge of the supervision and follow-up of the specialised operator's contract.	

Continent	Country	Town Name	Population	Step of the chain covered	Technology	Gover-nance	Type of contract	Lessons Learnt	Manage-ment
Latin America	Ecuador	Pedro Moncayo[2]	12000	Emptying Transport	Sewerage	Yes (Participatory development plan)	Municipal company with a community majority on its board of directors. Private operator hired to carry out systems improvement, operation and maintenance.	**Technology:** "Actions to augment sewer system coverage and wastewater treatment coverage must not be left aside for a later date as that creates the risk of them not being given the necessary priority to be addressed" **Institutional:** The role of the municipality is fundamental in obtaining resources for executing the investment projects and broadening the services."	
	Colombia	Marinilla*	26000	Containment Emptying Transport Treatment	Flush toilets Sewage network WWTP	Yes	Private operator: operates and provides technical assistance to the municipality to plan, finance and execute a master plan. 15 years contract	**Partnerships and Stakeholders:** Discussion between all the members of the actors involved can lead to agreements and then management of the service. Also, maintaining good relations between the private operator and the municipality allows improving contracts (ex: offering technical advice)- If a private operator serves several STLV, it can reach quite a reasonable level of professionalism and economies of scale that allows operators to reduce their operational costs.- By contracting private operators, one can observe a significant increase of basic service performance indicators, which leads to improved coverage and meets users' demands concerning service quality. The municipality contracting can allow the private operator to invest directly in extension and renewal of the system (moving from management contract to leasing contract).	
	Colombia	Rio Negro[1]	54837	Emptying Transport	Sewerage network	Yes	Mix management model (50% private and 50% public) / leased contract	N/A	

- ***Public sector & NGO***

Continent	Country	Town Name	Population	Step of the chain covered	Technology	Gover-nance	Lessons Learnt	Manage-ment
Africa	Uganda	Kyotera, [18]	12751	Containment	Public latrines	No	**Stakeholders:** inclusive participatory water and sanitation management improves the living conditions of vulnerable groups and gender equity. **Financial:** Opportunities in Water and Sanitation, business skills development, small business development.	
	Malawi	Kasungu*	70000	Containment Emptying Transport Treatment Reuse	Latrines Flush toilets Septic Tanks Sewage Oxidation ponds sewerage	No	**Technological:** O&M is essential for the success of the project **Institutional:** Determine who has what responsibility (between the state/local authorities). **Financial:** Funding required especially considering the municipality is a young organisation and has previously had poor revenue collection with a high turnover of staff.	
	Senegal	Bignona[19]	44783	Containment Reuse	On-site sanitation facilities	No	**Economic:** Market Driven Approach (MDA) showed opportunities for reuse of Solid Waste and FSM. **Advocacy:** SFD helped in advocacy to engage local authorities and state services to act.	
Asia	Bangladesh	Sakhipur [20,21]	32000	Collection Treatment Reuse	Co-composting	No	**Economic:** Where demand for compost exists, co-composting is viable to reduce FSM and SWM issues. **Beyond sanitation sector:** combining FSM and SWM can be complementary.	

- ***Public sector w/ Community***

Continent	Country	Town Name	Population	Step of the chain covered	Technology	Governance	Lessons Learnt	Management
Africa	Egypt	Abdel Kareem Issa[4]	System designed for 2000	Emptying Transport Treatment	Conventional sewer system and Anaerobic Baffled Reactor	No	**Technology:** Successful primary treatment example managed by a community member, only good for medium strength waste water and thanks to strong O&M.	
Asia	Vietnam	Two towns (Ha Tien, Sa Dec) [22]	40000, 95000	Containment	Pit latrines	No	**Financial:** Sanitation may be improved with household access to loans and education on sanitation.	For containment only

- ***Public sector & NGO (w/ Community)***

Continent	Country	Town Name	Population	Step of the chain covered	Technology	Governance	Lessons Learnt	Management
Asia	Nepal	Tansen*	35000 (but this project only for 200 households)	Containment Transport Treatment Disposal	Individual toilets Sewerage DEWATS	No	**Partnerships and Stakeholders:** NGO: acting as intermediaries between government and local communities. Existing CBOs did community planning and decision-making process. Willingness to take on O&M. Partial funding. **Institutional:** Municipality provided land for a treatment plant.	
	Nepal	Nala[23]	2274	Containment Treatment	septic tanks DEWATS	No	**Partnerships and Stakeholders:** Collaboration between foreign investor, community and municipality can have excellent results.	

Continent	Country	Town Name	Population	Step of the chain covered	Technology	Govern-ance	Lessons Learnt	Mana-geme-nt
Africa	Niger	Filingué*	25000	Containment Emptying Transport Reuse	pit latrines Gulper pump	No	**Education:** Sanitation not a priority due to a lack of awareness and knowledge. When people get informed about the health risks related to poor sanitation, there is more willingness to pay for it. **Partnerships and Stakeholders:** Political involvement/willingness is a critical success factor in achieving sanitation projects. **Technology:** Approach implemented has to be adapted to the local context. Mechanical emptying is not always the only solution and manual pit emptying could be adapted if managed properly. This example shows how important it is to select the sanitation actors thoroughly and that the success is not depending on the technology but on the management and willingness within the town	
	Mozambique	Rapale and Ribaue[24]	19000, 26000	Containment	Pit latrines built from traditional materials	No	**Technological:** The design of the sanitation program has to be flexible and context specific. Rural sanitation mobilization tools are applicable in the STLV context. **Institutional:** program should include an institutional sanitation component. Better evidence would contribute significantly to UNICEF's ability to advocate WASH provision to STLV. **Partnerships/Stakeholders:** developing markets in STLV is an opportunity to tap into rural markets that rely on them for markets and other consumer goods. Not all entrepreneurs are good sanitation service providers and the sanitation sector does not generate enough revenue to make it a stand-alone business.	
	Mauritania	Rosso*	45000	Containment Emptying Transport Reuse	Pit latrines, mechanical emptying Drying beds	No	**Institutional:** Political willingness is critical and participatory planning takes a trained local authority who is willing to assume its role of leader. Once running the authority must then act as a monitoring body. Compromises between actors is required. Low-cost technology can provide a sustainable and hygienic sanitation service in STLV. **Technology:** Sanitation access: 85 %: pit latrines are sealed to ensure no infiltration due to the high level of groundwater. That is why they need to be emptied regularly (4 times/year to ensure). Mechanical emptying is done (1 mechanical emptier) and faecal sludge is dumped at the treatment site located at the edge of the town (filtration and then sludge dumped in a disposal site). There were also two informal emptier using a donkey cart, Gulper pump and tanks. But this is not sufficient.	

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Appendix 6: Full sanitation chain case studies

Fact Sheet 1: Filingué, Niger	Population: 26,000

Baseline: Approximately 30% of the households had access to sanitation facilities and the emptying services were poor. A few manual emptiers were operating in the town but were not well equipped, leading to health and environmental hazards (hazardous working conditions, dumping of the excreta in the street, etc.). The municipality made a vacuum truck come from Niamey but the emptying tariffs were too expensive (because of the cost of the fuel), and only the liquid part was vacuumed.

