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### SI-A: Historical overview of selected strategic planning frameworks following a structured decision making (SDM) framework

<table>
<thead>
<tr>
<th>SDM Framework</th>
<th>Description</th>
<th>Key contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic Sanitation Planning (SSP)</strong>&lt;br&gt;(Kalbermatten, 1982a; Kalbermatten et al., 1982b; Kennedy-Walker et al., 2014; Middleton and Kalbermatten, 1990)</td>
<td>SSP is a multi-approach for phase-wise adaptive planning in opposition to sewer master planning. The aim is to be multi-technology (on-site, sewered, and centralized), multi-professions (not only sanitary engineers, but also economists, behavioural scientists, and health specialists), but also multi-criteria (technical, health, costs socio-economic, socio-cultural, institutional, and environmental) in order to identify locally appropriate solutions.</td>
<td>Multi-professional; multi-criteria; incremental improvement; community participation; appropriate technologies.</td>
</tr>
<tr>
<td><strong>Strategic Sanitation Approach (SSA)</strong>&lt;br&gt;(Taylor et al., 2003; Wright, 1997)</td>
<td>SSA is drawn from lessons learnt from early projects aiming at implementing SSP. It is based on two main core principles: (1) demand-driven and (2) incentive-driven. It involves: (i) a wider choice of technology options; (ii) recognition and analysis of consumers’ willingness to pay, and methods for matching service levels to affordability; (iii) innovative financing mechanisms and institutional frameworks, including unbundling of investments into affordable parts; and (iv) capacity building to enable all levels of governments and other stakeholders to implement responsive and sustainable programs. It suggests to provide support in five areas: operational; technical, technological, demand creation, investments, and financing.</td>
<td>Community participation; willingness to pay; capacity development; market-based approach.</td>
</tr>
<tr>
<td><strong>Household-Centred Environmental Sanitation (HCES)</strong>&lt;br&gt;(Eawag, 2005)</td>
<td>The HCES approach was conceived in response to the Bellagio Principles. The HCES approach is a radical departure from past central planning approaches as it places the household and its neighbourhood at the core of the planning process. The approach responds directly to needs and demands of the users an attempts to avoid problems, resulting from purely “bottom-up” or “top-down” approaches. Moreover, the approach suggests establishing a series of ‘zones’: the household, the neighbourhood, the community, the city ward, the city, and the wider environment. The sanitation problems should be addressed at the smallest appropriate zone and negotiations and agreements among different zones are required to provide a functional citywide solution. HCES provides a ten-step implementation methodology that follows a project cycle framework. It was piloted in several sites but the scope of citywide sanitation was never achieved.</td>
<td>Bridging top-down and bottom-up approaches using a multi-actor and multi-sector approach; different zones within one city all work together; 10-step implementation methodology.</td>
</tr>
<tr>
<td><strong>City Sanitation Planning (CSP)</strong>&lt;br&gt;(GoI, 2008; Walther, 2016; WSP, 2010)</td>
<td>The scope of City Sanitation Plans (CSPs) is a citywide sanitation sector development, addressing technical and non-technical aspects, and include the vision, missions, and goals of sanitation development, as well as strategies to meet these goals. It consists of five steps: (1) prepare to plan, (2) understand current problems, (3) develop solutions, (4) plan citywide, and (5) implementation. The principles are: synergies among actors; appropriate technologies; citywide sanitation with a focus on vulnerable and marginalized groups; awareness; incentives for private sector; use of existing sanitation services; community-based sanitation; engage stakeholders; enabling institutional and regulatory frameworks; funding from sources other than municipal governments; and adoption of step-wise development as available resources allow. CSP has been adopted in projects all over the world. In India, several hundred CSPs were and are developed as part of the New Urban Sanitation Policy (NUSP).</td>
<td>Consideration of marginalized groups; all solid and liquid waste streams.</td>
</tr>
<tr>
<td><strong>Community-led Urban Environmental Sanitation (CLUES)</strong>&lt;br&gt;(Lüthi et al., 2011)</td>
<td>CLUES is a follow up of HCES, based on some of the positive experiences on the local level. It includes 7 steps (instead of 10) and focuses on broader community level (rather than putting the household level at the centre) and tarter disenfranchised urban and peri-urban areas. It promotes a multi-sector and multi-actor approach and emphasizes the importance of the enabling environment: government support; legal frameworks; institutional arrangements; skills and capacities; financial arrangements; and socio-cultural acceptance. CLUES has been piloted in several projects in South-East Asia, Africa, and Latin America.</td>
<td>Enabling environment; 7-step methodology.</td>
</tr>
<tr>
<td><strong>Sanitation 21</strong>&lt;br&gt;(Parkinson et al., 2014)</td>
<td>Sanitation 21 focuses on developing explicit objectives, rather than on a given technology. Five features that should be covered: (1) build institutional commitment for planning; (2) understand the existing context and define priorities; (3) develop systems; (4) models for service delivery; and (5) prepare for implementation. The aim is to consider the diversity of currently available technologies and the different urban realities. It also accounts for the importance the enabling environment and an incremental approach. There is no documented case were Sanitation 21 was entirely adopted, but elements of it have influenced several projects.</td>
<td>Focus on objectives rather than technologies; citywide approach.</td>
</tr>
<tr>
<td><strong>Concerted municipal strategy (CMS)</strong>&lt;br&gt;(Leallé et al., 2012)</td>
<td>CMS is targeted to municipalities to understand local needs and prioritizing actions as part of a concerted process that involves all local stakeholders. Its scope includes water supply, wastewater, and excreta management. It encompasses several detailed guidance document, setting out main strategies tailored to the local visions, the demand, and to the financial and management capacities. It has four phases: engagement; diagnosis; developing a CMS; and implementation. CMS was piloted in several municipalities mainly in West Africa.</td>
<td>Specifically, for French-speaking areas; detailed guidance available; several case studies documented.</td>
</tr>
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</table>
### SI-B: Overview of currently available tools to operationalise urban strategic sanitation planning (SSP) along the six generic steps of structured decision making (SDM), according to (Gregory et al., 2012). Source: authors.

