Analytical Framework and Management Strategy for Large-Scale Sustainable Sanitation

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Abstract

The aim of this research is to provide a professional management strategy for large-scale sustainable sanitation. I have examined four questions: What is a suitable management strategy for large-scale sustainable sanitation? What are the key factors to assess management needs in a sanitation system and the impact of the strategy implemented? How can the strategy be used for decision making and planning? How can the strategy be applied in real projects?

Sustainable sanitation is one of the biggest challenges in the world today. In 2015 one third of the world population lacked access to adequate sanitation. Access, however, does not necessarily mean sustainable sanitation. The challenge is complex and inter-sectoral. Technologies are available but many countries lack the necessary management capacity and supportive institutional framework. Development projects are too often unbalanced, focusing on infrastructure and disregarding management support and institutional development. Research has focused on technology, decision support and management aspects, including sustainability criteria. But it lacks strategies that include the key management aspects of sustainable sanitation.

I carried out this research using a transdisciplinary approach integrating science and practice as well as different disciplines including engineering and economics. I planned and monitored the research using guiding principles and a logical framework. Methods included literature analyses and strategy, scorecard, tool, and case study development.

The results of this research are fourfold. *Result 1* is a management strategy with 10 key actions related to the institutional framework, organisation, technology and users. It is based on a new view of sustainable sanitation. *Result 2* operationalises the strategy with an analytical assessment framework consisting of 30 indicators and 120 rating criteria. These are the basis of a scorecard that is implemented as a software tool in *Result 3*. This tool enables informed experts to quickly assess, implement, and monitor management needs and interventions in a system or project. *Result 4* is a case study for a semi-arid Middle Eastern region. I used this case study to test and refine the strategy and tool and to illustrate their application. The study includes a professional implementation concept.

The results suggest that management strategy supports large-scale sustainable sanitation. The management needs assessment can be integrated into early stages of project planning. The strategy, when introduced within a project and used in daily operation, helps create professional management and a supportive institutional framework. Recommendations for further research include applying this strategy to further case studies for better validation, developing further indicators, conducting studies on strategy implementation and monitoring as well as integrating this strategy with other strategies such as financing and infrastructure strategies.

Contents

Symbols and abbreviations

€	Euro
AWW	Institut für Abwasserwirtschaft und Gewässerschutz, Institute of Wastewater Management and Water Protection
billion	10^9
BMBF	Bundesministerium für Bildung und Forschung; Federal Ministry of Education and Research, Germany
COD	Chemical oxygen demand
CRM	Customer relations management
d	Day
DWA	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall; German Association for Water, Wastewater and Waste
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
GFA	GFA Consulting Group
GFEU	Gesellschaft zur Förderung und Entwicklung der Umwelttechnologien, Society for the promotion and development of environmental technologies
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit; German technical cooperation, formerly GTZ
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit, German technical cooperation
h	Hour
HR	Human resources
HRD	Human resource development
HRM	Human resource management
I	Indicator
IPSWaT	International Postgraduate Studies in Water Technologies
IWA	International Water Association
IWRM	Integrated water resources management
JMP	WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation
K	Potassium
KA	Key Action
kg	Kilogramme
km^2	Square kilometre
LFA	Logical Framework Approach
M	Milestone
m^3	Cubic metre
MDG	Millennium Development Goals
MIS	Management information system

N	Nitrogen
NETSSAF	Network for the development of Sustainable Approaches for large scale implementation of Sanitation in Africa
NGOs	Non-governmental organisations
No.	Number
O&M	Operation and maintenance
OECD	Organisation for Economic Co-operation and Development
p	Person, population
P	Phosphorus, project phase
PE	Population equivalent
PI(s)	Performance indicator(s)
SDG	Sustainable Development Goals
SuSanA	Sustainable Sanitation Alliance
SWOT	Strengths, weaknesses, opportunities and threats
Syria	Syrian Arab Republic
TA	Technical assistance
TUHH	Technische Universität Hamburg-Harburg, Hamburg University of Technology
UFW	Unaccounted for water
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
US$	US dollar
w/	With
w/o	Without
WHO	World Health Organization
WWAP	United Nations World Water Assessment Programme
WWTP(s)	Wastewater treatment plant(s)

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1 Introduction

The introduction consists of six parts. The first part is a rationale which describes the context and importance of the research topic and identifies the research problem. The next parts describe the research objectives and planned approach as well as the target group, opportunities and limitations of this work. The last two parts explain key terms and the structure of this dissertation.

1.1 Rationale

The provision of sustainable sanitation is one of the biggest challenges in the world today. *Sustainable management* is thereby seen as being increasingly important. The challenge is diverse and closely related to water supply and other sectors including health, food, energy as well as urban and rural development. It must thus be tackled in a multidisciplinary way, taking advantage of integrated and innovative approaches. UN-Water, the United Nations (UN) coordination mechanism for water and sanitation, concludes from the International Decade for Action “Water for Life”, 2005-2015, that despite extensive global adoption of integrated water management approaches (UN-Water Decade Programme on Capacity Development 2015):

> “Improved knowledge, research, innovation and implementation towards much more productive and sustainable use of water, especially for food and energy, will be required ...”

This also relates to sanitation which makes a big contribution to better water use. Systems and technologies for sanitation are available for most conditions. However, many projects lack adequate planning and design, and financing but also institutional development, and management support that goes beyond technical training. Furthermore, there is too little support in helping the non-conventional to prevail over the conventional solutions, particularly in large-scale implementation, considering that new and innovative approaches and technologies are usually applied in small-scale pilot projects. To scale up successful pilot projects for innovative systems, as well as successful conventional systems, professional management strategies are missing.

The absence of such strategies has led to the non-consideration of important management aspects and failures in sanitation projects. The strategies must thereby consider not only the normal requirements of operation such as financing, human resources (HR) and customer satisfaction but also the special aspects of new systems such as reuse, marketing and required user awareness. Strategies must allow for both establishing new and improving existing systems, amongst others, by integrating innovative projects and initiatives. Strategies must also support institutional development to create legal requirements and enable and promote the dissemination of innovations.

1.1.1 Sanitation challenges

According to the WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation (JMP) of the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), 2.4 billion people, or one third of the world population, had no access to adequate sanitation facilities in 2015 (UNICEF and WHO 2015). Access to sanitation, however, does not always mean proper treatment of wastewater (see Challenges 1 and 4, and Section 1.1.2). This and other shortcomings bring huge problems for the environment, economy and people, in particular for human health. On the other side improved sanitation has a huge potential. Prüss-Üstün *et al.* (2008) estimated that worldwide, improving water, sanitation and hygiene have the potential to prevent at least 9.1% of the disease burden, or 6.3% of all deaths.

National and international organisations acknowledge the critical situation and the central role of sanitation and are trying to tackle it. With the end of the UN Water Decade and the expiry of the Millennium Development Goals (MDG; the sanitation target has been missed, see below) international action continues (UN General Assembly 2014b; UN 2015; UN-Water Decade Programme on Capacity Development 2015). In 2015, as part of a post-2015 sustainable development agenda the UN General Assembly (2015) adopted a new set of Sustainable Development Goals (SDG) developed by an open working group (UN General Assembly 2014a). These new goals build on the MDG and make sanitation even more important.

The most sanitation-related SDG is Goal 6 (UN General Assembly 2015):

> "Ensure availability and sustainable management of water and sanitation for all."

In addition to the previous goal of improving the availability of sanitation entitled as "access to improved sanitation" (UN 2015), *sustainable management* moves into focus. And there are other specific targets, e.g., by 2030, to end open defecation, improve water quality amongst others by halving the proportion of untreated wastewater and increasing recycling and safe reuse, as well as to expand international cooperation and capacity building support to developing countries (UN General Assembly 2015). However, considering the slow progress in improvements over past years, it is likely that sustainable sanitation will remain a global challenge in the future.

I summarise five general challenges of sanitation that are relevant to many regions:

1. Low sanitation coverage;
2. Population growth, urbanisation and informal settling;
3. Pressure on water supply, energy and food security;
4. Heavy pollution of the environment;
5. High incidence of illnesses and diseases.

Challenge 1: Low sanitation coverage. UNICEF and WHO (2015) reported that, in 2015, 68% of the global population used improved sanitation facilities while 2.4 billion people, or one third of the population, had no access to it. The term *improved* thereby stands for a minimum standard of service as defined by the JMP (see Table 1.1). Moreover, 82% of the global urban population and 51% of the rural population used improved sanitation; and 946 million people, nearly 40% of the population without improved sanitation, practiced open defecation. Considering that in developing countries only a small part of the wastewater is treated centrally, e.g. less than 10% in urban areas of Indonesia and Vietnam (World Bank 2015), sanitation is mainly based on on-site facilities, whose function is, however, often questioned (see Section 1.1.2).

While 2.1 billion people had gained access to improved sanitation since 1990, the findings of UNICEF and WHO (2015) make it clear that the MDG target for sanitation has been missed. By 2014, 95 countries had met the sanitation target; out of the developing regions only the Caucasus and Central Asia, Eastern Asia, Northern Africa and Western Asia. The least developed countries did not meet the target. Figure 1.1 illustrates the proportion of the population using improved facilities in 2015. Highlighted in black are countries, areas or territories, in which less than 50% of the population used improved sanitation. Nearly all developed countries had sanitation coverage while in developing countries the coverage varied widely. Since 1990, the No. of countries with less than 50% of the population using improved sanitation has declined, from 54 to 47. Countries with the lowest coverage are now mainly found in Sub-Saharan Africa and Southern Asia. Some reported data were insufficient or not applicable in 2015; but it can be traced with interactive maps of WHO and UNICEF (2016) which indicated, e.g. that coverage in Sudan was about 24% in 2014, and in Yemen about 53% in 2012.

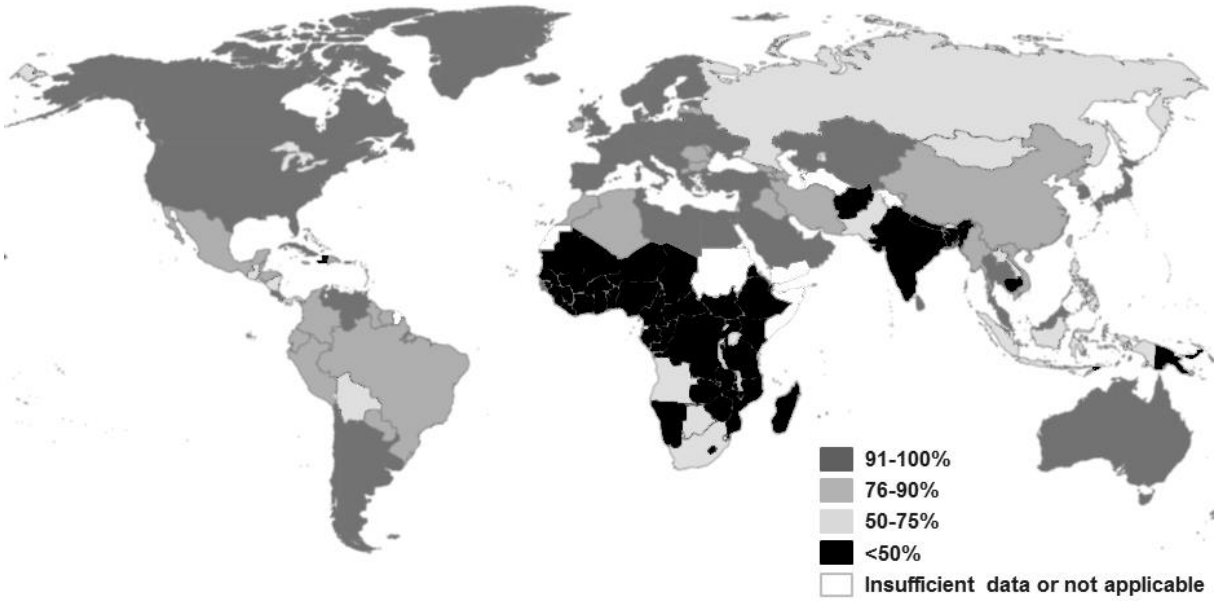


Figure 1.1: Sanitation coverage by country, area or territory in 2015 (UNICEF and WHO 2015, modified)

Despite the enormous challenges for sanitation in urban and peri-urban areas (see Challenge 2); rural sanitation remains a big task. According to UNICEF and WHO (2015), 70% of the global population without improved sanitation lived in rural areas including 90% of all people practising open defecation.

A major concern of rural and sparsely populated areas is the implementation as well as operation and maintenance (O&M) of conventional sewerage systems which often get extremely costly and do not meet the capacity of local service providers. Where such a system is present the performance of wastewater treatment is often insufficient or there is no wastewater treatment plant (WWTP) at all, while the collected wastewater is discharged without treatment (see Section 1.1.2). However, service areas with conventional sewerage systems are usually considered urban in developing countries as the presence of a sewer or another major facility is already a sign of an urban area; e.g. in Zambia where a new water supply facility automatically belongs to the urban water supply system (H. Heidtmann, personal communication, 3 February 2016).

But there are also other reasons for infrastructure failure in both rural and urban systems. UN-Water (2015), based on Hawkins *et al.* (2013) who concluded from the JMP and other analyses, highlighted broken pumping stations, sewer leakages and non-functioning WWTPs and related it to financing of O&M, and a lack of capacity at local service providers.

Non-conventional sanitation (see Section 1.1.2), often decentral, can be more appropriate. However, the implementation of such systems is often limited to small-scale projects. Many planners, financiers and decision-makers lack the necessary knowledge and experience to adopt new approaches, or the new approaches or technologies are not state of the art which is usually a requirement for large investments. In addition, users' awareness of and willingness to use toilets, change behaviour or participate in related projects can be low. Kristensen (2008) showed in a case study in Malaysia that users must be involved when implementing composting toilets to ensure willingness and participation. Tilley (2015) showed in a case study in South Africa that cash transfers helped increasing use and acceptance of urine-diverting dry-toilets where other approaches failed to change behaviour.

UNICEF and WHO (2015) define improved sanitation as hygienically separating human excreta from human contact and include facilities that are neither public nor shared with other households (see Table 1.1). However, the definition of improved sanitation and so also the accuracy of data reported are subject to debate. Some argue that the actual No. of unserved people is much higher, others are more optimistic for some regions.

Table 1.1: Classification of improved and unimproved sanitation by the JMP (UNICEF and WHO 2015, modified)

Improved sanitation	Unimproved sanitation
Improved sanitation facilities likely to ensure hygienic separation of human excreta from human contact and not shared or not public, including: • flush or pour flush to piped sewer system, septic tank or pit latrine; • ventilated improved pit latrine; • pit latrine with slab; • composting toilet.	*Shared sanitation facilities* of an otherwise acceptable type shared between two or more households. *Unimproved sanitation facilities* not ensuring hygienic separation of human excreta from human contact, including: • pit latrines without a slab or platform, • hanging latrines, • bucket latrines. *Open defecation*, when human faeces are disposed of in fields, forest, bushes, open bodies of water, beaches or other open spaces, or disposed of with solid waste.

In addition to the JMP, several other initiatives of the UN and cooperating organisations report on the status of sanitation at a global and regional level (Faures 2006). However, monitoring and reporting is difficult especially at a global level. On the one hand it is difficult to determine the exact *status quo* in all countries as data is limited in many regions (UNICEF and WHO 2015). On the other hand advancements of individual programmes and initiatives and verification of effectively implemented sanitation projects remain hidden or inexact. So the accuracy of data for monitoring the status in sanitation was subject to debate (Lenton *et al.* 2005; IWA 2006; Schäfer *et al.* 2007; Stockholm Environment Institute 2008; Baum *et al.* 2013). The debate reached the consensus that the real situation of sanitation coverage differs from the situation shown by many reports. Some found that in some regions the challenge to raise coverage is much higher than officially argued (e.g. Schäfer *et al.* 2007). Others draw a more optimistic scenario, e.g. arguing that the improved sanitation target of the former MDG can be achieved more quickly (Rosemarin *et al.* 2008; Stockholm Environment Institute 2008). However, it is also consensus that the challenges in sanitation are huge despite efforts and they are still growing especially in the less and the least developed countries. The key challenge is seen not only to be the provision of sanitation to meet coverage targets but also to ensure that “improved sanitation is sustainable” (Stockholm Environment Institute 2008).