Summary of the project:

- Number of beneficiaries/coverage: Approximately 95% of the population have pit latrines.
- What and how: Sanitation programme from 2006 to 2009 led by RAIL Niger:
  - Improvement of the sanitation access: The local authorities provided subsidies to the lowest-income households to build pit-latrines with SanPlat. This initiative generated a sanitation dynamic in the town, and other households purchased SanPlat latrines (in 2009: 1000 in total with 300 subsidised for the poorest and 700 paid by higher income-households). The project provided the construction materials and a mason; the household was in charge of providing the remaining labour, giving a sense of ownership.
  - Faecal sludge management program: Studies showed that there was not sufficient demand for more than one emptier and the purchase and operation of a desludging truck was not viable. The municipality contracted an experienced emptier already operating in Filingué. Subsidies financed a tank, a cart (designed with the emptier) and equipment: gloves, boots, mask, and shovel for the emptier. His activity was promoted, and he attended a workshop about the health risks related to sanitation. A General Assembly was set up with the emptier, the population and Local Authorities to define the affordable emptying tariffs that were viable for the emptier, resulting in a tariff decrease of 50%. The emptier was exempt from municipal tax.
- Follow up: A project coordinator ensured that the service is working and was adequately delivered. There was no additional financing.

Sanitation chain:

- Containment: Pit latrines with SanPlat (locally manufactured). The size of the pit was designed according to the number of users.
- Emptying: One manual emptier, equipped with a tank, donkey cart, motorised pump (for the liquid part), shovel and PPE. The price was fixed according to the depth of the pit.
- Transport: Excreta transported outside the city by the emptier using a donkey cart.
- Treatment: No treatment.
- Disposal/Reuse: Faecal sludge dumped into the fields, and sometimes used as a fertiliser by farmers.

Actors -Include funders	*Roles*
RAIL Niger	Support to the local authorities, SanPlat workshop, training of the emptier (health risks). Management of the decentralised cooperation.
Local authorities	Provide subsidies to the needy households, promote the role of the emptier within the town. The marketing communication was based on posters and a crier.
Community	The population was required to be involved in the construction and maintenance of the latrines, and to contract the worker for emptying services.
Emptier	Deliver emptying services. Purchased the donkey and maintained the material

Athis-Mons (French city)	Supported the construction of 200 household latrines through the decentralised cooperation and provided finance.

Results:

Positives:

- Involvement of the municipality (General Assembly, support training and emptying)
- Trained and equipped emptier to ensure health safety, providing good services to the population.
- The promotion and recognition of the emptier activity brought him more clients (passed from 3-5 to 15-20 clients per months on average) ensuring his livelihood.
- Population involved in the construction of latrines and platform. Community ownership and satisfaction.

Negatives:

- The demand was still low compared to the size of the population. Unhealthy practices were still happening (including OD)

Lessons:

Public Awareness: Sanitation is not a priority for communities due to a lack of awareness/knowledge about health issues. Information and education about the health risk related to poor sanitation increases willingness to pay.

Stakeholder: The selection of an experimented and motivated emptier is key.

Institutional: Political involvement/willingness is a significant success factor in achieving sanitation projects.

Technology: The approach implemented has to be adapted to the local context for the whole chain and use local materials.

This example shows how important it is to thoroughly select the sanitation actors thoroughly and that the success is not dependent on the technology but on the management and support within the town.

The increase in the number of users showed that this service should be formalised and promoted in other Nigerian settlements.

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Fact Sheet 2: Kasungu, Malawi	Population: 59,696

Baseline: Sanitation: 90% simple latrine with mud floor - no proper slab - small amount use squat hole cover from MATAMA initiative
- 56% improved sanitation according to WHO/UNICEF
- 46% if shared toilet excluded
- 33% of households used shared toilets

Very few pits were emptied -but there was enough space to dig new ones when full. There was little demand for pit emptying- 3 services available: 2 Gulpers (mechanical desludging), 1 manual operator using buckets and spades. Costs for transporting sludge were too expensive – hence waste was often emptied into new pit next to latrine.

Summary of the project:

- Number of beneficiaries/coverage: town level intervention
- What and how: The project is ongoing and has plans for the next 3 years to improve the whole sanitation chain of the town:
  - Immediate/Short Term: School toilets, Public toilets, Hospital Guardians' facilities, Slaughterhouse liquid and solid waste management, Recommission of sewers and ponds, with new sludge disposal facilities, Prison sewers and sludge treatment, Solid waste engineering study, KUMC revenue enhancement, Clarification of sanitation mandates and roles, Performance monitoring by KUMC
  - Medium-term - within 3 years: Rehabilitate sewers and ponds, Additional solid waste collection trucks, Upgrade of solid waste dump site, Tractor loader backhoe for solid waste disposal site, Solid waste operational management plan, Capacity development program for KUMC, Broadened sanitation messaging, Broadened solid waste messaging
  - Long-term - Beyond 3 years: Improved sanitation by-laws, Organisational development of KUMC
- Follow up: No information

Sanitation chain:

- Containment: Latrines
- Emptying: Sewage network (pipes broken and blocked) - poor coverage i.e. 12%
- Transport: No information
- Treatment: Oxidation ponds - poorly maintained and malfunctioning
- Disposal/Reuse: Use raw sludge as fertilizer

Actors -Include funders	*Roles*
WaterAid	Carried out initial assessment
MATAMA - local NGO (Mineral and Applied Technology Applicable in Malawi)	Tests all borehole water twice a year Plays a significant role in facilitating networking between the different role-players, but environmental health and sanitation and associated services remain a neglected area of municipal endeavour.
Kasungu Municipal Council (KUMC)	No information

Results: Ongoing

Lessons:

Technological: O&M is important for the success of the project
Institutional: Determine who has what responsibility (between the state/local authorities).
Financial: funding required especially considering the municipality is a young organisation and has previously had poor revenue collection with a high turnover of staff (training required).

Additional useful information:

Water - 93% - of households surveyed for this assessment use piped water for drinking, mainly from a tap in the yard (37%) or a water kiosk (34%).

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Fact Sheet 3: Rosso, Mauritania	Population: 45,000

Baseline: The municipality of Rosso was in charge of the sanitation service and proposed mechanical pit emptying managed by the public authorities but only one old truck was available. The vacuum truck often broke down and only a few latrines were emptied. The only alternative for households to empty their latrines was to pay manual emptier. Even though the willingness to pay of the population was not high, there was higher demand than offered by existing emptying services.

Summary of the project:

- Number of beneficiaries/coverage: 85% of the population has access to pit latrines, but they were in poor condition.
- What and how: Support was given to the local authority in charge of sanitation to conduct participatory planning. Dialogue with every stakeholder (local authority, private operator, manual emptier) and the population was implemented to make recommendations. All together, they defined the service that the local authority had to provide with support from GRET. Agreements were made on permanent capacity building for the local authority, and training and health protection for manual emptier. Finally, mechanised transport and treatment solutions were made available.
- Follow up: Indicators were defined for the financial and technical evaluation, and for the users' satisfaction evaluation. A control system was also put in place for the treatment infrastructure.