<table>
<thead>
<tr>
<th>Launch</th>
<th>Triggering as described in Urban Community-Led Total Sanitation (U-CLTS) or Participatory hygiene and sanitation transformation (PHAST), (Myers et al., 2016; Peal et al., 2010). Stakeholder analysis, participatory assessment methods, kick-off meetings, demand creation (see e.g. Conrardin et al., 2010; Conrardin et al., 2011; Lüthi et al., 2011).</th>
</tr>
</thead>
</table>
| Step 1: Decision context (diagnosis tools) | **Existing services and infrastructure:**  
  - Shit or Excreta Flow Diagrams (SFDs), (Peal et al., 2014a, b): Proportion of faecal waste that is managed and where the unmanaged portion ends up. Similar tool: Faecal waste rapid assessments from IRC (Saha and Shiva, 2018)  
  - Urban sanitation status index (USSI), (Blackett and Hawkins, 2016): Spatial mapping tool across the sanitation chain used for prioritising interventions.  
  - Enabling environment (Blackett and Hawkins, 2016; Scott et al., 2019):  
    - City Service Delivery Assessment (CSDA): Assesses the enabling environment and quality of services through the sanitation chain. Scorecard used to visualize assessment, indicating areas for actions.  
    - Prognosis for Change (Political Economy Analysis, PEA): Identifies interests and incentives that can prevent action, with possible entry points to overcome them.  
  - Public health:  
    - SaniPATH, developed by Emory University, combines environmental microbiological sampling and analysis process, behavioral observations and GIS mapping (Robb et al., 2017).  
  - Participatory Mapping, transect walk, demand assessment, household surveys, focus group discussions, environmental monitoring, problem tree analysis, SWOT analysis etc. (see e.g. Conrardin et al., 2010; Conrardin et al., 2011; Lüthi et al., 2011; Peal et al., 2010). |
| Step 2: Definition of decision objectives | **Separating means from ends** (Eisenführ et al., 2010; Gregory et al., 2012; Schuwirth et al., 2012).  
  - How to make good objective hierarchies, see e.g. (Haag et al., 2019; Marttunen et al., 2019).  
  - Definitions of sustainable sanitation and criteria to operationalise those:  
    - Objectives and criteria/indicators for sustainable sanitation (e.g. Balkema et al., 2002; Bracken et al., 2005; Butler and Parkinson, 1997; Chen and Beck, 1997; DWA, 2014; Foxon et al., 2002; Garf and Ferrer-Martí, 2011; Iwugo, 1979; Katukiza et al., 2010; Kvarnström et al., 2004; Kvarnström et al., 2011; Lennartsson et al., 2009; Lundin et al., 1999b; Muga and Mihelcic, 2008; Palme et al., 2005; Sahely et al., 2005; SuSanA, 2008; Willetts et al., 2013).  
    - Indicators and criteria focussing on appropriateness (e.g. Magara et al., 1986; Murphy et al., 2009; NETSSAF, 2006; Tilley et al., 2010). |
| Step 3: Decision options | **Creativity based methods, such as brainstorming,** (see e.g. in Eisenführ et al., 2010; Gregory et al., 2012).  
  - Decision matrix or strategy tables (Gregory et al., 2012; McConville et al., 2014).  
  - Semi-structured methods, such as decision trees (e.g. Mara et al., 2007).  
  - Scoring/ranking (e.g. Kvarnström and Petersens, 2004; Loetscher, 1999a; van Buuren, 2010).  
  - Information packages to choose from (e.g. Tilley et al., 2014b; Tilley et al., 2010). |
| Step 4 and 5: Evaluation of options and discussion of trade-offs | **Material flow analysis (MFA),** (e.g. Erni et al., 2011; Montangero et al., 2006; Ormandzhieva et al., 2014; Schütze et al., 2019; Spuhler et al., 2020).  
  - Life-cycle costing (LCC), (e.g. Burr and Fonseca, 2011; Fonseca, 2011; Langergraber, 2014a; Maurer, 2013; von Sperling and Salazar, 2013).  
  - Life Cycle Assessment (LCA), (e.g. Lundin et al., 1999a; Pasqualino et al., 2009; Renou et al., 2008; Suh and Rousseaux, 2002). |
| Step 6: Selection of preferred option | **Multi-criteria decision analysis (MCDA),** (e.g. Balkema et al., 2001; Carrard et al., 2010; Hendriksen et al., 2012; Hoffmann et al., 2000; Kalbar et al., 2012; Lai et al., 2008; Lundie et al., 2008; Malekpour et al., 2013; Mendoza and Martins, 2006; Schütze et al., 2019). All of them involve a screening stage similar to step 3, identifying decision options – but none are systematic and comprehensive.  
  - A number of different sustainability assessment tools developed by practitioners for practitioners, but only at a development stage and not yet very much tested are presented in (Schweitzer et al., 2014). |
### SI-B: Systematic comparison of different tools and methods assisting in the generation of sanitation technology and system decision options