The JMP classification of improved sanitation facilities does thereby not fulfil all technical and hygienic requirements to consider it sustainable. Conventional pit latrines widely fail to sanitise and hence contribute to groundwater pollution (Franceys *et al.* 1992; Esrey *et al.* 1998). Pit latrines alone, however, serve a very large No. of people thus causing environmental pollution and a high incidence of illnesses and diseases (EcoSanRes 2008b). Furthermore, many septic systems and WWTPs discharge wastewater into the environment with little or no sanitisation or nutrient removal (Lange and Otterpohl 2000, and others). Baum *et al.* (2013) estimated that there is a

significant lack of wastewater treatment worldwide, in addition to low coverage in developing countries. These and other limitations to sanitation systems considered *improved* by the JMP means that, in reality, less people have access to sanitation which is contrary to many reports.

UNICEF and WHO (2015) stated that during the MDG period, the amount and quality of information on the use of sanitation facilities has improved dramatically and the classification of the terms improved and unimproved has been refined. They consider the classification as a valuable indicator that is widely applicable referring to its increasing citation in press, research and industry. Bartram *et al.* (2014) considered international monitoring to facilitate the achievements of the MDG targets. However, UNICEF and WHO (2015) as well as Bartram *et al.* (2014) have been acknowledging the limitations in monitoring. Bartram *et al.* (2014) thereby called for improved statistical methods. The UN Department of Economic and Social Affairs (2015) called to generally developing monitoring systems through new approaches of monitoring sustainable development progress, which also relates to sanitation.

The debate on monitoring and accuracy of data indicates that the real numbers of people without access to sanitation probably differs from those reported and cited here. But the general picture and necessary direction of development becomes clear. Bartram *et al.* (2014) argued that international monitoring shapes the awareness of needs and calls on policy to act. In this sense I used the data in this research.

Challenge 2: Population growth, urbanisation and informal settling. According to the UN Department of Economic and Social Affairs, Population Division (2015a) the global population reached 7.3 billion in 2015. Sixty per cent of the population lives in Asia (4.4 billion), 16% in Africa (1.2 billion), 10% in Europe (738 million), 9% in Latin America and the Caribbean (634 million), and 5% in Northern America (358 million) and Oceania (39 million). The two largest countries are China (1.4 billion) and India (1.3 billion); they represent 19% and 18% of the global population, respectively. The global population is growing by 1.18% (83 million) per year which is slower than in the recent past. It is projected to reach 8.5 billion in 2030, 9.7 billion in 2050 and 11.2 billion by 2100. The fastest growing area is Africa with more than half of the global population growth expected between 2015 and 2050, or an addition of 1.3 billion out of the extra 2.4 billion people projected globally.

Population growth is a huge challenge for sanitation in many developing countries. In Oceania and Sub-Saharan Africa population growth surpassed increases in sanitation coverage between 1990 and 2015, especially in urban areas (UNICEF and WHO 2015). Urbanisation, characterised by rapidly growing cities and increasing informal settling in many developing countries, brings additional problems to the installation of new and rehabilitation of old infrastructure. In 1900, less than 15% of the global population (220 million) lived in cities (UN Population Fund 2007). Since 2007, more

people live in urban than rural areas, in 2014, 54% (3.9 billion) of the global population according to the UN Department of Economic and Social Affairs, Population Division (2015b). The division expects further increase it to about 60% (5 billion) by 2030 and 66% (6.3 billion) by 2050.

Figure 1.2 illustrates the development of the global urban and rural population between 1950 and 2014, and the projections until 2050.

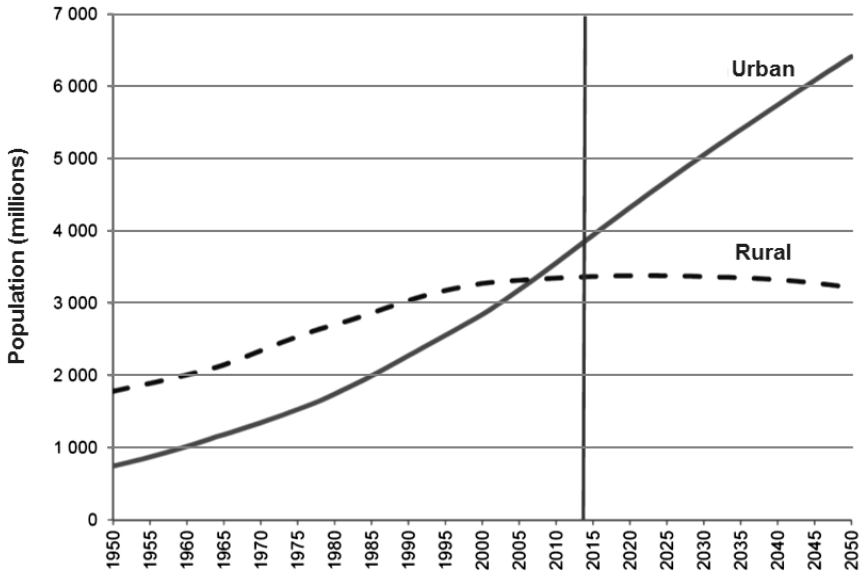


Figure 1.2: Urban and rural population worldwide 1950-2015 (UN Department of Economic and Social Affairs, Population Division 2015b; modified)

In 2015, 82% of the global urban population, and 51% of the global rural population used improved sanitation facilities (UNICEF and WHO 2015). Although the proportion of the poor urban population served with improved sanitation is not clearly determined (see below) global statistics confirm general trends. The UN Population Fund (2007) expected the urban centres in developing countries comprise to 80% by 2030.

Megacities, however, create a tremendous demand for sanitation infrastructure, and act as concentrated sources of pollution. Migration and industrialisation along with more production and consumption, all generating increasing demands for water, contribute to that and could increase pollution dramatically (Connor *et al.* 2015). Furthermore, with urbanisation world's cities get increasingly informal, especially in developing countries. Poor people mostly live in fast-growing informal urban and peri-urban settlements where sanitation coverage is particularly low (Schäfer *et al.* 2007). The UN Human Settlements Programme (2003) estimated that in 2010, more than 50% of the global population lived in slums, after a steady increase from 29% in 1950 to 47% in 2000. Connor *et al.* (2015) assumed that 30% of all city inhabitants lived in slums in 2015 but now city inhabitants represent more than half of the world's population (see Figure 1.2). Although the estimations vary, taking into account present

gaps in urban sanitation coverage and general development of urban settling indicates that more innovative approaches for sanitation are required to accelerate supply. This is also shown in practice, e.g. by Blume *et al.* (2015).

On the contrary some developed countries are characterised by declining population trends. These developments bring other problems for sanitation. For example in Germany, sanitation utilities (often operating central systems in sparsely populated rural areas) are exposed to changes of legal, technical and economic frameworks, and significant inhabitant-specific cost increases (Tränckner *et al.* 2014; see also DWA 2014). Such changes require the further adaptation of the existing systems.

Challenge 3: Pressure on water supply, energy and food security. For many countries, particularly developing countries, limited, often decreasing available and usable water resources are a major challenge being regularly reflected in the UN World Water Development Reports (WWAP 2006, 2009, 2012, 2014, 2015). The scarcity of water resources brings, on the one hand, water-born sewage systems to their technical limits and therefore disfunction and on the other hand water supply, energy as well as agriculture and food security are put under pressure.

It is regularly estimated that agriculture accounts for about 70% of the global freshwater withdrawals (World Resources Institute *et al.* 1998; Turner *et al.* 2004; Connor *et al.* 2009; FAO 2011; Faurès *et al.* 2012; Connor and Webber 2014); about 20% is demanded by industry and 10% by the municipal sector (FAO 2011, reporting 19% and 11%, respectively; Connor and Webber 2014). In low-income countries agriculture demands about 90% and in the least-developed countries even 94% of the total freshwater withdrawals (FAO 2011). Often, water balances are negative which implies that a growing population and economic development leads to increased water scarcity. Unauthorised but increasing exploitation of aquifers for irrigation has a great negative impact on reliable domestic and industrial water services. Moreover, the impact of resources depletion is caused by a rapid development of irrigated agriculture. The over-extraction of water for agriculture and industry causes water tables to sink and threatens the sustainability of water resources. Pressure on agriculture and food security is thus not only increasing by the consequences of periodic natural disasters such as floods and droughts, but also by water shortage. The overuse of water resources by agriculture and the need for food security are thereby directly related.

Addams *et al.* (2009) have assessed a worldwide gap between supply and demand for raw water of 60% (about 1.4 billion m^3) by 2030 considering an increase in supply under business-as-usual of 20% and historical improvements in water productivity of 20% (see Figure 1.3). Business-as-usual in water and sanitation industry will thus not meet the demand for water. A shift in thinking to new approaches and technologies allowing for reuse of valuable resources is necessary, and sustainable sanitation can significantly contribute to that.

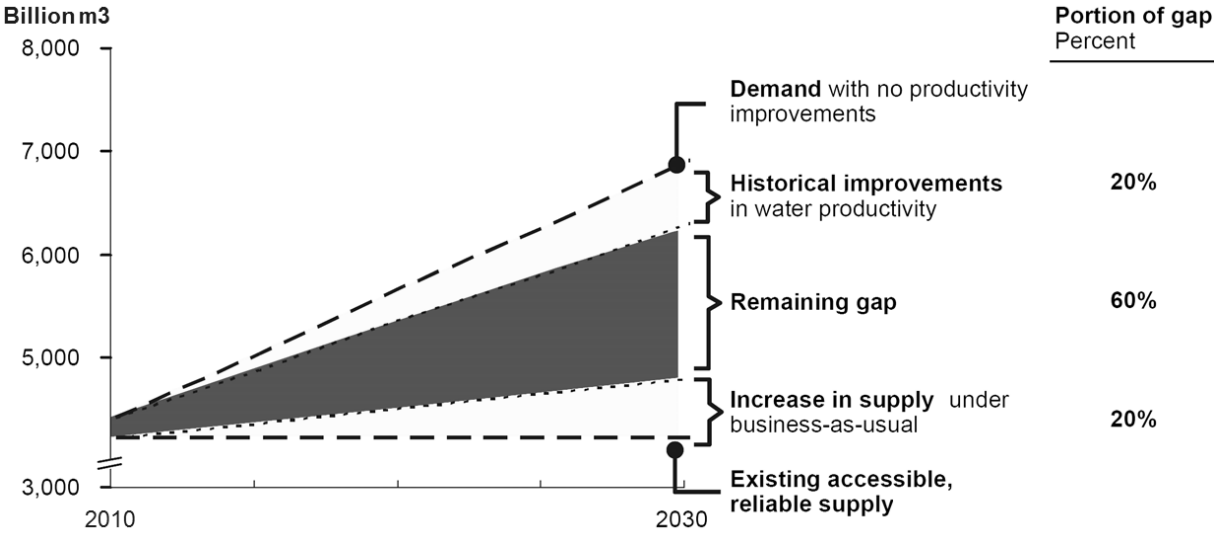


Figure 1.3: Supply and demand with raw water 2010, and estimated development until 2030 (Addams *et al.* 2009, modified)

Furthermore, sanitation is related to the challenge of sustainable energy supply. Lazarova *et al.* (2012) showed that water and energy are closely related; water and wastewater treatment needs energy, and energy production needs water. The authors showed also that reusing wastewater and closing water and energy cycles significantly contribute to reducing resources which is important especially in urban areas. Frostell and Song (2014) developed a systems perspective on water-energy efficiency which includes sanitation. Skambraks *et al.* (2014) demonstrated how an integrated sanitation system enables energy production in an urban setting in Hamburg, Germany.

Especially conventional sewerage sanitation systems require a reliable energy supply of pumping stations and WWTPs. In Zimbabwe, e.g., the absence of an adequate energy supply was the reason that untreated wastewater has been discharged into the environment which led to the outbreak of a cholera epidemic (H. Heidtmann, personal communication, 3 February 2016).

The relation of water and energy is also acknowledged in international politics. The UN Office of the President of the General Assembly (2014) highlighted that the use of water for energy production can impact freshwater resources affecting both their availability and their quality. Connor (2015) stated for the WWAP that as energy production depends on water, meeting demands for energy will generate increasing stress on freshwater resources with repercussions on other users such as agriculture and industry. The WWAP as well as other programmes thus called for more joint approaches when developing sanitation and related sectors such as water, energy and food. The programme also highlighted the role of sanitation for an effective management of water resources and reduction of water pollution. Sanitation systems can thereby generate energy; treated wastewater can be reused, thus again contributing

to water, energy and food security. Furthermore, the programme considered on-site sanitations as a challenge as well as an opportunity. Avoiding extensive sewer systems would lead to investment savings and allow for more innovative and decentralised system options that are less water and energy intensive, assuming a proper management of faecal sludge that avoids health risks and pollution. Also alternative approaches, e.g. Terra Preta sanitation (see Section 1.1.2), have more potential.

On the other hand, lack of nutrients and other resources increases pressure on agriculture thus food security. Soil quality and nutrients are major obstacles (WHO 2002; Rockström *et al.* 2005; Skoet and Stamoulis 2006; Gensch *et al.* 2012). Essential, but limited resources bonded to wastewater, e.g. phosphorus (P), potassium (K) or sulphur run short at global level (Steen 1998; Jönsson 2002; Gumbo 2005; Stark 2005; Tidåker 2007; EcoSanRes 2008a; Cordell *et al.* 2009; Cordell 2010; Cordell and White 2011). In conventional sanitation concepts these valuable resources are often discharged with mixed sewage. New sanitation systems allow for sorting wastewater and treating it to reuse the resources as soil conditioner and fertiliser (see Section 1.1.2).

Challenge 4: Heavy pollution of the environment. The UN-Water Decade Programme on Capacity Development (2015) concluded from the Water for Life Decade 2005-2015 that there is an urgent need to improve the global freshwater quality by reducing water pollution and improving wastewater reuse. Despite advances in science and technology as well as large efforts to expand and improve sanitation infrastructure, only a small proportion of wastewater is treated properly worldwide. The result is heavy pollution of the land and aquatic environment, besides the other problems described in this section.

It is widely estimated that 80% of the wastewater worldwide is not collected or properly treated (UN-Water 2015; Connor and Webber 2014, all based on the WWAP 2012, based on Corcoran *et al.* 2010). Further since 1997, researchers and practitioners including politicians, estimate that about 90% of wastewater in developing countries is discharged to the environment untreated or inadequately treated (Kjellén and McGranahan 1997; UN Economic and Social Council 1997; Hinrichsen *et al.* 1998; World Resources Institute *et al.* 1998; Revenga *et al.* 2000; Johnson *et al.* 2001; UN Department of Public Information 2002; Graßl *et al.* 2004; UN 2005; UNEP Finance Initiative and Stockholm International Water Institute 2005; Water Supply and Sanitation Collaborative Council 2008). The UN Department of Public Information (2002) thereby stated that 70% of the industrial waste in developing countries is discharged without treatment burdening the environment. The German Bundestag (2008) stated that 90-95% of all sewage from industry and households worldwide, not only developing countries, is discharged untreated.

Satoa *et al.* (2013) highlighted that the capacity of treatment depends on the income level of a country. The authors reported average wastewater treatment ratios of 70% in high-income countries, 38% in upper-middle-income countries, 28% in lower-middle-income countries and only 8% in low-income countries. They thereby noted that data availability on wastewater generation, treatment and use needs to be improved. Baum *et al.* (2013), cited in UN-Water (2015), estimated treatment ratios of 79%, 14%, 2% and nearly 0%, respectively in high, upper-middle, lower-middle and low-income countries (see Section 1.1.2).