Sanitation chain:

- Containment: Sealed pit latrines to ensure no infiltration into the groundwater (high water table).
- Emptying: 3 "Chinese trucks" with pumps for 1 municipal emptier and 2 contracted private operators (1 to 4 times/pit latrine/year), and 2 informal emptier using donkey carts, Gulper pump and tanks (but low storage capacity and slow service).
- Transport: Mechanised transport ("Chinese trucks" volume 3m3) and carts.
- Treatment: Drying beds.
- Disposal/Reuse: Landfill and disposal site on the edge of the town for manually emptied sludge.

Actors -Include funders	*Roles*
GRET	Support to the local authorities - training informal operators - communication to the population.
Local authority	Responsible for administering, operating, and maintaining the service provision.
Community	Consulted for the diagnosis and the planning.
Private workers	- Emptying and transport.
AFD	Funded the project Acteurs Locaux de l'Assainissement et des Déchets: Innovation 'ALADIN'- project that supported capacity building and providing equipment to emptiers.

Results:

- Regulation by institution: No sludge in the street allowed, but a public service delegation agreement for emptiers.
- Social: Training and health protection for emptiers.
- Technical: Trained manual emptiers. Mechanised transport and treatment solution was available.

- Monitoring: No proper control system leading to no use of the treatment technology. After 6 months from implementation, the population is reverting to former practices.

Lessons:

- The focus should be first placed on reinforcing the local authorities, to enable them to fulfil their defined roles and responsibilities.
- Technology must be appropriate to the local context.
- Political willingness is key
- Monitoring of the service is required at each level.
- Reach compromises between actors.
- Proper technical and financial studies must be carried out to select the appropriate technology: Chinese truck was probably not the appropriate solution

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Fact Sheet 4: Tikapur, Nepal	Population: 56,136 (2011 census)

Baseline: High existing on-site sanitation coverage but total lack of sanitation service chain (emptying, transport and treatment).

Summary of the project:

- Number of beneficiaries/coverage: 98% of household sanitation coverage (2016).
- What and how: As part of the programme Sanitation Planning for Small Towns in Nepal (start in 2016): Testing of planning tools, data collection exercise, utilising smartphone apps (Kobo Toolbox survey), SFD, GIS database.
- Follow up: Allows for better planning and advocacy of sanitation.

Sanitation chain:

- Containment: On-site sanitation technologies (60% of single pit latrine, 7% of double pit latrines, 19% Flush toilet connected to septic tank, 12% biogas digester) (SFD).
- Emptying: Manual emptying (38% emptied by family member, 65% by Informal manual emptying providers, 44% of latrines have never been emptied yet).
- Transport: Manual emptiers.
- Treatment: No centralised treatment.
- Disposal/Reuse: Waste dumped into the environment (86%) or buried in adjacent pits (14%).

Actors -Include funders	*Roles*
Asian Development Bank	Funder (as part of the Third Small Towns Programme for 26 towns in Nepal)
Eawag-Sandec	Technical support
UN-Habitat	Funding
Private sector	Informal manual emptying
The Water and Sanitation Users Committee (WSUC)	Local body responsible for water and sanitation services

Lessons:

- Mass awareness was needed to disseminate the concept of citywide sanitation planning.
- Need of more hands-on guidance material, lack of know-how in FSM at all levels (national, district, municipal, private sector).

Results: 30% of the faecal sludge is appropriately managed (SFD)

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Fact Sheet 5: Dumaguete, Philippines	Population: 100,000 (300,000-400,000 during the day)

Baseline: Septage was informally managed by unlicensed private operators using vacuum trucks, using a call-for-service business model. One operator provided the service, which meant it was unregulated regarding disposal location and fees charged. Collected septage was disposed of either to land, with runoff flowing directly to surface drainage, or directly to the drainage system. The service was expensive, at around USD 240 per emptying, which is approximately four times the current charge levied by the city's Septage Management Program.

Summary of the project:

- Number of beneficiaries/coverage: 98% of on-site sanitation
- What and how: Dumaguete, with other actors implemented the city's planned septage management program. Discussions were held for deciding options for collecting the septage (purchasing trucks or contracting the private sector). A septage treatment plant mechanism was put in place, and an Anaerobic Baffled Reactor system for the public market was built. Promotional campaigns were carried out to encourage cooperation with the desludging operators and payment of the user fee.

1 City government + water district financed the program's start-up.

2 Septage management plan was developed by city and used its own resources to design and construct system.

3 City owns and operates treatment plant. Local water utility conducts desludging. Tariff attached to water bill which covers debt service on plant and trucks as well as enabling septic tank desludging on rotating 5-year plan.

- Follow up: No information

Sanitation chain:

- Containment: Pit latrines, flush toilet (linked to a septic tank or open drains), or biogas digester.
- Emptying: Mechanical emptying and informal manual emptying providers.
- Transport: The mechanically emptied sludge is carried out by 6 desludging trucks - no sewers were present.
- Treatment: 50% of faecal sludge is adequately managed through a Septage Treatment Plant Mechanism - It is a low-cost treatment lagoon. The city public market uses an Anaerobic Baffled Reactor System
- Disposal/Reuse: There is no well-developed or profitable form of reuse of the treated sludge from the septage treatment system. For the 50% of non-treated sludge, there is no official discharge area. It is disposed of either directly into the garden of the house owners, in open drains, irrigation canals, buried in an adjacent pit or dumped into sea, rivers or wasteland.

Actors -Include funders	*Roles*
Private manual and mechanical pit emptiers	Operating on the sanitation service chain
Dumaguete City Water District (DCWD)	Responsible for the Philippine Sanitation Alliance: A 4-year program (2007 -2011) that supported the town to put in place Dumaguete Market and Septage Management Program
The Dumaguete City Mayor's Office	Jointly manages the City's new septage management program with DCWD

Results:

- Improvement was needed in FSM because services were mostly unregulated due to a lack of specific regulatory framework.
- The septage management facility was able to sustain itself through the user's fees.
- Septage management facility paved the way for the government of Dumaguete City to regulate private desludging service providers.

2010
i) Construction of the septage treatment plant was completed, six refurbished vacuum trucks were purchased, user fee collection started, and the system began receiving and treating faecal sludge.

2012
i) Administration and motor pool building are installed on-site to manage the system better.
ii) Mechanical skills are developed to allow for on-site vacuum tank maintenance.

2015
i) Full cost recovery is achieved, including all OpEx and CapEx.

The program shifted to the call-for-service model, from a door to door programme. The current program in Dumaguete City is working, but not everyone calls even though they are paying for the service. The net result is less septage being collected and treated than anticipated, resulting in lower operating expenses
Private de-sludgers, which used to dispose of septage indiscriminately, now dispose of collected sludge into the city's treatment plant for a small fee.

Lessons:

Dumaguete is home to the Philippines' first government-financed septage management system that became a model for other cities and towns who were motivated to initiate their own systems in their respective communities.
Promotional initiatives are an important reminder of the need for the service - they need to be kept going - when the promotion campaigns tapered off, so did the participation rate.
Plans need to be adaptive to the unforeseen.

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Fact Sheet 6: Hin Heup, Laos	**Population: 63,091 (district)**

Baseline: 99% of the town's households have access to pour-flush latrines. Simple soak pits were preferred to sealed septic tanks. Out of these households, 24% had desludging services for their pits, with the rest either opting to build a new one or had yet to fill their pit.

2009-2012: Local sanitation plan entailed construction of a small-scale sewer system and WWTP ran by a local private operator.