<table>
<thead>
<tr>
<th>Name</th>
<th>Short description</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Algorithm for the selection of sanitation technology (AST)</strong>&lt;br&gt;(Kalbermatte n, 1982a)</td>
<td>From 1976 the world bank undertook a research project to identify alternative technology options for water supply and sanitation in order to accelerate the improvement of access in developing countries. These technologies should be appropriate for the funds, the skills, and materials locally available, be socially accepted, and provide the main function of protecting the human health by reducing the transmission of excreta-related diseases. The reasoning behind was, that sewer systems in industrialized countries too have been evolved over time spans of more than 100 years and that to construct such a system from scratch in developing countries would be too expensive to reach the majority of the population (would only benefit the reach). The aim of the planning and design manual published in 1982 was to enable experts in selecting appropriate technologies from a list of potential ones through a first screening step and then by evaluating the costs of different options. The final decision rests with the beneficiaries based on the presentation of technical, social, economic, and health tests of the different options. The guidebook includes a library of possible technology options and a selection algorithm that helps to select the most appropriate sanitation technology for any given community in a developing country that incorporates economic, social, health, and technical criteria. The aim is to prompt the engineer to ask the right questions of which some can only be answered by the beneficiaries. The algorithm starts with the type of water supply, then asks for preferences regarding wastewater quantities and preferences for resource recovery. A sewer system is recommended if there is enough engineering consultants in charge of implementation sanitation improvement projects in developing countries.</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Criteria required to evaluate options are listed and combined with a three-stage algorithm (decision tree) which is systematic and transparent. However, except for the economic evaluation, there is little guidance on how to evaluate the listed criteria.</td>
<td>Systematic (using a transparent and reproducible framework for preassessment)</td>
</tr>
<tr>
<td>Algorithm for the selection of sanitation technology (AST) (Kalbermatte n, 1982a)</td>
<td>The list of possible option is (for 1982) very comprehensively including many onsite options that before were not seen to provide a acceptable service.</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>A number of climatic, site, population, environmental, sociocultural, and institutional factors are explained that should be considered in the decision-making process</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>The algorithm allows for Yes or No answers or provides threshold values (e.g. for the minimal amount of wastewater per person for sewers). There is no options to consider the information entered to be uncertain.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Even though this planning guidance was written before the definition of sustainable development in 1992 and sustainable sanitation in 2008, all relevant dimensions are considered.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>The list of possible option is (for 1982) quite comprehensively, but rigid and the algorithm are designed for exactly this type of options.</td>
<td>N</td>
</tr>
</tbody>
</table>
wastewater, there is no interest in night soil, and if
it is affordable. If this is not the case, on-site
options are recommended and tested in a second
and third stage algorithm, checking preferences
for the type of reuse product and the plot size
available for onsite facility construction.