Figure 1.4 illustrates the ratio of treated to untreated wastewater discharge for 10 regions, source 2004. The figure indicates that discharge of untreated wastewater is significantly higher in developing regions than in developed regions. Population growth and slow progress in installing and improving sanitation systems and services indicate that pollution will remain a challenge, especially in developing countries.

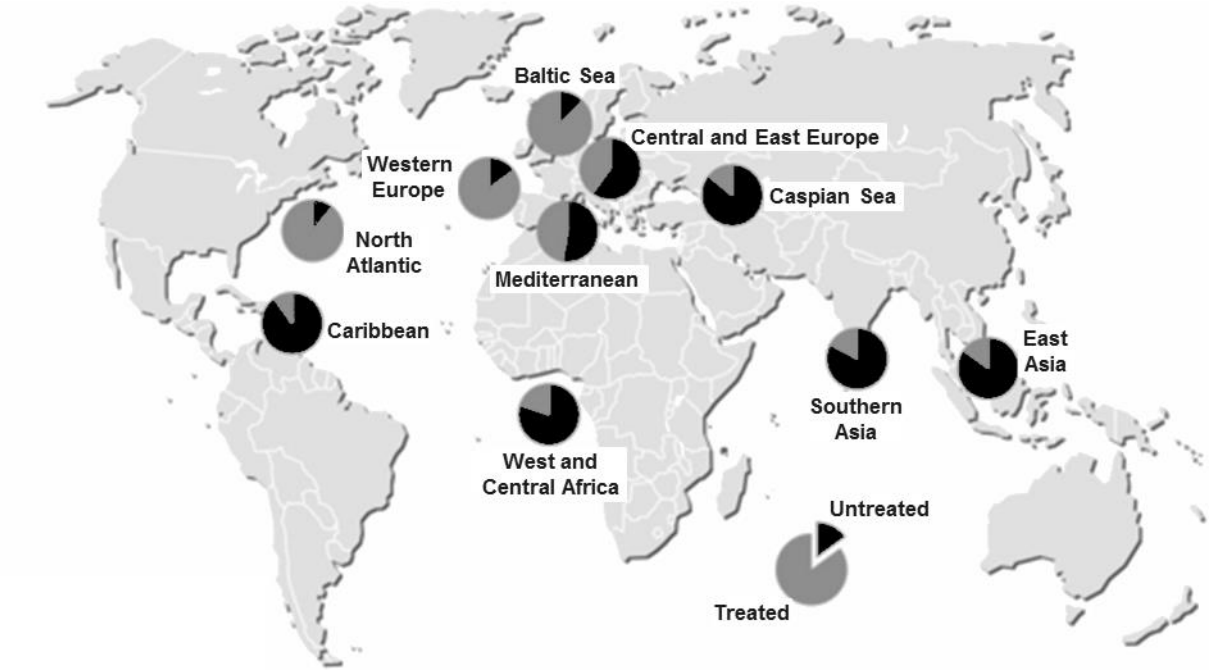


Figure 1.4: Ratio of wastewater treatment for 10 regions (UNEP/GRID-Arendal and Ahlenius 2010, adapted from Ahlenius and UNEP/GRID-Arendal 2008, based on UNEP 2004; modified)

The estimated treatment ratios of only 70-79% in high-income countries indicate that the situation in many developed countries is also critical. In 1995, only 30% of the wastewater from Mediterranean coastal towns in the European Union has been treated in any way before being discharged to the sea (European Environment Agency 1995). In 2002, out of 542 cities in the European Union with more than 150,000 inhabitants, 37 cities discharged all wastewater into the environment without treatment; 72 cities discharged most of their wastewater without or after inadequate treatment (Owen 2002). And even where wastewater is treated, the treatment processes are not always designed to reduce nutrients but rather to reduce organic matter which contributes to biological oxygen demand in secondary treatment (Selman *et*

al. 2008). Such a process is not effective in removing N and P; moreover, the nutrient content of effluents is high. Matsui (2002) estimated that only 30% of the world's sewage systems had secondary or better treatment.

And even where the quality of water resources has been significantly improved by the use of modern WWTPs, specific ingredients remain sources of pollution e.g. pharmaceutical residues (Winker *et al.* 2008; Winker 2009; Hillenbrand *et al.* 2014; Umweltbundesamt 2015). The European Environment Agency (2015) reported that the water quality has generally improved in Europe, but that the nutrient load of water bodies remains a problem.

The discharge of untreated or inadequately treated wastewater implies heavy pollution of rivers, lakes, and coastal areas causing health problems and lost development opportunities in affected areas as well as ecosystem degradation. Untreated domestic wastewater is thereby the main source of environmental pollution especially in coastal marine environments (Bijlsma *et al.* 2000). In 2004, over 70% of coral reefs were affected by discharges of untreated sewage (UN Governing Council of the UNEP 2004). Problems occur from the concentrated discharge of large amounts of human excreta in limited areas, e.g. from sewer outlets, disposal sites or beaches which people use as a toilet. But there are further sources of pollution. Selman and Greenhalgh (2009) expected the drivers of eutrophication to increase, including energy consumption, intensive agriculture and land use conversion, and pressure on productive capacity of agriculture and industry due to population growth. In addition untreated industrial waste is a big source of pollution. While in many developed countries pre-treatment requirements for industrial waste limit pollution, in developing countries an estimated 70% of the industrial waste reach water resources untreated (WWAP n.d.).

The deterioration of natural resources such as coral reefs, surface and groundwater sources leads to decreasing biodiversity, limited possibilities for fishing and agriculture and poor water quality. These limitations have significant economic impact on tourism, fisheries and other industries sensitive to environmental pollution. The result is not only a loss of income for people but also of capital values, e.g. through sinking real estate values in polluted areas. Furthermore, the high cost of interventions and water treatment arise and a not yet considered huge economic cost resulting from illnesses and diseases and their treatment (see Challenge 5). But also life and perspectives of the rural population are affected. In most rural areas of developing countries, the population are farmers; and their livelihoods and quality of life depend very much on the environment. The World Resources Institute *et al.* (2005) assessed that income derived from ecosystems is especially important to economic development of the rural poor population. Environmental protection is thus a key factor in influencing the quality of life.

Challenge 5: High incidence of illnesses and diseases. The influence of adequate sanitation on health is acknowledged by a large No. of medical experts who considered “the sanitation revolution as the greatest medical advance since 1840” (Ferriman 2007). Lack of adequate sanitation, however, significantly contributes to a high incidence of illnesses and diseases, along with environmental pollution, poor hygienic conditions and inappropriate drinking water supply. While unimproved toilets cause direct health risks, unimproved sanitation systems cause direct and indirect health risks. Untreated human excreta pollute water resources, thus maintaining a cycle of human disease and pollution of the environment by nutrient overloading and eutrophication. The related health problems are enormous, although the exact numbers reported vary.

Fewtrell *et al.* (2005) found in a meta-analysis of articles presenting water, hygiene and sanitation interventions together with a measurement of diarrhoea morbidity, that improvements in sanitation, in addition to water and hygiene interventions, significantly reduce the risks of diarrhoeal illness especially in less developed countries. Hutton *et al.* (2007) found that 190 million diarrhoea cases annually could have been averted worldwide by meeting the sanitation MDG target which, however, failed (see Challenge 1). EcoSanRes (2008b) estimated that, worldwide, about 1 billion people were infected with roundworm and 0.7 billion with hookworm.

Prüss-Üstün *et al.* (2008) estimated that, improving water, sanitation and hygiene has the potential to prevent 6.3% of all deaths (3.6 million in 2002); or at least 9.1% of the disease burden (135.7 million in 2002, measured in disability-adjusted life years, a measurement of the gap between current status and an ideal situation of health, see WHO 2016). Figure 1.5 illustrates their findings of diseases related to inadequate water supply, sanitation and hygiene. Diarrhoeal diseases have thereby the largest share (39%) followed by the consequences of malnutrition (21%) and malaria (14%). Some diseases were unquantifiable and thus not included in the figures including infectious diseases, injuries related to water use, and adverse effects from chemicals such as fluoride, arsenic, lead and nitrate.

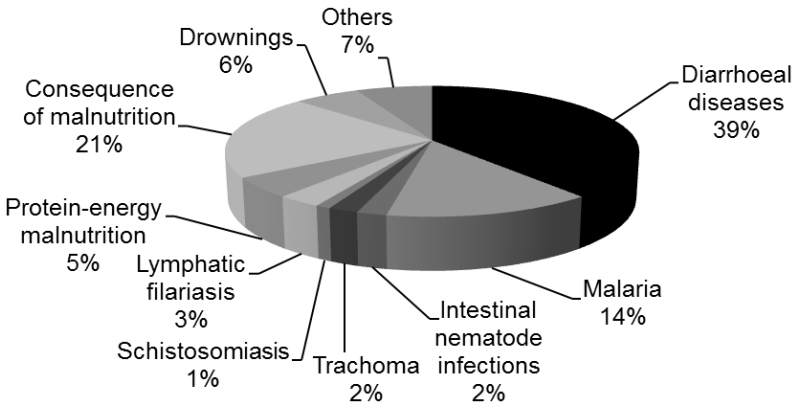


Figure 1.5: Diseases related to inadequate water supply, sanitation and hygiene, in disability-adjusted life years (Prüss-Üstün *et al.* 2008, modified)

Cairncross *et al.* (2010) proposed diarrhoea risk reductions of 36% with excreta disposal; though the authors noted limitations in the evidence for health benefits of sanitation they promoted the provision of sanitation to improve human health, along with measures of water supply and hygiene. And Bain *et al.* (2014) estimated that globally 1.8 billion people use a drinking water source suffering from faecal contamination.

In addition to personal health consequences, a high incidence of illnesses and diseases has a negative impact on the economy. Hutton and Haller (2004) estimated that a diarrhoea-caused loss of work-power brings a loss of income of about US$1.2 billion in developing countries worldwide. According to the UN Governing Council of the UNEP (2004) the global burden of human disease caused by sewage pollution of coastal waters is estimated at 4 million lost “man-years” every year equalling an economic loss of about US$16 billion per year. Hickling and Hutton (2014) found that 18 African countries lost a combined total of almost US$ 5.5 billion per year due to poor sanitation equalling national economic losses between 1% and 2.5% of the gross domestic product (GDP).

On the other side, investments in sanitation apart from other fields bring significant social and economic benefits to people. Hutton *et al.* (2007) assumed that improving sanitation can save 30 minutes of time per person per day, which can be considered a high individual social and economic benefit. Hutton *et al.* (2007), in relation to achieving the MDG targets with low cost interventions, and UN-Water (2008a) estimated that the return on US$1 investment in improving sanitation can bring over US$9; amongst other reasons, due to relative health impacts and related health cost savings and productivity benefit. The OECD (2011) assessed that benefit-cost ratios can be as high as 7 to 1 for basic water and sanitation services in developing countries related to benefits for public health, economy and the environment. Hutton (2012; 2013) found global benefit-cost ratios (US$ return per US$ invested) of 5.5 for sanitation, 2.0 for water supply and 4.3 for combined sanitation and water supply, including health and access time savings. Furthermore, he found that globally, the costs of universal access amount to US$35 billion per year for sanitation and US$17.5 billion for drinking-water over the 5-year period 2010-2015. Bain *et al.* (2015) considered the total US$53 billion per year for both sanitation and water supply as found by Hutton (2013) a small sum given this represented less than 0.1% of the global GDP in 2010 and seeing that the return on investment is many times higher (adopted in the report summary, WWAP 2015). All this data indicate that especially sanitation, besides water supply and hygiene, is an excellent field to invest in to bring significant social and economic benefits to people including health.

1.1.2 Sanitation systems and innovation

The variety of systems is large, resulting from a high degree of innovation in research and practice. There are different technologies and approaches meeting the local

conditions and needs of users worldwide (Lange and Otterpohl 2000; Ujang and Henze 2006; Mara *et al.* 2007; Mara and Evans 2011; Tilley *et al.* 2014). The naming and grouping of sanitation systems thereby varies according to the authors and institutions. I basically distinguish between *conventional* and *non-conventional* systems. Conventional sanitation systems comprise the most often applied systems; some can be very effective; but in fact, many are limited in terms of safety and sustainability. Non-conventional sanitation systems are developed to overcome those obstacles; they differ substantially and are mainly characterised by the separation of wastewater streams. The No. of successfully implemented non-conventional systems has been growing, and some have been emerging as an alternative in large-scale projects.

Conventional sanitation systems comprise *do-nothing systems* (Franceys *et al.* 1992), *drop-and-store systems* (Esrey *et al.* 1998), as well as *flush-and-discharge systems* (Esrey *et al.* 1998) in which no wastewater treatment is provided (see Figure 1.6). It also comprises conventional *sewerage + WWTP systems* in which wastewater treatment is provided by planned treatment facilities (see Figure 1.7). While do-nothing and drop-and-store systems still are the most common systems in developing countries, sewerage + WWTP systems are most common in developed countries (based on the low rate of connection in developing countries, and higher rate of connection and treatment in developed countries as in Table 1.2).

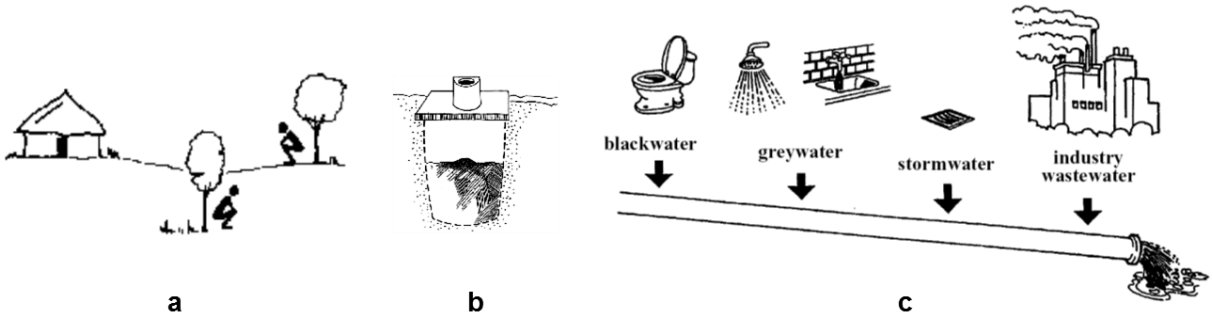


Figure 1.6: Conventional sanitation systems: (a) do-nothing systems (Franceys *et al.* 1992), (b) drop-and-store systems (Esrey *et al.* 1998) and (c) flush-and-discharge systems (Esrey *et al.* 1998)

Do-nothing systems (a) lack any technology or professional management. Therefore they are not an option for sustainable sanitation. Main practice is open defecation where people, when defecating, dispose excreta directly into fields, forest, bushes, open water bodies, beaches or other open spaces, or dispose of it with solid waste (see Table 1.1). UNICEF and WHO (2015) reported that, in 2015, 946 million people, i.e. nearly 13% of the global population, practice open defecation while 90% of them live in rural areas. India plays a key role; 60% out of the 946 million live there. They make up 44% of the Indian total population, 61% of the Indian rural and 10% of the Indian urban population. Basically open defecation protects human health as excreta are removed from dwellings. However, the collection or disposal or treatment of ex-

creta is not planned or regulated. The only self-regulating elements are people's perception of rightness and cleanliness, or their beliefs in religion or culture which in practice regulate this system (UNICEF and WHO 2008). However, considering the dangers arising from excreted pathogens, especially in densely settled areas, do-nothing systems are a burden for both human health and the local environment.