Summary of the project:

- Number of beneficiaries/coverage: 99% coverage
- What and how: Household collection piping consists of a simple PVC pipe connected to the main sewer line, allowing excreta matter to flow to the WWTP.
- Follow up: To ensure a good service quality delivered, the private operator had to submit a report every six months and meetings involving all the stakeholders were frequently held.

Sanitation chain:

- Containment: Pour flush toilets
- Emptying: Gravity fed sewer system
- Transport: Gravity fed sewer system
- Treatment: Anaerobic Baffled Reactor, with sludge drying beds. Designed for 30m^3 per day
- Disposal/Reuse: No mention of disposal and reuse.

Actors -Include funders	*Roles*
Le GRET	Financial and technical support to implement and monitor program
Steering Committee	Local stakeholders meet every six months.
Local Private Operator	15 year contract to manage sewage system. Includes O&M and new connections
Local Government	Built system.

Results:

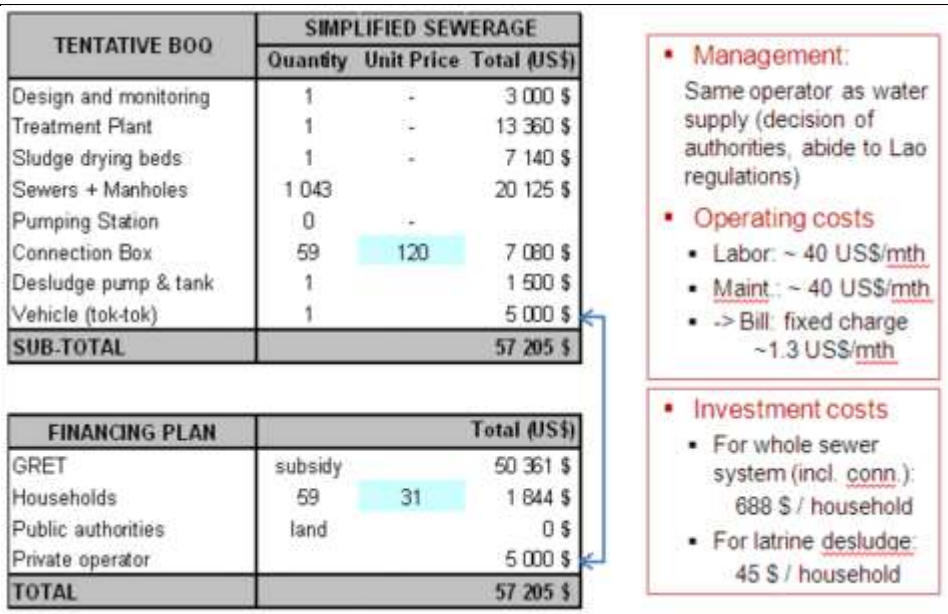
- Reduced pollution of water bodies
- O&M planned for 15 years, to be covered by tariffs
- This model was replicated in small towns in Mauritania and Senegal for the monitoring of: water, solid waste, sanitation and storm water management services delivery.

Lessons:

- Where there is a willingness to pay for a service, but no ability to provide CapEx, foreign investment and technical advice can kick-start sustainable solutions.

Additional useful information:

Decentralized Wastewater System in Hin Heup, Vientiane Province 2009–2012 €61,000



TENTATIVE BOO	SIMPLIFIED SEWERAGE		
	Quantity	Unit Price	Total (US$)
Design and monitoring	1	-	3 000 $
Treatment Plant	1	-	13 360 $
Sludge drying beds	1	-	7 140 $
Sewers + Manholes	1 043		20 125 $
Pumping Station	0	-	
Connection Box	59	120	7 080 $
Desludge pump & tank	1		1 500 $
Vehicle (tok-tok)	1		5 000 $
SUB-TOTAL			57 205 $

FINANCING PLAN			Total (US$)
GRET	subsidy		50 361 $
Households	59	31	1 844 $
Public authorities	land		0 $
Private operator			5 000 $
TOTAL			57 205 $

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WASA, DHUP and URI (Water Supply Authority, Department of Housing and Urban Planning and Urban Research Institute) (2002) *SMALL TOWNS WATER SUPPLY AND SANITATION INITIATIVE IN LAO PDR*. Vientiane, Lao PDR: Water Supply Authority (WASA). Available at: https://www.ircwash.org/resources/small-towns-water-supply-and-sanitation-initiative-lao-pdr-comparative-study-small-town.

Fact Sheet 7: Marinilla, Colombia	Population: 26,000

Baseline: ACUANTIOQUIA, a regional agency created in 1960, was responsible for the administration, operation, and financing of water systems in the region of Antioquia. ACUANTIOQUIA's performance was gradually affected by inefficient administrative practices. The shutdown of INSFOPAL's financial support (the national water company) further reduced ACUANTIOQUIA's ability to meet the increasing demand for adequate WSS services. In 1995, service provision was transferred to municipalities. In 1997, only 19,500 inhabitants had a connection to sewerage. The wastewater used to be discharged into the creek going through the city.

Summary of the project:

- Number of beneficiaries/coverage: 90% of the town was connected to sewerage
- What and how: The municipality of Marinilla worked for 15 years with CONHYDRA, a private operator, responsible for operating the sanitation services across the town. Its role was also to provide technical assistance to the municipality. This private operator was contracted by the regional agency ACUANTIOQUIA in the process of decentralisation of management of services in Colombia. Representative of the users in committees and the good relationship between all the actors allowed discussion and agreements between all of them concerning service quality. A Committee (composed by the director of CONHYDRA, the mayor, municipalities' staff and a representative of the user) was created to monitor the contract and the realisation of specified goals.
- Follow up: No information.

Sanitation chain:

- Containment: flush toilets
- Emptying: sewerage collection system
- Transport: sewerage collection system
- Treatment: 70lps primary WWTP. Only 60 % of the wastewater from the urban area was conducted to the treatment plant. In the rural area, 52% was conducted to the treatment plant (of which 5% through a collective system and 95% through individual connections)
- Disposal/Reuse: No information

Actors -Include funders	*Roles*
Municipality	Planned, financed, and monitored the operator's performance and supervised the accomplishment of the management contract objectives. The council approved the annual budget decision and all major decisions.
CONHYDRA: autonomous private operator	Administrated, operated and maintained the water and sanitation services and supported the municipality to plan, finance and execute a masterplan: improve coverage and quality of the service, construction of a WWTP, expansion to new clients, etc. Reforestation to protect the river basin.
ACUANTIOQUIA: auditor	Prepared the bidding documents and awarded a management contract to CONHYDRA (from 1997 to 2012). Owner of the physical infrastructures of Marinilla until transferred to the municipality and technical auditor.
Central State	Transferred funds to the municipality to support it in funding the contract of a private operator
Users	Participation and involvement in political decision-making through participatory democratic mechanisms.

	Paid a retributive tax of US$ 0.40 per month because of their wastewater being dumped in the river which partly financed the construction of the new treatment plant.
CORNARE: The Regional Environmental Agency	Granted (US$ 950,000) for the construction of the sewage collector system and the WWTP.
Ministry of Economic Development	Granted for the construction of the sewage collector system and the WWTP.