Algorithm for
the selection
of sustainable
sanitation
arrangement
(ASSA)
(Mara et al.,
2007)

In an article published in water policy this well-
recognized sanitation experts present an algorithm
developed as a guide to identify the most
appropriate arrangement in any given situation,
especially in poor and very poor rural and peri-
urban areas in developing countries. The
sanitation selection algorithm considers all the
available sanitation arrangements, including
ecological sanitation and low-cost sewerage. It is
firmly based on the principles of sustainable
sanitation defined based on four main principles:
health, affordability, environmental sustainability,
and institutional appropriateness.

The algorithm
is based on a
relatively low
number of
clear yes and
no questions
which need to
be answered
mainly by
local decision
makers.

A table
presents a list
of 9 sanitation
arrangements
which is not
comprehensiv
but covers
all the
questions
that at the time
of writing had a
reasonable
high
technology
readiness
level and were
therefore
readily
available for
practice.

The authors
provide a
useful
classification
diagram of
different
sanitation
systems based
on two
categorizes:
on-site/off-
site
installation,
and
decentralized,
centralized, or
intermittent
reuse (onsite
systems
dislodged
every few
years). But
little attention
is given to
collection of
products from
onsite
solutions.

The application of
the algorithm
allows to
consider local
conditions
when
answering the
questions. However,
there is only
very
superficial
information
on what
conditions
should be
considered
and no
guidance how
to evaluate
those.

The questions
are to be
answered by
no or yes and
there is no
room for
considering
different
stakeholder
preferences or
expert
opinion,
either future
changes. for
instance, the
question if
decentralized
reuse is locally
feasible
maybe
depends on
many
different
factors which
cannot all be
clearly
evaluated at
the
structuring
phase of
planning.

There is ample
room to
integrate the
algorithm
within a
participatory
planning
process where
the different
question
answers for
the algorithm
are
established
involving
stakeholders. However,
this
is not
explicitly
stated in the
paper nor are
there any
suggestions
how to do
this.

The algorithm
would need to
be redesigned
in order to
account for
novel options
as the list of
sanitation
arrangements
are predefined.

Relatively complex yes/no algorithm based on the
methods of anal cleansing, population density,
relatives involved in
Sanitation experts.

Planners involved in
urban sanitation.
A guide to sanitation selection (ASS) (Franceys et al., 2013; Pickford, 1991)

affordability, demand for reuse, land availability, soil conditions, and user acceptance.