Drop-and-store systems (b) comprise simple pit latrines and its variants. These systems enable the collection, containment and indefinite storage of excreta; they are the most common in the world (Esrey *et al.* 1998). The easiest method is collecting excreta in a chamber and storing it for an indefinite period. The main advantage in comparison with the do-nothing systems is the possibility of removing and containing excreta and pathogen, where the systems properly function. The disadvantages are missing opportunities for reusing nutrients from human waste, unhygienic storage processes accompanied by strong smells and the pollution of water sources e.g. through leakages to wells and groundwater. More shortcomings usually arise from lack of space for installation of storage facilities in densely settled areas and from operational problems, e.g. where chambers have to be emptied, too often bringing health risks for users and workers. This system is thus also not considered a serious option for sustainable sanitation.

Flush-and-discharge systems (c) allow the collection of wastewater from households and industry as well as stormwater and their transport to outlets outside dwellings. Sewerage is usually discharged untreated to water bodies and the environment. Sometimes it is basically treated, e.g. mechanically (Ujang and Henze 2006). However, these systems treat wastewater insufficiently, and discharged sewerage endangers human health and the environment. Also, while these systems allow for isolating and removing human waste from dwellings and so protecting human health and the environment inside dwellings, new problems are created for the people and the environment in the discharge areas, or further areas, e.g. suburbs, downstream a river, or just the ocean. Another difficulty with these systems can be the safe transport of sewerage in pipes or channels; e.g. in peri-urbans of Damascus, Syrian Arab Republic (Syria) sewer channels were destroyed and raw wastewater was distributed to fields for irrigation with open channels being unsecure for human contact (Mohamed 2004 and my own observations in 2007, see Section 6.1.1).

Table 1.2 indicates that many sewerage systems lack any wastewater treatment. It relates the share of people connected to a system without treatment to the share of people connected to a system with treatment. While in low, lower-middle and upper-middle income countries the connection rate is low, even in high-income countries, with higher connection rates, only about 80% of the collected wastewater is treated. The numbers, however, do not show how effective the treatment is. I also made a reference to on-site treatment without connection which makes a big share of sanitation in developing countries, but I could not find data on the share of proper facilities.

Table 1.2: Access to sewerage connection and sewerage connection with treatment in 2010 (UN-Water 2015, adapted from Baum *et al.* 2013; extended with a reference to on-site treatment)

Country income level[a]	p with access (%)		
	Connection	Connection and treatment	On-site treatment w/o connection
Low income	3.6	0.02	n/a[b]
Lower-middle income	12.7	2.0	
Upper-middle income	53.6	13.8	
High income	86.8	78.9	

[a] For reference to the country classification of developing/developed country, see Section 1.5.

[b] The proportion of improved on-site systems or mixed systems could not be verified. On-site systems make a big share of sanitation in developing countries, e.g. 85-90% in urban areas of Indonesia and Vietnam (World Bank 2015). However, UN-Water (2015) estimates, based on Peal *et al.* (2014), that worldwide only a small percentage of faecal sludge is managed and treated to an appropriate level.

Sewerage + WWTP systems allow for discharging wastewater as in flush-and-discharge systems and treating it according to standards in a WWTP at the end of a pipe (see Figure 1.7). Usually water is used to transport used water and excreta in gravity sewers and pumping sections to the WWTP. Alternative transport systems include flexible vacuum systems, reducing the amount of water required to transport solids or other systems such as simplified sewerage with smaller pipes and lower investment costs (Mara *et al.* 2007; Mara and Evans 2011). The constituents of wastewater, however, are seen pollutants removed by physical, biological and chemical treatment before the treated wastewater is discharged into the environment. Sludge and other residues from treatment processes are usually disposed as waste, spread on fields for fertilisation, or thermally treated in incineration plants.

Some authors considered sewerage + WWTP systems and flush-and-discharge systems one category (Esrey *et al.* 1998; Ilesanmi 2006). However, I distinguish between them because flush-and-discharge without treatment is common practice worldwide although it is dangerous for people and the environment (see Table 1.2); and sewerage + WWTP systems, where professionally designed, implemented, operated and maintained can significantly reduce dangers for human health and the environment even though challenges remain. This is shown in many developed countries, e.g. Germany (see Association of Drinking Water from Reservoirs *et al.* 2015). Beyond that, many conventional sewerage + WWTP systems are being developed to attain sustainable sanitation which leads to its consideration as a separate system.

Despite successful application worldwide, conventional sewerage + WWTP systems have several disadvantages. On the one hand, existing systems need to be continuously improved, e.g. to treat micropollutants (Winker *et al.* 2008; Winker 2009; Hillenbrand *et al.* 2014; Umweltbundesamt 2015); on the other hand, alternatives are required to extend sanitation coverage, considering only high cost, energy demand and the necessary capacity of staff to operate and maintain the systems.

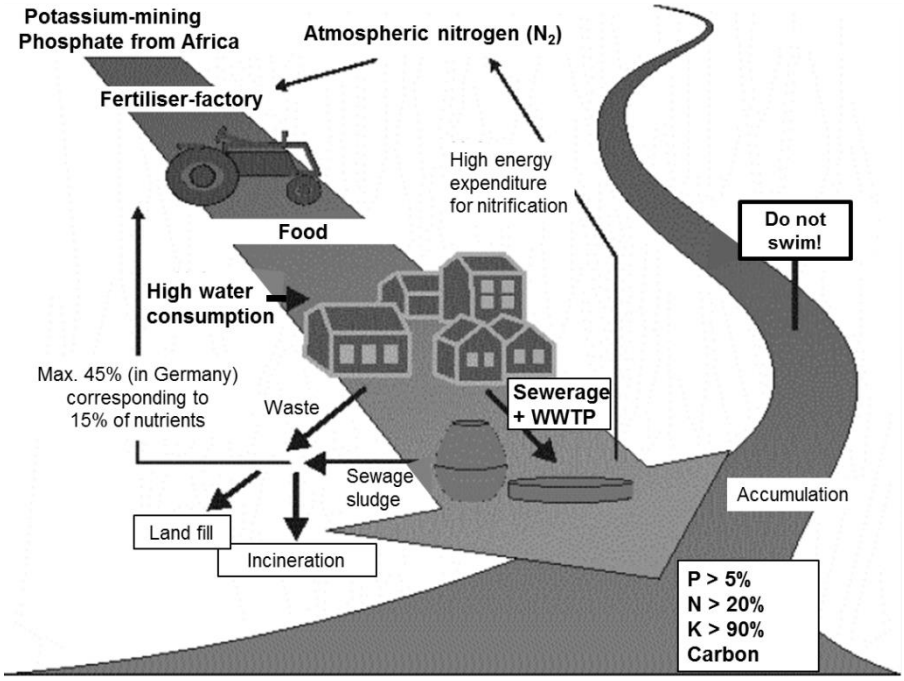


Figure 1.7: Conventional sewerage + WWTP systems and related challenges (Otterpohl *et al.* 1997, modified, translated)

New systems, approaches and technologies were developed to overcome the disadvantages of conventional sanitation. Some new ones, however, are adaptations of old practices applied by past or ancient civilisations, e.g. wastewater-fed aquaculture (Junge-Berberovic 2001), dehydrating toilets (Winblad and Simpson-Hébert 2004) and Terra Preta sanitation (Factura *et al.* 2010).

The crux in conventional sewerage + WWTP systems is that a relatively small amount of faeces, urine and other substances pollute a huge amount of water (see Figure 1.8). This brings limiting factors including high water consumption, nutrient and thus fertiliser losses, pollution from remaining constituents in outlets and waste damps, dilution and a resulting need for large treatment areas which can be problematic in densely settled areas, low flexibility in modification through heavy infrastructure, and the high cost of investment and O&M. Many developed countries can cope with these limitations; many developing countries, however, cannot; which often results in lack of coverage and non-functioning systems as described above.

Larsen and Gujer (1996) as well as Lange and Otterpohl (2000) documented that separation of wastewater at its source and reuse of wastewater have started to move from mainly industrial into domestic settings. Related projects were implemented, firstly, as small-scale pilot projects, e.g. in Germany (Werner *et al.* 2005), and later, as large-scale projects, e.g. for 50,000 people in Kenya (Kanathigoda 2015).

The design of source controlling sanitation systems is based on the diverse characteristics of the main constituents of wastewater. Otterpohl (2001a) defined five streams of wastewater: *blackwater*, i.e. faeces and urine collected from outlets of

flushing toilets or water from kitchen sinks; *brownwater*, i.e. faeces collected from separating toilets; *yellowwater*, i.e. urine collected from separating toilets or waterless urinals; *greywater*, i.e. freshwater collected from bathrooms or kitchen including automatic dishwashers and washing machines; and *rainwater*, i.e. water collected from outside surfaces. The German Association for Water, Wastewater and Waste (DWA 2008) further divided and specified these streams; yellowwater as urine with flushing water (from urine diverting toilets and urinals both with flush), and *urine* separately (from urine diverting toilets and urinals both without flush); brownwater as faeces with flushing water (from urine diverting toilets with flush), and *faeces* separately (from urine diverting dry toilets without flush), and *excreta* as urine and faeces (from toilets without flush), and faeces separately (from urine diverting dry toilets without flush).

Wastewater streams thereby differ according to load and amount. Depending on the accuracy of its separation in the toilet, blackwater, brownwater and yellowwater can contain minor constituents of each other stream. However, blackwater and kitchen waste contain much organic matter which is a valuable source for biogas production thus renewable energy. Blackwater and brownwater contain most pathogens and pharmaceutical residuals, thus they are of concern for health risks. Koenig (2008) found, e.g., that using urine diverting systems in township settlements in Durban, South Africa, reduced the incidence of diarrhoea by 30%. Furthermore, yellowwater contains large amounts of nitrogen (N) and P and can therefore be used as a source for fertiliser production (Behrendt *et al.* 2002; DWA 2008). Greywater and rainwater can be treated easily and reused in flushing toilets, for cleaning or irrigation.

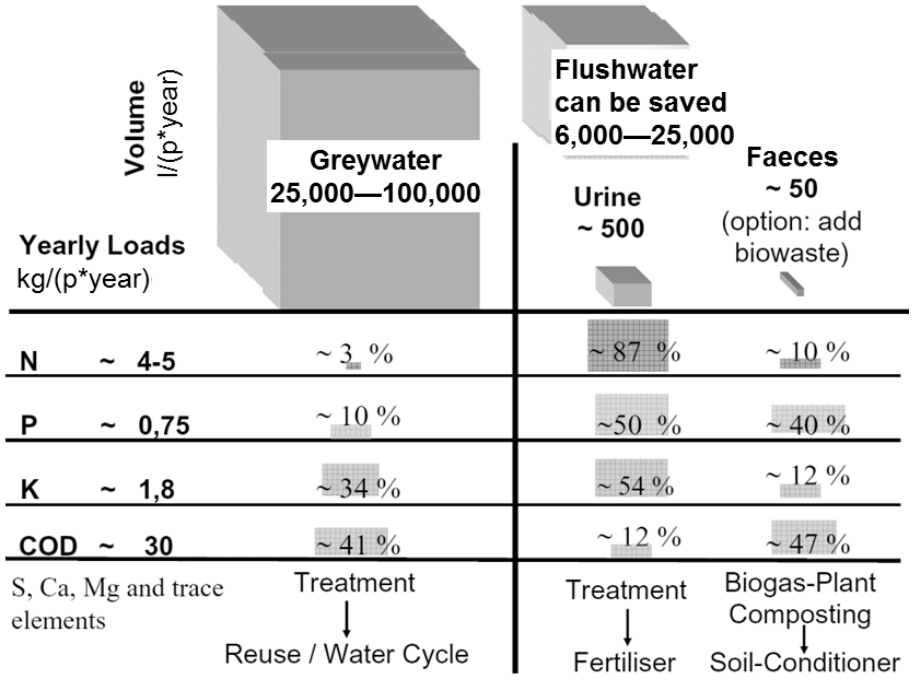


Figure 1.8: Characteristics of household wastewater (Otterpohl *et al.* 2004, compiled from Geigy, Wissenschaftliche Tabellen, Basel 1981, Vol. 1, Larsen and Gujer 1996 and Fittschen and Hahn 1998; modified, symbols adapted).

Figure 1.8 illustrates the average values for N, P, K and chemical oxygen demand (COD) in household wastewater in kg per person and year in comparison with the amount of water used. It shows the constituents of the wastewater streams when not mixed, yearly load of each stream and yearly load of N, P, K and COD in each stream. Further studies have been carried out to find design values (DWA 2008). However, the main characteristic of household wastewater is similar worldwide although the exact composition varies according to region, culture and household, and depends on the specific behaviour of the users.

Source control allows for a more flexible design of collection, transport and treatment facilities. New types of toilets have therefore been developed as well as new transport systems such as vacuum sewers that transport solids without water (DWA 2008; Tilley *et al.* 2014). At the end of the pipe, treating separated wastewater streams can be more effective than treating one large mass, as volumes are lower and concentrations are higher. This can result in a more appropriate and resource-efficient systems (Meinzinger 2010) as well as economic benefits (Schuen *et al.* 2009). Meinzinger (2010) showed in two case studies in Arba Minch, Ethiopia, a developing country and Hamburg, Germany, a developed country, that the appropriate development of a sanitation system can contribute to reducing water consumption, increasing energy efficiency and recovering nutrients for agriculture. This is innovative and can help overcome challenges in sanitation in both developing and developed countries.

Different high, medium and low-tech non-conventional solutions for urban and rural areas are available as alternatives to conventional solutions (DWA 2008). Many new systems are still under development or testing in pilot projects while others have already run for a long time or have proven their functions even before industrialisation. One example is the on-site sanitation concept of composting toilets, successfully applied to decentral areas of northern Europe where no gravity sewers were available to discharge sewage from households (Esrey *et al.* 1998; Mattila 2005). On-site concepts from the ancient past are dehydrating toilets which performed well in multi-storage houses in densely settled areas in Yemen (Winblad and Simpson-Hébert 2004) and Terra Preta sanitation which enabled efficient handling of excreta and biowaste through conversion into long-term fertile soils in ancient Amazonian cultures, in Brazil today (Factura *et al.* 2010). Winblad and Simpson-Hébert (2004), Werner *et al.* (2004b), DWA (2008) as well as Tilley *et al.* (2014) described other examples for alternative sanitation systems.

Non-conventional sanitation systems have been developed and implemented by both researchers and practitioners as alternative, improvement or extension options to conventional systems. The major characteristic of these systems, e.g. *ecological sanitation* is a multidisciplinary approach (Esrey *et al.* 1998; Jenssen *et al.* 2004; Werner *et al.* 2004b; Winblad and Simpson-Hébert 2004).

More than 50 experts of DWA (2008) developed a framework to classify *novel sanitation systems*, in German "*Neuartige Sanitärsysteme"*, here considered to be non-conventional systems. The experts summarised all relevant worldwide existing systems with focus on applicability in Germany. They described three categories of sanitation systems: *1-stream*, *2-stream*, and *3-stream*. The names reflect the No. of wastewater streams arising in the system; in 2-stream and 3-stream systems by source control at the place of water use, e.g. household. Two further categories arise from the use of either water or water-saving toilets, or waterless toilets.