Results:

Positives:

- More people connected to the system: 3000 more connections to sewers between 1997 and 2000 (+5%)
- Quality of the service upgraded after two and a half years
- Increase in customer satisfaction
- Infrastructure upgraded
- Long-term investments programme
- The private operator was regularly providing timely information and consulted the community leaders, organized public education campaigns through the media and visited schools and community groups.

Negatives:

- Tariff levels in Marinilla were below real costs, especially for low-income consumers who represented a large proportion of the population. Therefore, investment capacity was limited and relied on external funders.

Lessons:

- Communication and discussion (meetings, visits to schools and community groups, etc.) between all the members of the actors involved can lead to agreements and good management of the service. Maintaining good relationships between the private operator and the municipality allows for improved contracts.
- Local communities are capable of organising themselves, reduce political interference and promoting good governance practices for the benefit of all the users. Constructive community participation can strengthen the decentralisation process. Community involvement can secure efficient provision of services.
- By contracting private operators, one can observe a significant increase of basic service performance indicators, which leads to improved coverage and meets users' demands regarding service quality. It is facilitated by establishing in the contract incentives and penalties according to the operator's performance.
- Good customer service and concrete results contributed to increased legitimacy and community respect.:
- By serving several STLV (CONHYDRA is also managing six other municipalities), the private operator can reach quite a good level of professionalism and economies of scale that allows operators to reduce their operational costs.
- The municipality contracts can allow the private operator to invest directly in extension and renewal of the system.

Additional useful information:

This successful management model could be replicated in other Colombian cities and beyond.

References:

Arévalo, C. and Schippner, B. (2002) *Los servicios de agua y saneamiento en pequeñas ciudades Los operadores privados en Colombia*. Lima, Peru: WSP.

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WSP, Proconsul and Hydroconseil (2001) *Global small towns water and sanitation initiative - Comparative study of the water and sanitation services management models in the small towns of the developing countries: Colombia Case Study (Preliminary findings - Draft Paper)*. Lima, Peru: WSP. Available at: http://www.hydroconseil.com/attachments/article/Case study Colombia first findings.pdf.

Fact Sheet 8: Sechura, Peru	Population: 38,000 in 2011

Baseline: There are different figures regarding baseline data:

- In 2005, 25% Sewage coverage and only 8% Treatment (Caballero, no date)
- In 2005, 27% Sewage coverage and 73% wastewater treatment coverage, 1,391 sewer connections (Tapia Gamarra, 2012).

Summary of the project:

- ➢ Number of beneficiaries/coverage: 6,600 people
- ➢ What and how: Part of a national programme, the municipality decided in 2004 to change the management model of the water and sanitation services. A management contract was signed in 2006 between the Specialised Operator (SO) (see section Actors & Roles) and the municipality - a form of public-private partnership. The contract was signed for 10 years with possibilities of renewal.

The 4 steps of the project are described as:

- 1st: Diagnosis of the existing system, Sensitisation and information of the population on service quality, costs and overall project - 3 months.
- 2nd: Promotion for the shift of model and empowerment of the population through participation - months.
- 3rd: Implementation and capacity building of the 3 main actors (SO, the municipality and the community supervision board) - 12 months.
- 4th: Monitoring the results of the new management contracts and follow up plan - 16 months.

The main sanitation objectives of this shift of model were: increase the sewage network coverage, optimise the collection, treatment and disposal of wastewater, and ensure maintenance of the system.
10.2% of the bills revenues are put in an investment account managed by the municipality to be used for infrastructures or emergency cases concerning water and sanitation.

- ➢ Follow up: 4th step of the project:
- evaluation of the impacts of the new management model on the quality of the service
- promotion of the results to the population
- evaluation of public perception
- capacity building of local actors
- Quarterly evaluation of the performance of the service.

Sanitation chain:

- ➢ Containment: Flush toilets or latrines.
- ➢ Emptying: Household connection to sewage network.
- ➢ Transport: Household connection to sewage network.
- ➢ Treatment: Lagoons (still need improvements to meet effluents standards).
- ➢ Disposal/Reuse: No information

Actors -Include funders	*Roles*
Specialised Operator (SO): PROGESTION. A consortium of three enterprises including: -SERVIUNI SAC: Service company of the UNI SAC - multi-services - AGALSER SAC: Agua y Alcantarillado y Servicios SAC - sanitation sector	Administrated the system of WSS services Recruited local staff Identified bottlenecks and solutions Provided innovative sanitation technologies Communicated and educated the local population Strategy communicated to the community

- PIASA CONSULTORES SA: Specialised in engineering studies and architectures projects.	
The municipality of Sechura	Periodical reporting on accomplishments of the management contract Managed financing Advised in formulating WSS public investment projects Participated in oversight of investment works
Organised Civil Society - Community Supervision Board: Unidad de Vigilancia Ciudadana (UVC)	Oversaw the facility actions Periodically met with SO Enabled participation mechanisms Oversaw gender approach. Supported promotion of a culture of service payment
PPPL (Pilot Project for Improving Water and Sanitation Services in Small Towns)	Source of the initiative with the help of WSP - National programme leader
World Bank & Canadian International Development Agency	Funders

Results:

There were varied improvements in coverage:

- in 2008, 33% sewage coverage and 10% treatment (Caballero, no date)
- in 2011, 32% sewage coverage and 100% wastewater treatment coverage, 2,124 sewer connections (Tapia Gamarra, 2012)

Positives:

- Improvement of the water and sanitation services, extension of the covered areas.
- Better distribution of the services and less illegal connections.
- Improved customer relations and willingness to pay.
- Regular income ensured due to service payment by fishing industry (60%).
- National water and sanitation law incorporated Specialized Operator as actor in service administration.
- Tariffs covered operation and maintenance costs.

Negatives:

- Delays in WSS investments by the municipality.
- Need for a water treatment plant to reduce the impact on the environment
- The community committee ceased to meet in 2009 resulting in a lack of good relations between the SO and the population.
- Goals were set according to a forecasted population growth which was surpassed. Therefore, the SO has not been able to meet initial coverage goals.

Lessons:

- A stable political environment, engagement of the municipality and the community's support of the change to the management model, were factors of success.
- Goals should be achievable, taking into account resources available for investment (the one settled at the beginning of the project were too ambitious and not achieved because the municipality did not invest enough).
- The municipality, government and population engagement were determining factors for this type of contract to be put in place. The better billing put in place by the new management model enabled

more investments and better service coverage. However, the lack of coordination between the operator, the municipality and the community might have been the main reason for the service functioning poorly.
- Effective communication between all the actors was a factor of success: as soon as the community committee ceased to meet, there was reduced coordination and transparency in service operation.

References:

Caballero, J. (no date) *The Case of Sechura, Peru A public-private social partnership* [PowerPoint presentation]. Water and Sanitation Program (WSP).

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Fact Sheet 9: 14 towns in the region of Tumbe, Peru: Tumbes, Zarumilla, Corrales, La Cruz, Zorritos, Cancas, Puerto Pizarro, Aguas Verdes, Pampas de Hospital, San Jacinto, San Juan de la Virgen, Papayal and Matapalo.	**Population: 225,000 (2011)**

Baseline: In 2005, there was 45% of sewer coverage, 13% wastewater treatment coverage, and 23,063 sewer connections in the cluster.