<table>
<thead>
<tr>
<th>Technology selection scheme for FSM (TSS for FSM)</th>
<th>Clear question to be answered by no or yes.</th>
<th>Predefined set of 11 options.</th>
<th>Some options mention several components of the systems (sewage) other only focus on one element (e.g. septic tank, or VIP).</th>
<th>The questions are designed to consider the local conditions.</th>
<th>There are only two possible answers for each questions.</th>
<th>There is room that the algorithm is applied in a facilitated participatory set-up. But no guidance how to do this is provided.</th>
<th>The focus is on technology appropriateness only</th>
<th>Fixed set of possible options, difficult to adapt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology selection scheme for FSM (TSS for FSM)</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

This technology selection tree guides the user to the identification of a combination of technologies to treat faecal sludge based on an initial characterisation and quantification of sludge.

Planners involved in faecal sludge management (FSM).

<table>
<thead>
<tr>
<th>Scoring/ranking</th>
<th>SANEX (Loetscher, 1999a; Loetscher and Keller, 2002)</th>
<th>The criteria used for screening and for rating are well explained and their evaluation is clearly defined. However, the assessment is sensitive to the expert's judgement when choosing among the predefined possible evaluation scores for the criteria (mainly the rating criteria).</th>
<th>A predefined list of technology is used based on literature review and field validation.</th>
<th>The technology options are assembled in trains each presenting one alternative and consisting of at least one of the following elements: on-site collection, treatment, disposal and reuse, off-site conveyance, treatment, disposal and reuse (e.g. pour-flush toilet + septic tank + drain field).</th>
<th>The evaluation of criteria for screening and rating is informed by the local conditions.</th>
<th>The user requires to answer the questions based on predefined answers (mostly Boolean).</th>
<th>The software requires an expert user. But it is up to the expert if he would like to implement data collection in a participatory set-up. However, there are some concerns regarding the complexity and the transparency of the evaluation methods.</th>
<th>Technical, environmental, social, and institutional criteria are well covered. Economic criteria are dealt with in a independent module. Environmental criteria (e.g. resource recovery or losses, emissions) and helath issues get little attention.</th>
<th>The list of possible options is quite comprehensiv e (approx 25 technologies resulting in 83 predefined trains), but it cannot be expanded.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planners involved in faecal sludge management (FSM).</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td></td>
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</tbody>
</table>

Software designed to assist planners and communities in assessing the suitability of technology alternatives. The evaluation is based on two steps: (1) 20 mainly technical criteria are is used to screen for feasible alternatives; (2) a model derived from Multi-attribute Utility Technique (MAUT) uses technical, socio-cultural and institutional criteria to compare the remaining alternatives with regard to their feasibility and sustainability. Additionally, an independent costing module calculates the capital and the recurrent costs of sanitation systems.

Planners, decision makers, and communities.

<table>
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<tr>
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<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
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</table>

Systematic but not comprehensiv e, not flexible, often focusing directly at the evaluation of options with little to no guidance how to screen leading to transparency issues and the risk of eliminating options to early.
A manual for the planning and implementation of sanitation projects based on sanitation system function requirements rather than sanitation technologies. The manual is intended to create and support an open and democratic sanitation planning process and is aimed at planners and implementers at project level. The main strength is a comprehensive overview on criteria relevant for sustainable sanitation which has benefitted from many experts involved also in the development of other decision support tools (e.g. SANEX). The main weakness is the lack of information on potential solutions as well as information and guidance how to evaluate the criteria.

Practitioners active in sanitation planning (e.g. from governmental agencies, NGOs, etc.).