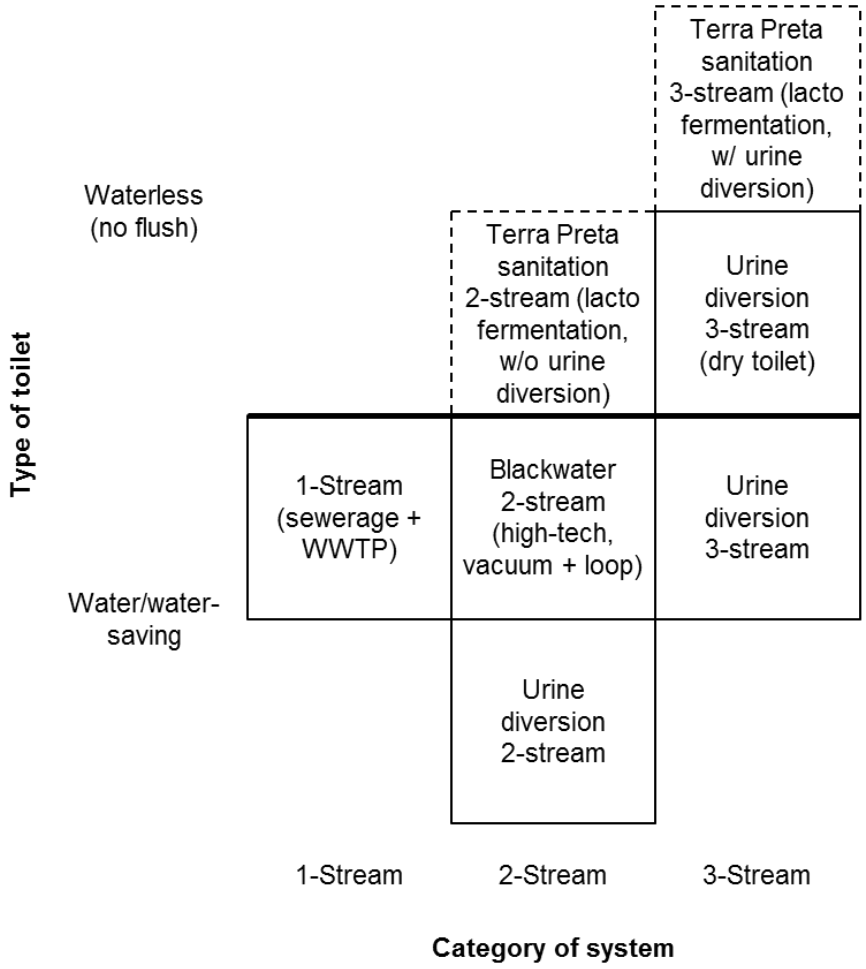


Figure 1.9: Matrix of non-conventional sanitation systems with potential for large-scale sustainable implementation

Figure 1.9 illustrates seven groups of non-conventional sanitation systems which showed potential for large-scale implementation at least at the pilot study scale showing significant operating experience, or, in dotted lines, in research projects focusing on large-scale implementation. Five groups are as defined by DWA (2008); the two groups of Terra Preta sanitation are newly defined as a future system option based on Bettendorf *et al.* (2015). The matrix categorises the groups of systems by the type of toilet used, i.e. water and water-saving, or waterless, and the No. of wastewater streams, i.e. 1-, 2- and 3-stream after the DWA framework. The water/water-saving toilet can be a flush or vacuum toilet; the waterless toilet can be a

dry or composting toilet. Sewerage + WWTP systems can be implemented conventionally, i.e. sewerage with secondary or tertiary treatment, and non-conventionally, i.e. with enhanced reuse of wastewater and associated streams. Terra Preta sanitation systems are shown with dotted lines as they are still being developed to show their potential for the future. It can be integrated into other systems. Industrial wastewater is assumed to be treated separately in all systems. Rainwater is assumed to be discharged separately in all systems except in sewerage + WWTP systems, where it can be mixed, and jointly discharged and treated with the wastewater.

1-Stream systems (sewerage + WWTP) do not allow for the separation of wastewater streams at its source. After discharge, wastewater is either treated to eliminate N and P or, in novel systems, to reclaim it together with the water. Customers use water or water-saving toilets. Applications of conventional forms can be found worldwide in central and decentral conditions as well as of low and high technology. These systems include WWTPs with common treatment technology, mostly for elimination of nutrients. However, there are possibilities for advanced modification of these systems with enhanced options for reuse (DWA 2008). Alternative sewerage options are available, e.g. vacuum sewerage (DWA 2008) or simplified sewerage using small-diameter pipes (Mara *et al.* 2007; Mara and Evans 2011).

Blackwater 2-stream systems (high-tech, vacuum + loop) allow for the separation of greywater and blackwater before discharge. The remaining wastewater is low in load and amount. The separation of wastewater streams enables a reclaim of water, N and P. Furthermore, these systems allow for thermal energy use. Customers use water or water-saving toilets, possibly combined with vacuum sewerage. Applications include the pilot project Ecological housing estate Lübeck-Flintenbreite, Germany for 140 inhabitants, planned for 350 inhabitants (Werner *et al.* 2005; DWA 2008), and a small-scale pilot project with a public toilet at Hamburg main station (Albrecht 2012).

Urine diversion 2-stream systems allow for the separation of yellowwater, and brown or greywater before discharge. The separation of wastewater streams enables a reclaim of water, N and P. The remaining wastewater is low in load and amount. Customers use water or water-saving toilets, which include waterless urinals, urine diversion toilets, urine storage and reuse systems (Münch and Winker 2009). Applications include the ecosan project SolarCity Pichling, Linz, Austria for about 250 inhabitants (Oldenburg *et al.* 2006) and the smaller project Innovative Wastewater Management Lambertsmuehle in Burscheid, Germany for 8 population equivalents (PE, Schlick *et al.* 2005).

There are also experiences with *faeces 2-stream systems* (dry toilets, DWA 2008) which separate greywater and undiluted wet excreta (no wastewater remains). The systems allow for a reclaim of water, N and P; customers use waterless toilets. Applications include the long-term project Ecological Settlement Allermöhe, Hamburg,

Germany for about 120 inhabitants in 34 houses (Jurga *et al.* 2005a) and the Automated Composting Toilet System at Asahiyama Zoo, Asahikawa City, Japan with 31 toilets (Huelgas *et al.* 2006; DWA 2008). However, based on operation experience it is recommended to include urine diversion in these systems, which, in fact, makes it urine diversion 3-stream systems (dry toilets, DWA 2008). These systems are therefore not considered as a large-scale sustainable sanitation option.

Urine diversion 3-stream systems allow for the separation of yellowwater and greywater before discharge. The remaining wastewater is low in load and amount. These systems enable a reclaim of water, N and P. Customers use water or water-saving toilets. Applications include a demonstration project at office buildings and apartment houses of a WWTP in Berlin-Stahnsdorf, Germany (Peter-Fröhlich *et al.* 2007; DWA 2008; Peter-Fröhlich *et al.* 2008), and the office building of Hans Huber AG in Berching, Germany for about 200 users daily (Huber and Christ 2004; DWA 2008).

Urine diversion 3-stream systems (dry toilets) allow for the separation of greywater and yellowwater as well as undiluted dry faeces (no wastewater remains). The systems allow for reclaiming water, N and P. Customers use waterless toilets. Schuen *et al.* (2009) found in projects with urine diverting dry toilets in Sub-Saharan Africa which have been implemented in sufficient numbers, that excreta separation (here of urine from faeces at the source) facilitates the reuse of nutrients contained in urine and faeces, which contributed to increased crop yields in local agriculture. In addition, they found advantages related to reduced odour and ease of sludge removal from latrines. Other applications include the long-term project Gebers Collective Housing Project in Orhem, Sweden for 80 inhabitants (Syahril *et al.* 2005); Erdos Eco-Town Project Dongsheng, Inner Mongolia for about 2,500 inhabitants in 825 multi-storey apartments, nursery school and public service centre (Zhu 2006; Lixia *et al.* 2008); and the large-scale Urine Diverting Dry Toilets Dissemination Programme in Guanxi province, China with about 685,000 toilets in 2003 (Jurga *et al.* 2005b). Furthermore, between 2003 and 2010, 960 individual, 50 school and kindergarten and 7 public urine diverting dry toilets have been implemented in different countries in Eastern Europe, the Caucasus and Central Asia (Wendland *et al.* 2011).

Terra Preta sanitation 2-stream and 3-stream systems have been developed mainly as an extension option for both conventional and non-conventional sanitation systems. It allows transforming excreta into fertile soil that can be used in agriculture. The main advantage of such a system approach is a possible effective integration of sanitation, bio-waste management and agriculture (Factura *et al.* 2010). The idea has been inspired by the discovery of Terra Preta as soils produced by an ancient Amazonian civilisation (Factura *et al.* 2010; Otterpohl *et al.* 2015). As a system, Terra Preta sanitation shows potential especially in combination with urine diverting dry toilets (Bettendorf *et al.* 2015) which makes it a 3-stream system as in Figure 1.9. Yellowwater and greywater is separated; undiluted dry faeces are either mixed with char-

coal, or stabilised and treated using lactic acid fermentation with subsequent vermicomposting (Factura *et al.* 2010; Otterpohl 2012; Bettendorf *et al.* 2014; De Gisi *et al.* 2014; Bettendorf *et al.* 2015). Lactic acid fermentation is thereby an anaerobic process that avoids gas and odour production which is important in dense settled urban settings (Factura *et al.* 2010; De Gisi *et al.* 2014). Treatment can take place in-situ or ex-situ (Bettendorf *et al.* 2015) and induced by liquid microbial supplement (Andreev *et al.* 2012; Bettendorf *et al.* 2015). No wastewater remains in the system. Although Terra Preta sanitation is considered a new system approach, lack of practical case studies requires further research and development (Bettendorf *et al.* 2015). Applications refer to the small-scale and household level as well as scientific studies and development projects for application in urban settings. Potential for the future, however, has been assessed (Factura *et al.* 2010; Bettendorf *et al.* 2015).

Table 1.3 summarises the key data of non-conventional sanitation systems. Data comprise category, system, principle, arising wastewater streams and main treatment targets; Terra Preta sanitation is added as a future option.

Table 1.3: Characteristics of non-conventional sanitation systems (based on DWA 2008, translated, modified, and Bettendorf *et al.* 2015 for data on Terra Preta sanitation)

Category	System	Principle	Streams	Treatment target
1-Stream systems	1-Stream (sewerage + WWTP)	Wastewater jointly discharged	Wastewater mixed	Discharge and elimination, or recovery and reuse
2-Stream systems	Blackwater 2-stream (high-tech, vacuum + loop)	Greywater separated, remaining wastewater low in load and volume	Greywater, blackwater	Recovery and reuse
	Urine diversion 2-stream	Yellowwater separated, remaining wastewater low in load	Yellowwater, brownwater/ greywater	Recovery and reuse
	Terra Preta sanitation 2-stream (lacto fermentation, w/o urine diversion)	Greywater separated, wet excreta undiluted and stabilised, no remaining wastewater	Greywater, excreta, biowaste	Recovery and reuse
3-Stream systems	Urine diversion 3-stream	Yellow- and greywater separated, remaining wastewater low in load and volume	Yellowwater, greywater, brownwater	Recovery and reuse
	Urine diversion 3-stream (dry toilets)	Yellow- and greywater separated, dry faeces undiluted, no remaining wastewater	Urine, greywater, faeces	Recovery and reuse
	Terra Preta sanitation 3-stream (lacto fermentation, w/ urine diversion)	Yellow- and greywater separated, dry faeces undiluted and stabilised, no remaining wastewater	Urine, greywater, faeces, biowaste	Recovery and reuse

In conclusion, non-conventional sanitation systems, i.e. source control- and reuse-oriented systems, can be highly innovative in comparison with conventional systems.

But these systems can also be more complex especially at household level, and require multidisciplinary management support especially for raising awareness and building participation of users. Significant promotion is usually necessary to convince users, planners, operators and decision-makers of the advantages of non-conventional systems and facilitate the necessary shift in thinking from conventional to sustainable sanitation. Related experiences can be found in various projects, e.g. in Germany where a change from normal water toilets and sewer connections on urine-diverting toilets and greywater discharge or reuse required substantial promotion and enthusiasm of the stakeholders (Huber and Christ 2004; Werner *et al.* 2005; Peter-Fröhlich *et al.* 2008). Other examples can be found in Sub-Sahara Africa, where Schuen *et al.* (2009) assessed selected large-scale *ecological sanitation* projects. They found economic benefits from improved sanitation and excreta reuse including health and environmental benefits; but they saw none of the implemented systems which could provide an obvious model for upscaling without considerable external support including subsidies. While in South Africa and Burkina Faso household latrines and excreta management sites were heavily subsidised; in Kabale, Uganda subsidies were not applied, but users were not classified as being poor which made a difference. These and other examples indicate a substantial need for management support to promote and implement sustainable sanitation, especially when introducing non-conventional systems, approaches or technologies.

1.1.3 Sanitation projects

Improving management in sanitation is considered to be increasingly important rather than a purely technical optimisation or exclusive focus on access to sanitation infrastructure. The UN-Water Decade Programme on Capacity Development (2015) specified, while calling for much more productive and sustainable use of water, (see Section 1.1.1), that in particular the sanitation and hygiene subsector suffers from human, institutional and financial resource constraints, which relates to management. *Sustainable management* in sanitation has been moving into focus with the SDG (see Section 1.1.1) targeting in particular the expansion of international cooperation and capacity building support to developing countries including wastewater treatment, recycling and reuse technologies by 2030 (UN General Assembly 2015). This refers particularly to management and requires appropriate strategies. The need for improved management in sanitation is recognised not only by policy makers but also by many scientists and professionals.

Inadequate planning and design. The Sanitation 21 task force of the International Water Association (IWA 2006) argued that:

> technologies are available and better planning and design are necessary for the provision of sustainable sanitation services, especially in growing urban areas.

The task force thereby affirmed the internationally fast-growing perception that “conventional approaches to sanitation planning and design seem to fail with depressing regularity”. Parkinson *et al.* (2014) acknowledged this and other ideas of the group, and developed it. The authors provided a planning framework with key principles and process guidelines to develop appropriate urban sanitation services that are affordable for users. They considered technology, but also management, institutional setting and other demands for improvement. The authors highlighted that there is no uniform planning procedure that can ensure sustainable solutions for every urban area.

Also, many other experts stressed that purely the technical challenges of sustainable sanitation are not the most important. Otterpohl (2001b) stated “all social and economic conditions can be met” considering the possibilities resulting from available systems and technologies and that creativity is needed to find appropriate solutions of implementing, operating and financing. Brikké and Bredero (2003) highlighted the importance of the requirements to O&M for technology choice; Schertenleib (2005) proposed a “planning household-centred” approach with a high degree of user participation in planning. The Sustainable Sanitation Alliance (SuSanA) called for “productive sanitation systems” (Gensch *et al.* 2012), i.e. for a paradigm shift in sanitation planning and management towards recycle-oriented closed loop approaches. Cairns-Smith *et al.* (2014) called for using a “portfolio approach” thus thinking beyond sewer-based systems in sanitation planning while considering the key differences and full cost of different solutions, in particular for large-scale urban implementation.

Otterpohl (2008) further recommended “integrated planning” and “demand side management” to design cost-efficient, sustainable sanitation systems. The Network for the development of Sustainable Approaches for large scale implementation of Sanitation in Africa (NETSSAF 2008) developed a participatory planning approach to set up framework conditions particularly for implementing large-scale cost-effective sustainable sanitation systems in Sub-Saharan Africa. Tilley *et al.* (2010) developed a method for organising and defining systems to facilitate informed decision-making and integration of all sanitation elements taking into account the many sanitation innovations and existing technologies appropriate in different settings. They categorise technologies based on their “product-process” specificity and link them into logical systems using a “flowstream” concept. Lüthi *et al.* (2011) called for considering sanitation as key element of the “urban metabolism” and increasing sustainability by linking it with other sectors like waste and urban planning considering its ability to provide valuable resources to the system like irrigation water, biogas or nutrients.

Besides goals and planning frameworks for sustainable sanitation specific technologies and implementation approaches are being developed in both science and practice. An example in science is increasing research on Terra Preta sanitation as an efficient method of treatment and new system option (Bettendorf *et al.* 2015). An example in practice is the development of upscaling concepts for water supply and san-

itation in low-income urban areas to overcome the stagnation in extending coverage in many parts of Sub-Saharan Africa (Blume *et al.* 2015). Such developments bring specific aspects of sanitation that need to be taken into account in strategies while here also, focus is less on technology but more on integrating it with non-technical aspects.