Summary of the project:

- Number of beneficiaries/coverage: 37,200
- What and how: In 2004, three provincial municipalities in the Tumbes region agreed to hand over the water and sanitation services to a private entity (ATUSA) through a 30 years co-financed concession contract. US$ 24.4 million investment was made on the overall project, of which US$ 11.2 for sanitation (of which US$ 1.8 is a national contribution, and the rest is not to be reimbursed).
  - 1st step: Planning.
  - 2nd step: Promotion and communication to the local population the details on the concession.
  - 3rd step: Implementation - increase and improve coverage.
- Follow up: No information

Sanitation chain:

- Containment: Flush toilets or latrines.
- Emptying: Household connection to sewerage.
- Transport: Household connection to sewerage.
- Treatment: Decentralised treatment plant (1 per city), often lagoons
- Disposal/Reuse: N/A.

Actors -Include funders	*Roles*
Operator: Aguas de Tumbes S.A (ATUSA) concession between LATINAGUAS (Argentinian company) and CONCYSSA (Peruvian company)	Responsible for the water and sanitation services provision (operation and maintenance) and for required investments.
Municipalities	Grantor
Agencia de Promoción de la Inversión Privada (PROINVERSIÓN)	Made the studies prior to the concession, consulted the population on tariffs and selected the external contractor. Regulator body.
Municipalities coordination unit	Audited the facility's activities (was never operational).
The National Sanitation agency	Supervised the investment (counterparts to KfW) and gave an opinion on the extension of the services.
Superintendencia Nacional de Servicios de Saneamiento (SUNASS)	Monitored operator activities, quality of the service, the finance. Approves the master plans and tariffs. Regulator.

KfW (German Development Bank)	Funder: US$ 9,4 million (loan) + US$ 11 million (grant)
Republic of Peru	Loan contract and financial support with KfW of EUR 8,9 million.
Development fund Canada-Peru	US$ 4 million

Results:

- In 2010, 44% sewer coverage and 33% wastewater treatment coverage, 23,686 sewer connections.
- Less successful experience out of 4 case studies on PPP in Peru.
- Uneven results in the different municipalities. In Zorritos the WWTP generated bad odours and environmental contamination.

Positives:

- Increase in quality of the services.
- More connections to the sewer system, 2.5 times more wastewater treated.
- Contamination and pollution of the environment reduced.
- Improvements in public health (but not entirely in-line with the concession contract).

Negatives:

- The planned and non-functioning body in charge of linking the local authorities and the concession is missing.
- Non-achievement of goals compromised the operator's credibility towards users and local authorities and impacted the operators' access to funds.
- Users were unsatisfied and demanded compensation; local authorities claimed to be more responsive to feedback.

Lessons:

- Goals should be reviewed in a realistic and clear way, without ambiguities.
- Plans must be based on actual financial resources available and not be too ambitious.
- The operator must be responsive to the concerns of the municipalities, find solutions and communicate on how the objectives will be met.

Factors of success:

Political

- Political willingness to find a new management model.
- Combined efforts of the different municipalities to find solutions.
- International financial help enabled quick investment.
- Autonomy of the concession avoids political interferences.

Economic and Technical

- IT tools enabled a good Information Management.
- Constant capacity building of the staff.

References:

- Aguas de Tumbes (2010) *Plan Maestro Optimizado De La Empresa Prestadora De Servicios De Saneamiento Aguas De Tumbes*. Tumbes: Aguas de Tumbes.
- Tapia Gamarra, C. (2012) *Standing the Test of Time: the experience of Four Peruvian Small towns in managing their Water Supply and Sanitation Services*. Lima, Peru: The World Bank, Water and Sanitation Program. Available at: www.wsp.org.
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Fact Sheet 10: Lakshmipur, Bangladesh	Population: 83,112 (2011)

Baseline: The predominant OSS are toilets connected to septic tank and pour-flush latrines. Sanitation facilities of 11 establishments were physically surveyed, which included 7 houses, 1 school and 1 office. Among these, two were off-set pit pour-flush toilets. The remaining were toilets connected to septic tanks; only two of these had soakage pits.

Summary of the project:

- Number of beneficiaries/coverage: Wherever trucks have access and people are willing to pay
- What and how: The basic concept of the FSM adopted in these ongoing projects consisted of the collection of faecal sludge from septic tanks and pits through 'Vacutug' and transportation of the sludge for treatment and/or disposal. i) the construction of the sludge treatment system (at the outskirts of the town) and ii) the procurement of tractor towed tanks with suction pumps (Vacutug) of capacity 2m^3 and 0.7m^3. The plant has been operational since May 2013.
- Follow up: It is important that the Municipality attains the technical capacity to operate and maintain the sludge treatment plant. Although, a faecal sludge treatment plant is smaller in scale and has few electro-mechanical parts (when compared to sewage treatment systems) the successful operation of the system requires engineering capacity for its operation and maintenance.

Sanitation chain:

- Containment: household/community pour-flush latrines connected to pits or septic tank system.
- Emptying & Transport: people usually de-sludge their septic tanks/pits when they overflow; some also reported desludging at fixed regular interval. The Paurashava (Municipality) introduced a mechanical desludging service in 2013, and many people used this service. The Municipality had received three mechanical desludging equipment (Vacutug) from the Secondary Town Water Supply and Sanitation Sector project (funded by the GoB and ADB) run by DPHE. But the extent of service was limited; more resources were required to expand the service. People also use manual desludging services, especially in areas inaccessible by Vacutug; manual desludging is slightly cheaper than the mechanical service, costing about BDT 500 to 1000 (excluding the cost of salt, kerosene, bamboo, rope, etc.) Desludging can be requested at the Municipality Office for a fee of BDT 1000 (USD 12.5), half the former price. The municipality then sets a date for the desludging operation and the Vacutug and crew are sent to the house on the scheduled date. The sweepers are paid BDT 50 per trip (i.e., desludging event).
- Treatment: faecal sludge treatment plant with support from the Secondary Town Water Supply and Sanitation Sector project (funded by the GoB and ADB) run by DPHE. DPHE designed and implemented the treatment plant. The plant has been established on 0.30 acre land owned by the Municipality. The treatment plant is based on planted filter bed system (Reed Bed System) and sludge drying bed. The plant received about 42 m^3 of sludge per week. The liquid effluent discharged from the plant into the environment is to national discharge standards.
- Disposal/Reuse: End-use of treated sludge has not yet been considered, and there is no data on the quality of compost or dried sludge produced at the treatment plant.

Actors -Include funders	*Roles*
Paurashava (Municipality)	Introduced mechanical desludging in 2013, appointed Vacutug operators
ADB	Funded desludging equipment and faecal sludge treatment through secondary Town Water Supply and Sanitation Sector Project
Department of Public Health Engineering (DPHE)	Ran the Town Water Supply and Sanitation Sector Project

Results:

Positives: Job creation; Treatment of sewage

Negatives:

- No end use of sludge.
- Improving access to septic tanks and pit latrines for easy mechanical desludging. Presently, it is difficult for the Vacutug to access septic tanks that are in dense settlements or inaccessible spaces.
- Ensuring that the on-site systems like the septic tanks and pit latrines are not directly connected to storm water drains. This practice not only results in environmental pollution but also poses challenges in estimating the demand and load of the emptying and treatment service respectively
- Improvements in the emptying and collection of faecal sludge. The present service charges BDT 1000 per trip. It involves an application and fee, and a 1-3 days wait. That the majority of households had not yet used the Municipality service and instead depend on the manual services provided locally to clean their pits/ septic tanks, although they are more expensive. The faecal sludge removed from the pits/septic tanks were either buried or disposed to open drains or water bodies causing direct pollution.