<table>
<thead>
<tr>
<th>N</th>
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<tbody>
<tr>
<td>A well-structured list of evaluation criteria is provided to define the local terms of requirements as a basis for identifying appropriate sanitation options. There are two blocks of criteria, the primary functions (e.g. health and environmental protection) and the practical functions (e.g. user friendliness, reliability, affordability). However, there is no guidance at all on how to evaluate these.</td>
<td>No information on the technologies to consider is provided</td>
<td>The focus is on the functionalities that a sanitation option fulfils. In order to consider local conditions, the user of the manual needs to evaluate if this functionality can be obtained given the local conditions.</td>
<td>As there is no information on how to evaluate the appropriateness of different options to the criteria outlined in the ToR, there is room to adopt an evaluation model that is able to capture uncertainty.</td>
</tr>
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Y N N Y N Y N Y
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<tr>
<th>Water and Wastewater Treatment Technologies Appropriate for Reuse (WAWTTAR) (Finney and Gearheart, 2004)</th>
<th>The WAWTTAR software is a decision support platform developed to assist planners select suitable water and wastewater treatment processes at the pre-planning phase. Suitable means appropriate to the material and manpower resource capabilities of particular countries at particular times. The motivation is to minimize system failures due to inappropriate treatment technologies and a lack of operation and maintenance. It works in a three-step procedure: first, options which are feasible given the local geographical conditions and skills and resources available for operation and maintenance are identified. Then, additional constraints such as effluent standards, public health standards, ecological standards, are used to screen for appropriate options which undergo a pre-feasibility assessment including user cost, total costs, O&amp;M and capital costs, adaptability, performance data, and environmental impact.</th>
<th>Each technology is evaluated according to a predefined set of screening and evaluation criteria.</th>
<th>The software includes a relatively large library of processes (technologies) and corresponding data. But it remains static.</th>
<th>The tool is designed to identify options which fit to the local geographical conditions as well as resources and skills available for implementation and operation and maintenance.</th>
<th>Uncertainties could only be considered using scenario analysis.</th>
<th>Only expert application.</th>
<th>Theoretically the technology appropriate to the reuse scenario could be extended, but only by the software developers.</th>
</tr>
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<tr>
<td>SANitation Choice Involving Stakeholders (SANCHIS) (van Buuren, 2010; van Buuren and Hendriksen, 2010)</td>
<td>A participatory methodology based on multi-criteria decision analysis developed by the environmental policy group at Wageningen University. It is designed to enable experts and non-expert to connect the local experience with systemic knowledge in order to generate, assess and select sustainable drainage and sanitation solution.</td>
<td>Authorities in developing countries connecting experts and non-experts.</td>
<td>Y</td>
<td>Clear screening and evaluation criteria are provided, including guidance on how to evaluate those.</td>
<td>Y</td>
<td>Supported by a database of 58 drainage and sanitation system options which is quite comprehensive but static.</td>
<td>Y</td>
</tr>
<tr>
<td>Technology selection method (TSM) (Katukiza et al., 2010)</td>
<td>A technology selection method that for the selection of appropriate sanitation solutions for urban slums. The method considers sustainability criteria, including social acceptance, technological and physical applicability, economical and institutional aspects, and the need to protect and promote human health and the environment. It consists of a two-step procedure: feasibility assessment using technical criteria and ranking using multi-criteria assessment.</td>
<td>Not clearly defined but probably most useful for planners working with urban sanitation within NGOs or governmental agencies.</td>
<td>N</td>
<td>The technical criteria for the screening step are predefined and a method how to evaluate those is also provided. However, the ranking of the feasible options is based purely on expert or N</td>
<td>A relatively small number of technologies were considered in the technology selection, based on whether they are currently used in slums or have potential for N</td>
<td>There is not a clear distinction between technology and system for the different sanitation options: some include entire systems (septic tank system) and other not (VIP).</td>
<td>Y</td>
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### Technology Applicability Framework (TAF)

(Olschewski, 2013; Olschewski and Casey, 2015)

The Technology Applicability Framework (TAF) is a decision support methodology to assess the key requirements for successful introduction of a technology in a given context. It is centered around 18 sustainability indicators in six dimensions (social, economic and financial, environmental, legal and institutional, skills and knowledge, and technological). The criteria are evaluated in a participatory process from three perspectives: (i) users/buyers, (ii) producers/providers, and (iii) regulators/investors/facilitators involving all key stakeholders (e.g., municipality and nongovernmental organizations (NGOs)). Each criterion for each dimension gets a black, red, yellow, or green score illustrating the match or mismatch to the local conditions.