Lack of management capacity and institutional framework. On the other hand, the choice of the technology must take the basic framework for management in a project area into account and being realistic about improvements to be achieved within the duration of a project. The IWA (2006) acknowledged that realistic assessment of the management requirements in each domain help to plan and design sanitation technology better. This relates in particular to non-conventional systems which are often new and usually require substantial change in management and behaviour.

In developing countries, however, institutions, service providers and local administration responsible for sanitation often lack the necessary management capacities and support strategies, or do not match the management requirements of a planned system. The Water Supply and Sanitation Collaborative Council and Eawag (2005) stated that water supply agencies are likely to be the most advanced, and in many municipalities institutional capacity in other sectors range from poor to almost non-existent, especially in their dealings with low-income areas. Connor *et al.* (2012) stated that poor access to water resources and services result significantly from a lack of appropriate institutions for managing and securing resources for building both human capacity and physical infrastructure. The authors concluded that some developing countries, often those with the greatest needs, are unable to absorb aid for sanitation and the need to strengthen their systems to plan, implement and monitor the provision of sanitation services especially in unserved areas. Furthermore, even where national strategies are well developed, institutions are well coordinated and financing is available, progress in sanitation may still be limited by lack of sufficiently trained staff and work conditions that are conductive to effective outputs. The implementation of reforms often fails as stakeholders are not adequately involved (Johansson and Kvarnström 2005).

So many infrastructure projects require professional management strategies to prepare all stakeholders for investments which are usually significant. International donors that support sanitation development with substantial finances require appropriate institutions, and project planning that is financially secured including a long-term operation of the system. This applies in particular to large-scale projects. Improving public organisations is thereby one of the most persistent and difficult challenges in development and development cooperation, but crucial for achieving sustained progress, growth and poverty reduction (Boesen 2007). In some areas, however, sanitation institutions and service providers must be developed from scratch as there are just no systems and management structures do not exist.

Limited "soft" support from development projects. Many governments and donor institutions, however, support the development of appropriate institutions and professional management framework, often, only to a limited extend. UN-Water (2015) stated that many water institutions in developing countries lack the necessary financing and capacity. Accordingly, they require new funding for more effective institutional implementation, and need to use existing funding more efficiently. However, also according to the authors, most funding goes into infrastructure development rather than into institutional development and human capacity building.

Björklund *et al.* (2009) stated that:

> "... much bilateral aid for sanitation and drinking water fails to achieve a balance between soft and hard infrastructure."

According to their findings the vast majority of donor investments in sanitation were in infrastructure in 2008, and only a minor part of investments were for "soft" support such as support for policies, legal systems and capacity building, here considered as management support. Figure 1.10 illustrates donor investments in both sanitation and drinking water systems. "Soft" support in sanitation was estimated to be 20% of the investments by the European Commission, nearly 10% of investment by France, and less than 5% by each Austria and Germany. In France and Austria, the "soft" support was thereby lower in sanitation than in drinking water.

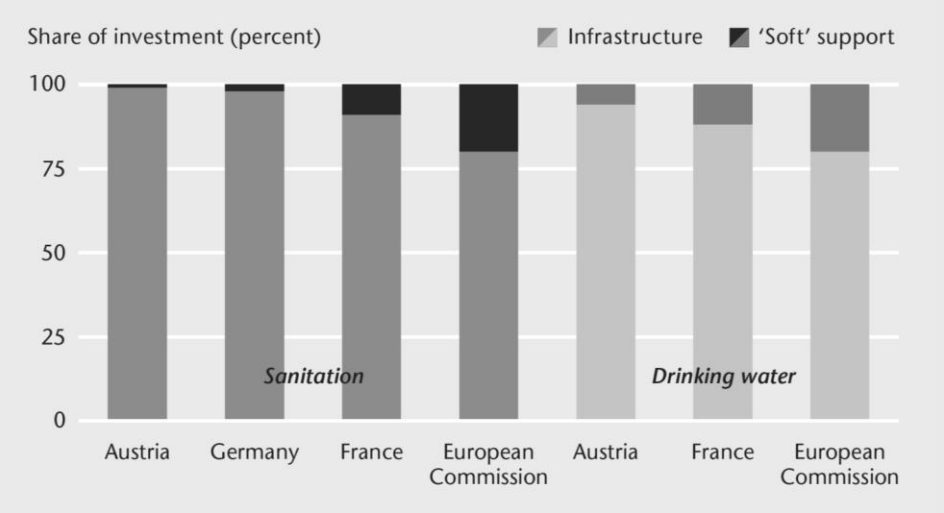


Figure 1.10: Shares of "soft" support and infrastructure of donor investments in sanitation and drinking water (Björklund *et al.* 2009, based on UN-Water 2008d; modified)

Björklund *et al.* (2009) further argued that deficits in financing, especially for O&M costs, would be a substantial addition to investment costs in new systems. Governments often turn to external aid to fill financing gaps and donors would seem to favour financing new infrastructure rather than O&M. They argued that in most urban public water systems charges hardly cover the recurrent costs of O&M while in rural areas neglect of O&M and cost recovery contribute to non-functionality.

Triche and McIntosh (2009) reported that in India, projects on both water supply and sanitation focused on developing infrastructure rather than institutions and management areas such as efficiency, service quality, financial viability, customer relations as well as pro-poor targets. Training programmes focused on technical and engineering skills, but rarely on strategic commercial and managerial aspects. Resulting obstacles were found such as service providers that lacked autonomy, capital and HR as well as incentives for serving the poor; municipalities and utilities that were not held accountable for service provision; and small private service providers that were not recognised, encouraged, and regulated.

The challenges of management and institutional development for improving water and sanitation are also discussed in connection with current large-scale investment programmes in central and eastern European countries (IWA 2015a). Subject to debate amongst others is to whether infrastructure investments are supported by needed changes in institutions and professional capabilities including management tools, attitudes and approaches (IWA 2015a, 2015b); and if policies, regulations as well as tender and procurement rules are being adapted fast enough to secure the benefits of the investments (IWA 2015b). Significant gaps in decrees, regulations and standards as well as unclear institutional arrangements and poor coordination causing gaps in management and planning, insufficient investments, delays and other problems are also recognised in Southeast Asian sanitation projects (World Bank 2015).

So investments in physical sanitation infrastructure must be accompanied by substantial “soft” support, i.e. management support, which is still not the case in all projects even on a large scale. Related strategies help developing and introducing the required management actions. Strategies must thereby consider parallel reforms and other developments in the sanitation sector but also in related sectors, as well as the required timing of implementation due to related infrastructure investment measures.

Unbalanced approaches to projects. The findings of Björklund *et al.* (2009) and other experts (see above) indicate that sanitation projects in developing countries are too often unbalanced, focusing on the implementation of infrastructure. Figure 1.11 therefore illustrates two approaches to sanitation projects based on the two major phases of projects construction and operation: approach (a) unbalanced and approach (b) balanced towards the sustainable implementation of both infrastructure and services. Approach a shows a fundamental imbalance between implementation and operation. It focuses on investments in sanitation infrastructure, implementation support for constructing the infrastructure, or project management, and technical training related to O&M of infrastructure such as plants and machines installed. Project management thereby includes planning, design, tendering, and construction supervision including test operation. It is, together with measures on the technical training, usually carried out by a consortium of national and international Implementation Consultants, often engineering firms or companies.

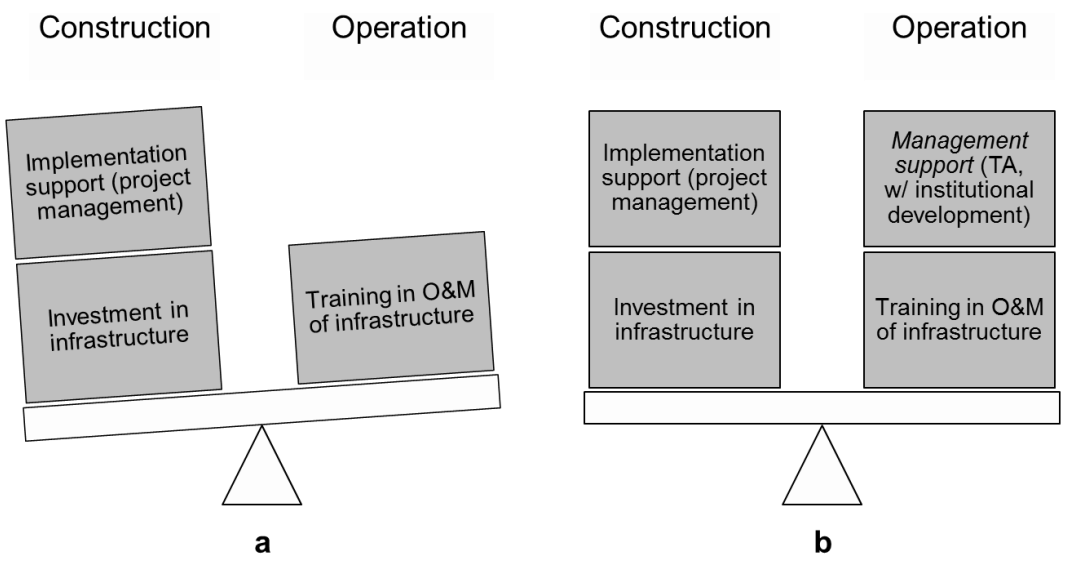


Figure 1.11: Approaches to sanitation projects: (a) unbalanced, without management support; (b) balanced, with management support (TA) including institutional development where necessary—towards sustainable projects

Approach b is more balanced towards sustaining the project achievements. It adds management support of the implementing institutions and future operators to prepare for the operation phase, e.g. by technical assistance (TA). This management support goes beyond technical training and includes institutional development where necessary. This approach is usually carried out by a consortium of national and international Implementation Consultants and Management Consultants. Measures of institutional development or capacity building, however, can be separate components of large-scale water and sanitation sector programmes.

To implement projects by approach b the use of a professional management strategy can be supportive. Small-scale pilot projects may be successfully implemented with mainly technical approaches such as approach a. But in larger projects a strategic management approach will increase the likelihood of sustainable implementation. This refers in particular to projects requiring high awareness and strong participation of users and other stakeholders. For example, Evans (2005a) reported on a pilot project in Pakistan that communities and households were mobilised to invest in sewers and latrines taking into account limits of financing. Jönsson *et al.* (2010) showed that farmers need to participate in initial planning of recycling sanitation systems to ensure proper implementation of those systems. Such approaches require substantial communication, coordination and management support.

Where the integration of many stakeholders or other difficulties in a project need to be overcome, professional management support can ensure effective communication and coordination at relatively low cost compared with infrastructure investments. Appropriate strategies can thereby also support the set-up of small-scale service providers. They need to be integrated into professional management structures (Collignon and Vézina 2001; Solo 2003; Blume *et al.* 2015) which also can be supported

by related strategies. Large-scale projects, however, need in any case substantial external management support for achieving sustained results. Scaling up sanitation can thereby create a new role for governments (Evans 2004, 2005b) in particular as far as establishing meaningful benchmarks and a monitoring progress (Evans *et al.* 2004). Hence, management actions are often required at different levels, e.g. national, regional and local.

As for pro-poor strategies, utilities can play an important role in developing a necessary management framework and in building capacities. Richards (2010) highlighted the importance of utilities providing a more comprehensive and professional approach to basic sanitation provision. Local authorities should focus on education, enforcement of regulations and raising public awareness. Financing of basic sanitation, however, in doing so should not impose an unacceptable burden on the utility's customers. Dardenne (2010) called for a more holistic approach in informal settlement areas, where the division of tasks between a provider and a regulator can be difficult. Both, however, agreed on the need for intensive public advocacy and the involvement of the beneficiaries (Kohn and Pfeiffer 2010). Appropriate approaches to projects targeting to serve the poor especially in urban areas are being developed with increasing success (Blume *et al.* 2015). Those learnings need to be taken into account when developing strategies and design projects.

Finally, related sanitation interventions are too often seen exclusively as engineering tasks (Holden 2008). Sanitation, however, is a wide field involving different disciplines including economics, engineering and many others. This must be considered in the implementation of projects as well as in professional management strategies.

Increasingly, inter-sectoral integration of projects brings additional requirements to management support strategies in sanitation. Merdes *et al.* (2008) documented that the German development cooperation in sanitation becomes more holistic and promotes more inter-sectoral cooperation. Sanitation projects are thereby increasingly integrated with other sector measures, e.g. education or health promotion, and contain more pro-poor components.

The experts stated that national policies can achieve improvements in sanitation and wastewater management especially in:

- the water sector, e.g. involvement of water utilities in central sewage systems and decentralised sanitation facilities;
- urban development, e.g. microcredits to improve housing conditions;
- healthcare, e.g. education programmes to improve hygiene behaviour;
- education, e.g. to raise user awareness of water use and the link between health and hygiene, thereby targeting women and school children;
- rural development in energy production, e.g. the use of biogas and nutrients.

In particular, the nexus of water, energy, food and climate came to the fore leading to the set-up of new inter-sectoral approaches among institutions and implementing agencies worldwide (Hoff 2011; Dubois *et al.* 2014; Lundy and Bowdish 2014; WWAP 2014; Stockholm Environment Institute 2015; Woltering and Heide 2015). The basic idea of these approaches is to combine actions with related objectives, e.g. securing water as well as energy and food to reduce poverty and hunger and support climate protection (see also Section 1.1.2). The development of the nexus and related approaches has been supported by global conferences; amongst others, in 2011, in Bonn where several initiatives were started (GIZ 2016), and in 2014, at The University of North Carolina at Chapel Hill (2015) where a nexus declaration was prepared which was, later, submitted to the UN as input to the SDG process (Dodds and Bartram 2014).

Forward-looking management strategies must take into account the developments in the design and implementation of sector strategies and development programmes and projects, and therefore be holistic and flexible. Furthermore, management strategies must consider the specific requirements of non-conventional sanitation systems as described in Section 1.1.2. Management strategies must thereby not only focus on the operation and marketing of a specific system or technology, but also on all necessary management aspects that allow for professional operation as well as on institutional aspects that enable and promote sustainable sanitation solutions.

1.1.4 Sanitation research

There has being a shift in thinking towards the need for improving the scientific basis for sustainable sanitation including management taking into account in particular the enormous challenges in sanitation in developing countries (UN-Water Decade Programme on Capacity Development 2015). More research on strategic management aspects in sanitation is needed due to the requirements to improved implementation approaches as demanded by professional associations (IWA 2006; Parkinson *et al.* 2014), the growth of innovative and non-conventional systems and technologies (see Section 1.1.2) as well as the particularly challenging specific aspects of sustainable sanitation such as serving the urban poor (Blume *et al.* 2015).

Lack of combined engineering-management research. There has been extensive research on sustainable sanitation including economic and management aspects. For example, Rudolph and Schäfer (2001) assessed alternative water systems with an international perspective; Rudolph *et al.* (2005) developed water sector guidelines. Other research focused on strategies to improve the transfer of knowledge, technology and services in sanitation (Cornel *et al.* 2005; Lange and Orth 2010; Niederste-Hollenberg *et al.* 2013). In this context large joint research projects have been carried out in Germany, focusing on the development of technologies and treatment methods for municipal wastewater treatment that are adapted to conditions in devel-

oping countries (Scheer *et al.* 2012; BMBF, Resources and Sustainability Department 2013; Emscher Wassertechnik 2015), and prior to that (Cornel *et al.* 2005; Lange and Orth 2010; Schmidtlein 2011). However, in many research projects, management questions are being examined to a much lesser extent in comparison with technical questions, see, e.g., adapted economic methods (Rudolph and Harbach 2010) and monetary and non-monetary selection criteria (Rudolph *et al.* 2010) in the mentioned joint projects.

Furthermore, researchers focused on the simulation of treatment methods as well as the development of decision supporting tools and frameworks including selection strategies. But mostly these are technology-oriented and aim at improving the base for technology choice or developing more efficient sanitation systems. Investigations increasingly include criteria of sustainability such as social, economic and environmental as well as different aspects of management and institutional development.