Lessons:

The interest and capacity of the municipality are important factors for the success of all FSM services including treatment.

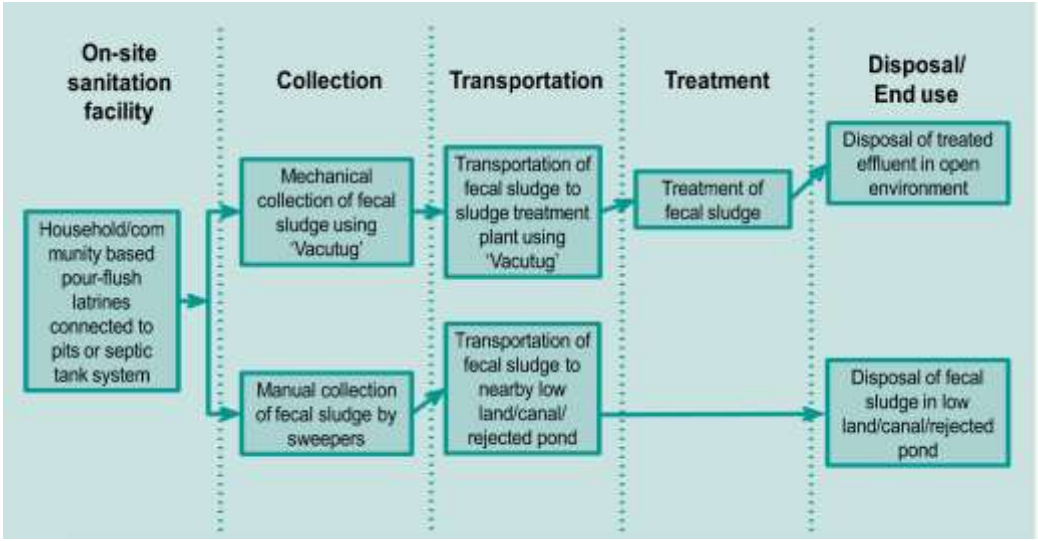
Absence of a specific FSM regulatory framework is a major impediment to planning and implementation of successful FSM initiatives in the urban areas of Bangladesh

It is important that the programmes and initiatives to improve sanitation in Bangladesh realise the importance of the successful operation of the facility at Lakshmipur and make available adequate support to the city in this initiative.

An information campaign educates the population to understand the benefits.

Additional useful information:

Water: 40% of the area has piped water supply; remaining area water supply was provided using tube wells, surface water sources, etc.



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Mujibur Rahman, M., Ashraf Ali, M., Rahman Choudhury, M., Azizur Rahman, M., Mohammad Redwan, A., Farhan Noor, N. Islam Sohan, A. (2015) *Fecal Sludge Management (FSM) Scenario in Urban Areas of Bangladesh*. ITN-BUET.

Fact Sheet 11: Chilaw, Sri Lanka	Population: 25,000

Baseline: Administered by Urban Council (UC). The UC's sanitation functions include maintenance of public toilets, drainage, water quality surveillance, food quality, and septage disposal. Up to May 2015, the septage from overflowing septic tanks was applied to coconut lands away from the UC area. The sanitation activities were managed under the Public Health Inspector's department where the records are maintained on water quality, waterborne diseases, public toilets and records of the operation of gully trucks. The UC provides the service of emptying the septic tanks on request for a fee.

Summary of the project:

- Number of beneficiaries/coverage: Those who have septic tanks de-sludged.
- What and how: faecal sludge treatment facility built and commissioned 2015 (1 million Euros to build).
- Follow up: full sanitation up and running.

Sanitation chain:

- Containment: septic tanks.
- Emptying & Transport: The UC maintains two trucks of capacity 3,000 litres and 5,000 litres for the septage disposal. The UC provides the service of emptying the septic tanks on request at a fee of 14.5€ for the people living within the UC limits and charge SLR 35.5€ for the people outside the UC limits to empty the septic tanks using trucks.
- Treatment: The treatment system consists of a flow-through pond system with an anaerobic, facultative and maturation ponds. The capacity of the facility is 39 m3 per day. The facility is situated 10 km away from the UC limits and is designed to receive a minimum input load of 6 trucks per day.
- Disposal/Reuse: Discharge treated wastewater to the land via a reed bed. The ponds fill very slowly and need emptying only every 5-10 years, using a front loader as for the drying beds. The plants in the reed-bed system need replacing every few years. This is done by hand, and the old plants are normally loaded onto a truck and taken to the solid waste disposal site. Suggested at time of construction of using treated sludge as fertiliser for agriculture.

Actors -Include funders	*Roles*
Asian Development Bank (ADB) assisted by Dry Zone Urban Water & Sanitation Project (DZUWSP)	DZUWSP is supported by ADB through a project loan and grant. The Ministry of Water Supply and Drainage (MWSD) is the Executing Agency (EA) for the program and NWSDB is the Implementing Agency (IA).
Urban council	Oversee operation of new treatment plant as well as desludging septic tanks.

Results:

Positives: Successfully implemented treatment and Disposal/reuse

Negatives: High cost of desludging, especially for those outside of UC limits/perimeter, O&M

Lessons:

Utilises existing technology (septic tanks, vacuum trucks) and framework (Town council) to complete the sanitation chain.

Well thought plan and proposal (including perceived potential impacts on physical, environmental, economic, social/cultural resources).

References:

Dasgupta, S. Murali, R., George, N., and Kapur, D. (2016) *Faecal Waste Management in Smaller Cities Across South Asia: Getting Right the Policy and Practice*. New Delhi: Centre for Policy Research. Available at: http://cprindia.org/research/reports/faecal-waste-management-smaller-cities-across-south-asia-getting-right-policy-and

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Appendix 7: Interviews analyses

Themes		Institutional			Financial		
Type of organisation	**Code**	**Capacity building**	**Cluster**	**Policies**	**Service payment**	**Economy of scale**	**Financial resources**
University	**KI1**	Lack of it, there are limited operational, management and administrative skills - need organisation at a municipal level. Need for capacity building of the people in charge of the sanitation service.	Most efficient model tends to be to have one treatment plant at district level and truck all the waste due to economy of scale. Allow competent operators to get involved. Look at modelling the costs. Use the bidding process to get the contractors to find at what level clustering would achieve savings.		Should transition from single high fees to get to a subscription service - fees should be the same for everyone. Use of subsidies, such as cross-subsidies with water.		Very limited in small towns - bonding fees with water services could help. Transport and treatment are the expensive and important aspects to find finance for.
International NGO	**KI2**	Work on the local stakeholder's capabilities. Train, support and do capacity building on the long term.	More an emergency measure as it increases the price of the service (not viable).	Allow operators some scope in defining criteria.	No ability to pay. Once the system is functioning, it is supposed to and can work only with local payments.	Towns are often too small (not enough customers) to make the service viable.	Subsidies; at least for the infrastructure, and often for the service.
International NGO	**KI3**	Send people abroad for training, create incentives through good leadership. Human resources capacity building to deliver better services.	Solution - can overcome economy of scale challenge - works for dense areas.		Need better market collection fee system.	No economy of scale. Need clustering or association with big city.	Low ability at the local level to raise its own funds - insufficient to pay staff and CapEx. - Cross-subsidies are difficult when sectors are divided.
University	**KI4**	National leadership.	Large part of the solution.	The solution.		Too small for an economy of scale, but depends on how it is defined. Indian government pushes utility to go further and further out of town.	Lack of financial capacities to develop integrated sanitation systems. No universal rules for cross subsidies