<table>
<thead>
<tr>
<th>Community preferences using pairwise ranking as a multi-criteria decision analysis method.</th>
<th>Use in slum settings.</th>
<th>Technologies of for collection, off-site treatment, or reuse or disposal are not explicitly evaluated.</th>
<th>Financial capacities are not considered.</th>
<th>Members making the ranking and the availability of data.</th>
<th>Promote human health and the environment.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Y</strong> The 18 criteria are systematically evaluating each technology. But the evaluation is based on stakeholder judgement which have the potential to be badly informed or biased.</td>
<td><strong>Y</strong> Any sanitation and water technology can be tested.</td>
<td><strong>N</strong> The assessment is only at a the technology level as does not give information of the potential performance of the entire system required for service provision.</td>
<td><strong>N</strong> To some extend the uncertainties can be captured by the scores for each criteria, but the scoring is intransparent.</td>
<td><strong>Y</strong> The methodology is designed to be embedded in a participatory set-up. The minimal required participation is that all stakeholder groups provide at least one judgement for scoring of the 18 criteria.</td>
<td><strong>Y</strong> The 18 criteria cover all sustainability dimension including social, economic, environmental, legal and institutional, skills and knowledge and technological aspects.</td>
</tr>
</tbody>
</table>

### Sustainability-based Sanitation Planning Tool (SusTA)

(Nayono, 2014)

The Sustainability-based Sanitation Planning Tool (SusTA) is a methodology designed for sanitation planners in developing countries to evaluate different technology options. The aim is to enable comprehensive sustainability assessments, considering local conditions. It consists of five steps: (1) analysis of stakeholders and sanitation policy in the region, (2) distance-to-target analysis on sanitation conditions in the region, (3) examination of physical and socio-economic conditions in the project area, (4) contextualisation of the technology assessment process in the project area, and (5) sustainability-oriented technology assessment at the project level. These steps are conducted at two levels of planning – the region and the project area.

<table>
<thead>
<tr>
<th>Sanitation planners in developing countries.</th>
<th>Technology developers and all actors active in WASH service provision (e.g. NGOs and governmental agencies).</th>
<th>The methodology provides a list of criteria for feasibility and sustainability assessment as well as a guidance how to evaluate these.</th>
<th>A moderate number of technologies that have been implemented in the study region is evaluated.</th>
<th>Valid systems have to be built manually from the technology options.</th>
<th>Currently uncertainty is not considered, but could be built in.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Y</strong></td>
<td><strong>N</strong></td>
<td><strong>N</strong></td>
<td><strong>Y</strong></td>
<td><strong>Y</strong></td>
<td><strong>Y</strong></td>
</tr>
</tbody>
</table>

| Can be applied for any new water or sanitation technology. | Given the data is available, the methodology could be applied to any sanitation technology and system. | The evaluation framework compares the local requirements to the technology performance. | The evaluation framework is based on a broad literature review of sustainability criteria for sanitation. |
|---|---|---|---|---|---|
The CLARA STP (Ketema and Langergraber, 2016; Langergraber et al., 2015) simpliﬁed planning tool is an Excel-based software tool which allows the comparison of different water and sanitation systems based on their net present value. Simpliﬁed means that the software tool is based on numbers of simplifying assumptions, which allow the planner to use the SPT with the limited amount of data available at the pre-planning stage of a project. Due to the resulting error the water and sanitation systems which will be compared using the SPT have to be fundamentally different, as minor differences will not result in a signiﬁcantly different NPV.

Information packages

| WSP Guidebook (WSP, 2007) | The aim of this source book is to ﬁll in the gap in knowledge and experience among policy-makers and the handful of sanitation practitioners both at national and local level on strategic sanitation planning and alternative options for sanitation, wastewater collection, and treatment and their relative performance. Information about sanitation and wastewater management, as well as about the considerations related to planning for sanitation projects in different types of environment are provided. It distils some of the core concepts of sanitation in a user-friendly format so that the book can serve as a practical reference to sanitation professionals and investment decision-makers, particularly the local governments. It suggests to organise decision making in a two-step iterative process considering restricting variables (e.g. available water supply) and inﬂuencing technical (e.g. compliance with standards) and demand variables (e.g. willingness to pay). It also presents 5 typiﬁed community and enterprise proﬁles. | N | Y | Y | Y | N | N | Y | Y | Y | Y | Comprehensiv e but not systematic, not ﬂexible |}

| Planners involved in urban sanitation. | Y | Even though only costs are compared, the comparison is straightforward and transparent. | Y | A for the time of the publication data quite catalogue of technology options is provided. | Y | The cost evaluation is contextualized by using local market prices for informing the cost functions. | Y | The cost estimation can work with data available at the pre-planning phase. But the uncertainty cannot be considered explicitly. | N | The tool is meant for a purely expert assessment. However, the resulting cost data can be used in any participatory planning framework using e.g. multi-criteria decision analysis. | N | Only costs are evaluated and compares. | N | The technology library can be extended but requires important amounts of additional data and programming efforts. |}