For example, Cordova (2003) showed options and factors affecting the feasibility of large-scale urban dry sanitation programmes. Mattila (2005) outlined concrete management options for on-site sanitation systems. The Swedish research programme Urban Water developed decision support tools for urban water and wastewater systems, based on five criteria groups for sustainability assessments including economy, environment, technology, health and hygiene, and socio-cultural aspects (Malmqvist and Palmquist 2005). Söderberg and Johansson (2006) assessed institutional capacity as the key to implement sustainable urban water systems besides O&M, and the need to act in a multi-disciplinary way. McConville (2008) studied global approaches to sanitation planning and implementation and compared them with existing local planning and decision-making conditions in West Africa. She concluded that improving sanitation conditions requires tools based on participation, social marketing and approaches for planning, capacity development and feedback.

Researchers of NETSSAF (Barreto-Dillon and Buzie-Fru 2008; NETSSAF 2008) again focused on participatory planning approaches and the management of sanitation in developing countries. Malisie (2008) conducted a sustainability assessment on sanitation systems for low-income urban areas in Indonesia, illustrating in different contexts how sustainability of sanitation systems can be assessed using an integrated comparative approach. Herbst (2008) developed tools for assessing central and decentral wastewater infrastructure systems as a basis for decision-support. Lennartsson *et al.* (2009) developed approaches to compare sanitation systems using sustainability criteria. Meinzinger (2010) used material and energy flow analysis for comparative assessments of resource efficiency of urban sanitation systems. Drewko (2013) investigated low-tech sustainable sanitation options for Ghana and Ethiopia with mainly economic, social and technical aspects. Nayono (2014) developed a planning tool for assessing the sustainability of sanitation technologies in developing countries and the identification of specific problems and interests influencing the se-

lection of a sanitation system in a case study in Indonesia, taking into account technical and non-technical aspects including policy, stakeholders and socio-economic conditions in the regional and project area. And Tilley (2015) assessed acceptance, impact and feasibility of incentives for increasing toilet coverage in a case study in South Africa.

The range of sustainability-oriented research in sanitation has thus been increasing. This corresponds to the paradigm shift towards sustainable sanitation, and the resulting demand for improved knowledge, research and innovation as determined by the UN (see Section 1.1.1).

To further improve the scientific basis for sustainable sanitation, especially management as a way to get there, more holistic, innovative and professional strategies are required. Transdisciplinarity that integrates science and practice as well as different disciplines may well be an improved and appropriate approach.

The key to accelerating progress in the provision of sustainable sanitation is to spread innovations, i.e. basically to scale up innovative sanitation systems, products and services. Different conceptual and technical options are available, and many systems have been developed to meet the challenges in sanitation. Furthermore, awareness of sanitation has been raised during past years through campaigns, conferences, donor policies and country strategies. While most large-scale projects still focus on conventional approaches and technologies; mainly technology innovations have been a driver for promising development in sanitation in many smaller projects worldwide. Management aspects of the dissemination of those innovations need to be of higher priority especially in engineering sciences, the core discipline of sanitation, and ideally developed and implemented in transdisciplinary approaches.

So developing a management strategy that is aimed at the dissemination of innovation taking into account professional requirements for large-scale systems, significantly contributes to achieving the SDG and improving the situation in sanitation.

1.2 Objectives

This research is basically to make a contribution to tackling the enormous challenges in sanitation worldwide particularly in developing countries. It thereby focuses on the impact of professional management on the implementation of sustainable sanitation systems. There is an overall objective, and a research objective which is operationalised with four research questions.

Overall objective that describes the context in which this work refers to, and the planned impact of it:

> To contribute to the scientific basis for sustainable sanitation and its large-scale implementation in practice.

Research objective that contributes to the overall objective, and describes the expected outcome of this work:

> To provide a professional management strategy for large-scale sustainable sanitation.

Research questions that specify the research objective, while answers to those questions constitute the outcome of this work:

1. What is a suitable management strategy for large-scale sustainable sanitation?
2. What are the key factors to assess management needs in a sanitation system and the impact of the strategy implemented?
3. How can the developed strategy be used for decision making and planning?
4. How can the developed strategy be applied in real-world projects?

Research planning to answer those questions included a transdisciplinary approach and four main activities: (1) developing a management strategy with key actions for large-scale sustainable sanitation that is based on scientific analyses and arguments from practice; (2) identifying key factors for success such as indicators or criteria to assess management needs in a sanitation system and the success of actions implemented; (3) developing a tool that facilitates the management needs assessment; and (4) applying the strategy and tool to a real-world case in a developing country.

1.3 Target group and opportunities

This research contributes to building knowledge and methodology of implementing sustainable sanitation on a large scale, focusing on institutional framework and management practices. The results of this research may be useful for both researchers and practitioners.

The target group of this research is in three factions:

- *Decision-makers and financiers who plan and coordinate the implementation of sanitation projects and programmes*—to help improve the planning and implementation of projects and programmes, thus sustaining investments. Beyond that, to help improve approaches to project, programme, and sector development.

- *Utility managers, consultants and other practitioners*—to help develop and monitor sanitation systems and services through identifying management needs and fields of action, thus contributing to sustaining systems and services. Also, to help improve the planning of investments and the upscaling of best practices.

- *Researchers and students from engineering and non-engineering sciences related to sanitation*—to help improve the development of technical, managerial and other solutions towards sustainable sanitation; and to initiate new ideas.

Finally, this work may also help raise awareness amongst non-specialists or laymen of the advantages and requirements of sustainable sanitation. It may thus facilitate the large-scale implementation of sustainable sanitation worldwide.

Opportunities arise for both science and practice. First of all, both researchers and practitioners can use the new tool to quickly assess and illustrate management needs in a system or project. Furthermore, they can use the tool to plan and monitor management interventions.

In science, opportunities thereby result in various disciplines while mainly in engineering and management. In particular, if engineers consider the management needs in the early processes of technology development, the developed products and approaches will meet the needs of sustainable sanitation better. So this research can contribute to improving the development of sanitation technologies and concepts. Beyond that, this research highlights relevant aspects that should be looked at in more detail than it was possible to do in this research because of limited time and resources.

In practice, opportunities evolve from a huge world market for sustainable sanitation, especially in countries where technologies and services are not available or not affordable for all people. This research therefore provides an analytical framework and strategy for professional management of large-scale sustainable sanitation. It supports the implementation of sanitation projects on the one hand and raises potential for marketing innovative sanitation technologies on the other. Where investment projects are accompanied by a professional management strategy, sustainable sanitation on a large scale will be more likely and upscaling is likely to be faster.

Section 7 contains recommendations for further research.

1.4 Limitations

Most researchers are limited in what they can study at one time. I also had to focus and could not analyse every aspect of sustainable sanitation. So this research demands further research, in particular for the real-world application of the results. Limitations in both time and budget made it impossible to implement a real-world project. While I used a model case in a developing country in semi-arid climate to test and improve the previously achieved results and show how it can be applied, the implementation of the case study in a real project was not possible.

Limitations also include lack of time and resources for comprehensive field studies. This mainly refers to the access and availability of data. However, the data obtained as well as data from literature were adequate to fulfil the objectives of this research. A long-term field project or even different case studies, however, could provide more data and thus a better framework to optimise the management strategy.

Based on the limitations I have made some assumptions in this research which are summarised in in Section 2.2. The implications on the validity of the outcome of this work are discussed in Section 7.

1.5 Key terms

There are key terms within the present dissertation whose understanding may vary from one reader to another. This section explains how I use it in this research.

Conventional sanitation includes flush-and-discharge systems, drop-and-store systems and do-nothing systems (see Section 1.1.2).

Developed/developing country classifies a country. Developed countries are considered "developed countries" (UN Statistics Division 2013), "high income economies" (World Bank 2016) or "advanced economies" (International Monetary Fund 2015); developing countries considered "less developed and least developed countries" (UN Statistics Division 2013), "low and middle income economies" (World Bank 2016) or "emerging and developing economies" (International Monetary Fund 2015). The classification takes into account the differences in sanitation between developing and developed countries, but I generally tried to avoid any stigmatisation.

Large scale refers to systems providing sanitation services to many people, i.e. usually beyond quarter level in urban areas. Those systems cannot be operated by non- or semi-professionals only, i.e. without a professional service provider. Large scale is not explicitly defined on the basis of a specific minimum No. of inhabitants or PE. Such a No. would depend on the local conditions, e.g. rural or urban. It can relate to a sparsely-settled large rural area but also to a densely settled urban area e.g. a high-rise building self-sufficient serving many people.

Management is generally defined "the control and organization of something" (Cambridge University Press 2016). Here, it is considered the control and organisation of sanitation under social, economic and environmental goals. In the sanitation industry management is too often seen as part of an engineering perspective, i.e. as the technical management of wastewater. At universities it is common practice to consider sanitation as exclusively an engineering science. Thus, the integration of related sciences runs short in both research and education. Here, management of sanitation is considered holistically taking into account all disciplines relevant for sanitation with focus on the major disciplines engineering and economics.

Non-conventional sanitation includes others than conventional sanitation systems, e.g. *ecological sanitation* or *novel sanitation systems* (see Section 1.1.2).

Professional is traditionally considered such as "relating to work that needs special training or education" (Cambridge University Press 2016). Contrary to needs, sanitation systems in developing countries are not always planned, implemented and oper-

ated by sanitation professionals. In particular, many non-conventional projects are designed and implemented by non-professionals, i.e. people who are highly involved and dedicated to sanitation, but who do not have the professional educational background in sanitation (Panesar *et al.* 2006). However, despite the success of particular initiatives it is necessary to integrate it with the professional sanitation industry to ensure sustainability and effective upscaling (see Section 4.4).

Sanitation is generally used substitutable to *wastewater management*, in German *"Sanitärversorgung"* or *"Siedlungshygiene und Abwassermanagement"* (both translations see Merdes *et al.* 2008); for a specific definition see Section 3.2.2.

Service provider is considered an organisation giving customers access to sanitation or other services. As for sanitation it can provide sanitation related infrastructure, services and products. Used as a generic term; organisation can be public, private, or public–private, large or small, and central or decentral.

Strategy is, amongst others, traditionally considered as "a detailed plan for achieving success in situations such as [...] industry [...], or the skill of planning for such situations" (Cambridge University Press 2016). Here, strategy is considered as a detailed plan to achieve success in the time frame of the sanitation projects in developing countries, e.g. 7 years as in the case study (see Section 6.4.1), building the foundation for sustainable sanitation.

Sustainable sanitation, see Section 3.2.3.

Sustainability, see Section 3.2.1.

Utility is generally used substitutable to *service provider* (see above); however, it is considered to be a professional organisation with a wide range of processes and functions. Small and smallest enterprises focusing on a specific sanitation service are considered as a service provider or *micro organisation* (see Section 4.4).

1.6 Structure of this dissertation

The front of this dissertation contains an abstract, the table of contents as well as lists of symbols, abbreviations, figures and tables. The back provides a record of all references and two appendices of additional information. The main part of is divided into seven sections.

Section 1 introduces the research. It describes the problem and gives background information about it. Furthermore, it states the research objectives, and specifies the target group, opportunities and limitations. Finally it explains the key terms and structure of this dissertation.

Section 2 describes the methodology that I applied to this research. It describes the approach with guiding principles, coordination and management, and the idea of transdisciplinarity. Furthermore, it describes a logical framework as a guiding instrument as well as the processes of research, and the main methods used.

Sections 3—6 present the research results numbered 1—4, and their discussion:

- *Result 1*—management strategy including the underlying strategic framework with analyses of the key strategic issues and strategic objectives, as well as strategy formulation and strategy map.

- *Result 2*—key strategic actions in detail and an analytical framework consisting of indicators and rating criteria suitable to assess management needs in a sanitation system and the level of success of strategic actions implemented.

- *Result 3*—analytical tool to assess management needs in a system, developed as a scorecard and implemented as an Excel file, to support planning of the strategy and monitoring of strategy implementation.

- *Result 4*—case study for a semi-arid Middle Eastern region including a management needs assessment and a professional implementation concept based on the outcome of the assessment.

Section 7 concludes this research. It contains an assessment of the major results and its implications for practice, and the usefulness of the methodology applied. It also contains recommendations for further research.

Appendix A provides the assessment tool in printed version including questionnaire and evaluation sheet.

Appendix B provides the output tables of the case study. It includes the questionnaire and evaluation sheet, comments on the assessment of indicators and a one-page project profile of the defined TA-project as part of the implementation concept.

2 Methodology

The methodology describes how I carried out this research. Firstly, it describes the approach which includes the research philosophy with guiding principles, coordination and management and the application of the idea of transdisciplinarity. Next, it describes a logical framework that I used as the key method to plan and monitor this research. Finally, it describes the processes of research and the methods used.

2.1 Approach

This research is based on critical thinking, literature analyses as well as strategy, scorecard, tool, and case study development. The aim was to provide a professional management strategy for large-scale sustainable sanitation. That includes an analytical assessment framework as well as an implementation concept. The strategy should support both the installation of new and the improvement of existing systems, and be valid for conventional and non-conventional systems which can be centralised and decentralised. It should be applicable in developing countries without regional limitations; but I assumed that it would also be applicable in developed countries.

To meet these needs I used a transdisciplinary approach, characterised by the involvement of institutions from science and practice with different disciplinary orientation and a real-world case study which, however, was developed as model case. During this research, I worked at the university and in the consulting industry. I was involved in more than ten studies and projects in water supply and sanitation, mainly in development cooperation. To work goal-oriented I used the Logical Framework Approach (LFA) that is used in many development projects. Furthermore, I worked process-oriented and used methods from different disciplines but especially from engineering and economic sciences.

2.1.1 Guiding principles

At the beginning of this research I developed four guiding principles:

1. Provide a scientific foundation,
2. Integrate relevant disciplines and views from practice,
3. Link sanitation to business opportunities,
4. Produce applicable results.

Guiding Principle 1: Provide a scientific foundation. This research comprises literature reviews, field data, strategic analyses, developments, a case study and critical thinking. The focus was on lessons learned from both science and practice and on the development of a practice-oriented strategy with key actions and assessment framework. The first step was an analysis of the key strategic issues which provided the underlying theoretical structure for a management strategy towards a sustainable

development of sanitation systems and services. A second step was a strategic analysis which delivered the key strategic actions as well as strategic indicators and rating criteria. Findings are based on literature studies, theoretical analyses and the evaluation of studies and projects. A third step was a case study to test and improve the strategy. To operationalise the research I used a methodology integrating science and practice. Statements in this dissertation are supported by published literature from science or practice or by original work. Some results are based on internal analysis and reports as I have indicated. Results from publications are used as facts and refer to the original source for further details.

Guiding Principle 2: Integrate relevant disciplines and views from practice. Sustainable sanitation requires the integration of knowledge from different fields, e.g. engineering, economics, health, environment, business administration, law and public relations. In practice, engineering and economics are the major disciplines for planning and constructing sanitation infrastructure and for providing sanitation services. Engineering is thereby the constitutional discipline of sanitation which is founded historically (Imhoff 1999; Sickert 1999; Gujer 2002). This observation is reflected by the structure of academic personnel responsible for operations in a sanitation service provider, where engineers and economists represent the two major groups. Engineers, however, are in the majority. They therefore play a significant role in the provision of sustainable sanitation services for tackling the global challenges in this field.

In practice, however, sanitation interventions are too often seen exclusively as engineering tasks (Holden 2008). A lack of institutional and socio-economic knowledge has been widely shown, not only by the many unsustainable conventional water-based sewage systems, but also by many non-conventional projects. Often such projects have a strong technological base but face a lacking institutional or social framework (Kalbermatten *et al.* 1999; Water Supply and Sanitation Collaborative Council and Eawag 2005). To overcome these obstacles a multidisciplinary approach to sanitation projects is required in practice as well as in research which, in addition, requires action and practice orientation. So research on sustainable sanitation has two characteristics: the variety of disciplines involved and its practice orientation. In this research this demanded an approach that allows on the one hand, for answering real-world problems with science and on the other, for providing applicable results to solve those problems.