Themes		Institutional			Financial		
Type of organisation	**Code**	**Capacity building**	**Cluster**	**Policies**	**Service payment**	**Economy of scale**	**Financial resources**
International NGO	**KI5**	Lack of time and qualified staff - lack of capacity to choose the appropriate model.	Has shown some good results. However, can be quite political. Water operator's partnership is an emerging method.			Doesn't just depend on the population size.	Poor financing. Need for funding partners (eg WSP). Cross subsidies can be a good solution but conflicting between sectors.
Local NGO	**KI6**	Need to train the operator - when decentralising the service, need to transfer the skills.		From experiences; projects where the municipality is involved and responsible are more successful - requires political will.	Negotiate the tariff between service provider and poorest households.		
Consultancy	**KI7**	Municipalities in charge, without capacities or tools.	Promising solution (and for water) especially for small towns. Private operator to manage (not invest).	Needs regulation to control downstream segment - recent change in policies and strategies - need public policy.	Budget of sanitation utility is mostly user paid - real demand for emptying, people are ready to pay for service but will not pay for downstream treatment.	It is key. Less Cross-subsidies 60-80 k is not viable for most operators (number may be a bit smaller now but still around 50k). 1 (truck) per 80 to 100k people.	Challenge: financing mechanisms are not in place in ST, users are the main financial actor. Make a sanitation Tax, to make a budget for investment downstream. Offer incentives to private operator.
Local NGO	**KI8**	No skills in ST - need training - but focus on soft skills.	Can be a solution if ST close enough - high operational cost are unappealing for private operator - need official agreements.		Service works if there is willingness to pay.	Depends on the context & factors (technical options, local capacities, etc.).	Investments funds not available in ST.
Consultancy	**KI9**	Government has no capacity and no global understanding of the system.	Good solution if ST are aiming to complete the full sanitation chain - costs of emptying become quickly really high.	Need a framework of policy making - good sanitation marketing strategies - with incentives for the private sector - create enabling environment.	Look at the ability to pay rather than the willingness to pay.	Need to be possible for all technology.	Should come from central gov't or donors or funding agencies - waving fees and taxes incentives (for private sector).

Themes		Infrastructures		Service management			
Type of organisation	**Code**	**Technical**	**Management**	**Private operator**	**Community management**	**Authorities**	**Role/ responsibilities**
University	**KI1**	Don't try to move away from pit latrines or empty them if you don't have anywhere to safely dispose of the excreta, it is safer in the ground. Technology is not the issue, the focus needs to be on institutional framework. Treatment plant are often poorly designed and managed.	Building the systems is easy, it is the management that is the tough part (operational business). Limited management/operational skills. In small towns, no one is interested (unwillingness and inability) in working on contractualisation of operator. Need for a dynamic management of services.	It requires organisation and competences of the local authority in case they choose to delegate the service management. Esta blish market rules.	Should move from household management to a city system.	Focus on organisationa l capacity and structures	Local authorities must know their responsibilities. Clear contracts with guidelines should be set up. Strong institutional framework needed
International NGO	**KI2**	Sewers are too expensive for ST and they require too much technical capabilities. Use basic technical solution (understandable, manageable and cheap, eg: DEWATS). Big vacuum trucks are not always a good solution.	Local people should be able to manage.			Hard to mobilise (sanitation is not seen as priority).	Defining the roles & responsibilities of everyone.
International NGO	**KI3**		Skilled staff required - challenge to retain staff (skilled people move from public to private sector) - Lack of qualified staff.	PPP does not work (see e.g. in Kenya) - private sector only can work.	In favour of participatory approach - easier because less complexity in government institutions.		
University	**KI4**	Lack of Infrastructure. Opportunities of reusing waste for agricultural purposes. Have a spinal sewer system with easy plug in, or transfer stations. Technology needs to be appropriate.	Not professionally managed.	Public provision should be viable, but not profitable. Not the case for private service provision.	When utility expands, they move away from community management.		Agree and assign clear tasks to different actors.

Themes		Infrastructures		Service management			
Type of organisation	**Code**	**Technical**	**Management**	**Private operator**	**Community management**	**Authorities**	**Role/ responsibilities**
International NGO	**KI5**	Institutional sanitation is the hardest. Do something cheap or that generates income.	Find partners, for mentoring support (as happens the in water sector).			Political will is essential.	
Local NGO	**KI6**	Use a technically adapted solution (motor pomp) rather than non-affordable equipment (e.g. truck from the next city could not remove solid part of pit, so unaffordable).	Municipality and emptier know their own responsibilities.	Responsible for operating the system.	Responsible for building the containment (pits) but without subsidies.	Contracts the private operator - committee to control the system - need political will.	From experiences; projects where the municipality is involved, are more responsible, and works with the private operator are more successful.
Consultancy	**KI7**	Not the main challenge; no need to innovate. On site sanitation at household level, very few sewers. Technology is understood but how to build a low cost WWT - improvement depends on the population size and the intial level on sanitation.	Issue - need regulation and control for pit emptying and downstream segment.	The market is small so hard to attract the private sector but still, it should be responsible for the service	Responsible for building their own latrines.	Local authorities are not aware of the public service possi bilities aroun d sanitation - should offer incentives to the private sector to operate - should invest in downstream segment.	Public management of vacuum trucks is very difficult. Should be private sector.

Themes		Infrastructures		Service management			
Type of organisation	**Code**	**Technical**	**Management**	**Private operator**	**Community management**	**Authorities**	**Role/ responsibilities**
Local NGO	**KI8**	Need to be localy adapted, maintained and monitored - need ownership of the system in place - inadequate tech makes the system unmaintainable and unviable.	Need control system to make sure it is well run. Also control system will reduce corruption.	The market is not sufficient.	If engaged and with promotion of the service, can ensure use of system; but does not work without organisation and political will.	Weak, lack of human resources and of skills, no organisational capacities - need to reinforce the public authorities.	Need to be clearly defined from the start - involvement of all the stakeholders necessary.
Consultancy	**KI9**	Needs to be flexible, cheap and upgradable - work according to the population density - work on standardised technologies - developed a modular technology?	Work on the whole chain - if household level segment not dealt with, the whole chain won't work.	Private sector is weak - unregulated (operator can fix their prices because no competition) - can operate if has guidelines from the local gov't - strong private sector involvement ensures success.	The community is usually willing to have a service.	Their role is to ensure the service by either doing it themselves or by contracting a private operator - should invest in treatment - has to be receptive to the private sector.	Household responsible for pits, private sector responsible for emptying/transport, local government responsible for treatment (because requires investments).

Appendix 8: Simplified diagram for the selection of sanitation chains

FIGURE 5. Simplified diagram for the selection of sanitation chains