| Excel-based software tool which allows the comparison of different water and sanitation systems based on their net present value. | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | Comprehensiv e but not systematic, not ﬂexible |}
The Compendium is a guidance document for engineers and planners in low- and middle-income countries, primarily intended to be used for communicative planning processes involving local communities and facilitating an informed choice. It provides a huge range of information on established and “improved” sanitation technologies and systems including the whole range of urban, peri-urban and rural options without bias and/or agenda, it is divided into two parts: (1) the System Templates and a description about how to use them; and (2) the Technology Information Sheets. Thereby it helps to increase the recognition that a fully functioning sanitation ‘chain’ must link toilets to a treatment facility via an operational collection and transportation system. In recent years, the Compendium has become the most popular technical compilation in the sanitation sector and is widely acclaimed by a large audience as an international reference tool.

### Compendium (Tilley et al., 2014)

| Y | The selection of an appropriate sanitation chain and the corresponding technologies are based on clearly explained criteria which can be evaluated using the questions provided by the guide. |
| Y | The list of technologies covers a broad range of available technology options at the time of publication. |
| Y | The list of technologies covers a broad range of available technology options at the time of publication. |
| N | Only three types of systems are considered. There is no room hybrid or combined systems. |
| N | The guide is targeted to decision makers and many of the evaluation criteria (e.g. ‘acceptance’) are predefined for the technologies (e.g. ‘high’/’low’) and not matched with local preferences or demand. |
| N | The evaluation of technologies is based on mainly technical, physical, and economic and financial criteria. User acceptance is partly covered, environmental protection or level of health protection are not considered. |

A methodology guide as support to the CMS framework with the aim to assist local decision-makers and technicians in the choice of sanitation technologies best suited to their local authority in sub-Saharan Africa. It contains a three steps procedure for the selection of an appropriate technology option (characterizing the town, determining a sanitation chain, selecting appropriate technologies) and a compilation of factsheets on the technologies. The three sanitation chains suggested are: on-site sanitation, small-piped sewerage, and conventional sewerage.

### Pros and cons

| N | What are the advantages and disadvantages of the procedure? |
| N | The statement made about potential appropriateness of technology are static and based on expert judgement. |
| N | The information compilation provides a good information package that can be used for capacity development of local experts and non-experts, enabling them to take a more active role in the planning process. |
| N | The technology library can be extended with a reasonable effort. |

Local authorities, national and decentralized technical departments, local stakeholders (NGOs, engineering firms), as well as development partners

### Evidence based decision making

| N | The concept of technology matrix and the concept of technology chain are recognized by the development community. |
| N | Some systematic evaluation and therefore no consideration of uncertainty. The statement on potential appropriateness of technology are static and based on expert judgement. |
| N | Some systematic evaluation but different aspects are explained. |

| N | The evaluation of technologies is based on mainly technical, physical, and economic and financial criteria. User acceptance is partly covered, environmental protection or level of health protection are not considered. |
| N | Even though the technology library could be extended, the three possible types of systems are static. |

**The selection**

Monvois et al., 2012

Information Sheets on the technologies. The three sanitation chains suggested are: on-site sanitation, small-piped sewerage, and conventional sewerage.
References

Eawag, 2005. Household-Centred Environmental Sanitation
Implementing the Bellagio Principles in Urban Environmental Sanitation - Provisional Guideline for Decision Makers. Swiss Federal Institute of Aquatic Science and Technology (Eawag), Dübendorf.


Franceys, R., Shaw, R., Davey, K., 2013. Poster 021: A guide to sanitation selection. Water, Engineering and Development Centre (WEDC), Loughborough University, UK.


Monvois, J., Gabert, J., Frenoux, C.m., Guillaume, M., 2012. How to select appropriate technical solutions for sanitation. Concerted Municipal Strategies (CMS), a program coordinated by the Municipal Development Partnership (MDP) and programme Solidarité Eau (pS-Eau).