I found that various research approaches tend to meet the above demands. Nevertheless, while technical solutions may be found in lab and field experiments, the development of a management strategy has to be based on practice experience in management projects. Transdisciplinarity reflects central elements of such demand. I therefore applied it to this research by cooperating with a consulting firm and testing the results of this research in a real-world case (see Section 2.1.2).

Guiding Principle 3: Link sanitation to business opportunities. Sanitation, professionally provided, is a service and thus a business associated with improved conditions for human health and the environment. Business may start at the toilet, where producers and sellers have economic interests, and may end at the WWTP, where producers of treatment equipment and operators have the same interests. Many other players can be involved in the sanitation business, depending on the type of system planned or in place, e.g. consultants, construction companies, individuals and users, e.g. farmers. These stakeholders benefit directly from the system. Sanitation can affect, however, indirectly, e.g. on fishermen downstream a river who may be enabled to raise their earnings after improved wastewater treatment results in cleaner waters and an enhanced fish population.

Linking sanitation to business opportunities also can play a key role in filling financing gaps especially in low-income countries. Bramley and Breslin (2010) described an approach in Malawi where sanitation is considered to be a business to accelerate progress in providing sanitation coverage, mainly latrines. Focus is particularly on business opportunities due to the delivery of services and O&M. Other experience shows that governments acknowledge the use of reliable access to water resources as a competitive advantage to attract business (Sanctuary *et al.* 2005). Sustainable sanitation supports such advantages as it significantly contributes to safe access to water, human health and environmental protection. Moreover, appropriate, often non-conventional systems create the demand for locally developed and produced sanitation facilities, e.g. toilets (Bongi and Morel 2005) which is important to developing countries, especially the poor ones. More business opportunities evolve when sanitation systems allow for reuse of resources which would otherwise be discharged with sewage. For example, nutrients can be reused from on-site systems in rural and agricultural areas (Koné 2007); e.g. marketing and selling products and recycled nutrients through private providers, often small and smallest enterprises (Cairncross 2004; Jenkins 2004; Obika 2004), or the self-use of nutrients by farmers to improve their access to fertiliser for subsistence and food production.

In this research, I tried to consider the correlation of sustainable sanitation and economic development. I based it on the assumption that only economic benefits and professional business structures for O&M can ensure long-term impact and self-continuity of sanitation projects in developing countries, after consultants and development agencies have finished a project and left. Examples show that this is not often the case, e.g. in a project in Malawi where after closure of an on-site sanitation project no further distribution of sanplats (which indeed worked well during the project) took place due to costs and transport problems occurred (Collenberg 2009). This research then shows a way to enhance business opportunities in sanitation through providing a strategy that focuses on professional management of sustainable sanitation on a large scale as well as on a supportive institutional framework.

Guiding Principle 4: Produce applicable results. A transdisciplinary approach applied to this research requires the transformation of results into real-world solutions. According to that the outcome of this research is key actions, indicators and rating criteria to deliver concrete suggestions for real-world needs, as well as an analytical assessment tool that supports scientists and practitioners in real projects. A case study in a developing country helped to check the applicability of results.

Furthermore, close cooperation between science and practice ensured the inflow of project experience of my own and colleagues. With a technical university and a consulting firm, I have studied and taken part in in the planning and implementation of water and sanitation studies and projects in Asia, Africa, Middle East and south-eastern Europe, mainly in Egypt, Jordan, Yemen, India, Syria, Serbia and the Republic of Macedonia. During that work I focused on the requirements of donor-funded projects, as international donors are still the main funding source for large-scale sanitation projects. This approach provided significant arguments for the needs of sanitation projects which I found important when considering the findings of this research in practice. Furthermore, this approach should contribute to increasing the acceptance of non-conventional sanitation with decision-makers from authorities and donors.

2.1.2 Coordination and management

The research has been prepared, planned, coordinated and implemented by myself including the preparation of this dissertation. Three German institutions provided organisational and financial support and facilitated scientific exchange, steering and supervision.

The *Hamburg University of Technology* (TUHH) through the Institute of Wastewater Management and Water Protection (AWW) was the leading research institution. The institute provided organisational and financial support as well as scientific exchange, steering and supervision. It provided arguments from science pertaining to both the technical and the managerial aspects of sustainable sanitation.

The *Federal Ministry of Education and Research, Germany* (BMBF) through the International Bureau of the BMBF provided organisational and financial support as well as scientific exchange in frame of the scholarship programme International Postgraduate Studies in Water Technologies (IPSWaT).

GFA Consulting Group (GFA) provided organisational support as well as arguments from practice pertaining to aspects of sanitation management and institutional development. As worldwide operating consulting firm, GFA provides services in project and programme management, feasibility and sector studies, and fund management. With GFA's Water and Sanitation Department, I carried out different study assignments in developing countries that provided some data for this research.

2.1.3 Transdisciplinarity

Rationale. The term *transdisciplinarity* is seldom mentioned in research papers and practice reports in comparison with *interdisciplinarity* which has become a common phrase. In fact, many researchers and practitioners do not clearly distinguish between the ideas of transdisciplinarity and interdisciplinarity (Blättel-Mink *et al.* 2003; Mittelstraß 2005; Wiek *et al.* 2005). Both ideas are suitable for tackling real-world problems and researchers can benefit from both when considering the differences between and benefiting from the advantages of each. However, Klein (2008) showed that researchers should also consider aspects important to research performance, e.g. requirements for evaluation methods.

Generally, interdisciplinarity aims at producing results in different disciplines on a cooperative basis while transdisciplinarity aims at a mutual working process that includes real-world needs and focuses on applicable results. Specifically, transdisciplinary approaches integrate society and science in two steps: (1) translating a real-world problem from society into a scientific problem; and (2) transforming research results to solutions that are applicable to society (see Figure 2.1). However, the understanding of transdisciplinarity has changed throughout time.

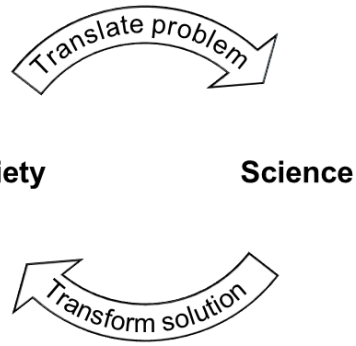


Figure 2.1: Transdisciplinary research integrating society and science

At first transdisciplinarity was understood an organising principle that can change structures of universities to enable social reforms through scientific players (Blättel-Mink *et al.* 2003). Later it was seen as a scientific principle of work to cross the boundaries of disciplines and today, researchers consider real-world problems to be a crucial rationale for transdisciplinary in research (Hirsch 1995; Blättel-Mink *et al.* 2003). Researchers started promoting and using transdisciplinary approaches to build relations between theory and practice, thus to deal better with transitions of complex human-environment systems towards sustainable development in particular (Hirsch 1995; Hirsch Hadorn *et al.* 2008). An application of that idea is the transdisciplinary case study research for sustainable development (Wiek *et al.* 2005). So focus on case studies allows a mutual learning process, the development of appropriate methodologies and an exchange of experience which indeed helps to find innovative solutions for real-world problems; this is relevant for sanitation research.

Despite the wide acknowledgment of transdisciplinary approaches in both research and practice some scientists think these approaches are questionable. Sometimes the methodological know-how, which can be limited pertaining to specific research problems, is seen crucial (Wiek *et al.* 2005). However, researchers use transdisciplinarity more and more successfully in their work. In 2009, a German conference highlighted the need for not only the attractiveness and the potential of trans- and interdisciplinary research for solving current and future problems in different sectors including construction, real estate and infrastructure, being of importance for the future development of societies (Federal Ministry of Transport, Building and Urban Development and Bauhaus-Universität Weimar 2009; Londong 2009). Cordell (2010) also used a transdisciplinary approach in a PhD study on the sustainability implications of P scarcity, which relates to sustainable sanitation.

Definitions. Researchers define transdisciplinarity differently. Mittelstraß (1992) defined it in a philosophical way, i.e. as knowledge or research disengaging itself from its technical or disciplinary boundaries, defining problems while looking at developments beyond science and disciplinary boundaries, and solving problems independently from disciplines. So he understood transdisciplinary research as a principle of integrative forms of research comprising methods to relate scientific knowledge and extra-scientific experience and practice in problem-solving. Mittelstraß (2005) added that a transdisciplinary approach deals with real-world problems and does not focus on science only.

Jaeger and Scheringer (1998) defined transdisciplinarity as being problem and practice oriented. Both see it as crucial that during the early stages of research projects, researchers enable a process of problem formulation and problem solving that dissolves from disciplinary research interests and methods constraints, even more than in interdisciplinary work. They should translate real-world problems into scientific problems in such way that science can deal with those problems. A problem should therefore be separated into its parts; key problems have to be defined; and the later integration of results must be considered. Theoretical framework and suitable methods should be defined in the beginning of research. Finally, research is characterised by permanent exchange and mutual reference to stakeholders.

Jahn (2001) distinguished between two directions. In the “engineering model” communication of scientific knowledge from scientists to practitioners is central while non-scientists apply findings from research. This model is relevant for technology innovation and especially for concepts of supply and discharge. Disciplinary cooperation is thereby pragmatic and usually necessary to reach a joint objective or develop a product. Transdisciplinarity is understood as being objective or product oriented. In the “integrative model”, complex problem dynamic is central. Two types of solutions are carried out: practical solutions for society and internal solutions for science. The latter usually leads to new problems and therefore to scientific progress.

Application in this research. The transdisciplinary approach of this research is based on the ideas of Jaeger and Scheringer (1998), and of Mittelstraß (1992; 2005). I used it to (a) translate a real-world problem from society (large-scale sustainable sanitation) into a scientific problem, (b) solve the problem by research and development (science), and (c) transform the results to real-world solutions (society). Figure 2.2 illustrates this approach. Society was represented by GFA and a case study; science by the TUHH and IPSWaT. Working with GFA and developing the case study allowed identify real-world problems, provide arguments from practice to scientific problem-solving, and apply real-world solutions. Research at the TUHH and involvement in IPSWaT allowed translate real-world problems into scientific problems, develop scientific solutions, and transform scientific solutions to a real-world solution.

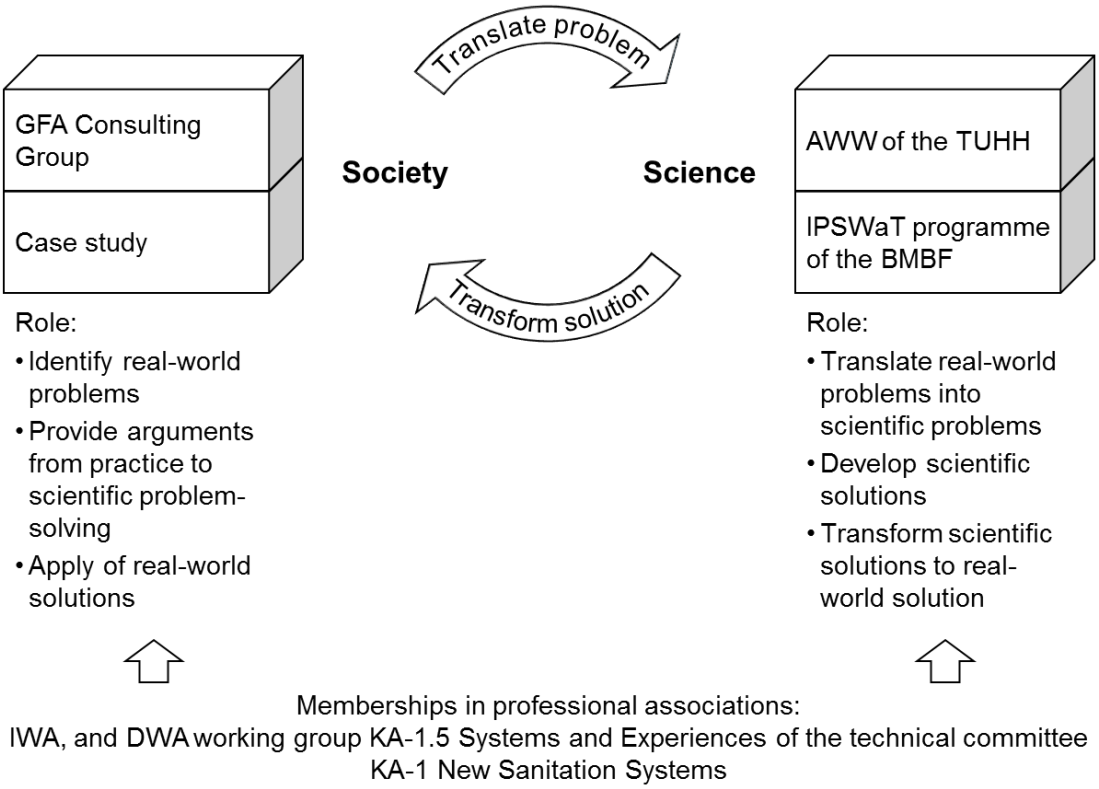


Figure 2.2: Transdisciplinary approach to this research

Furthermore, the transdisciplinary character of this research is reflected by a close cooperation between science and practice and different disciplines, i.e. between GFA and the AWW, and the IPSWaT programme funded by the BMBF. During this research I worked as a research assistant at the AWW, i.e. engineering and science, and later as a consultant with GFA, i.e. economic and practice. IPSWaT integrated researchers from different disciplines in water and sanitation to share knowledge and experience. GFA and the case study brought arguments from practice to identify real-world needs pertaining to the management of sustainable sanitation and to support the transformation of research results into real-world solutions. Research at the AWW and involvement in IPSWaT represented scientific problem solving.

At the AWW, I carried out research focusing on technological aspects of sanitation including concepts for O&M and to study the needs of sanitation management from a technical point of view. I benefited from various research projects in which I took part including Efficient Management of Wastewater, its Treatment and Reuse in the Mediterranean Countries (Al Baz *et al.* 2008), Development of sustainable sanitation technology for a low-cost housing project in Addis Ababa, Ethiopia (Meinzinger *et al.* 2008) and Resource-Oriented Sanitation concepts for peri-urban areas in Africa (2015). Research at the AWW made this work international, and provided insight and criticism from various disciplines also beyond engineering. Insights to the challenges to sustainable sanitation projects raised my awareness of management and hence of the need for an integrated engineering–management approach.

At GFA, parallel to professional work, I carried out research with focus on management aspects of sustainable sanitation. I worked as a consultant in water and sanitation projects in developing countries in the Middle East, Africa, Asia and South-East Europe. Focus was on developing professional institutional and management frameworks to water and wastewater projects. Amongst others, I carried out study assignments to assess institutions and projects and designed framework for sustainable water supply and sanitation. Data obtained during two assignments to Syria were partly used to create the model case in this work. I learnt also how multi and bilateral donor agencies and development banks approach international sanitation projects.

Furthermore, I benefited from various accompanying activities providing arguments from both society (industry) and science. I learnt from working groups, personal networks and scientific exchange. From 2006 to 2009, I joined the DWA working group KA-1.5 Systems and Experience where we assessed non-conventional sanitation systems and projects worldwide (DWA 2008). I also took part in the IPSWaT network and the IWA Young Water Professional Programme.

Beyond that, I took part in more than 15 German national and international workshops, seminars and conferences covering different aspects of sustainable sanitation including engineering and management. During these events I gathered data for this research, and established contacts to experts for scientific exchange.

Finally, I visited over 10 pilot projects of sustainable sanitation during study tours and self-organised travels including: (a) Ecological housing estate in Lübeck-Flintenbreite, Germany (Werner *et al.* 2005); (b) Ecological settlement Allermoehe in Hamburg, Germany (Jurga *et al.* 2005a); (c) Gebers collective housing project in Orhem, Sweden (Syahril *et al.* 2005); (d) greywater treatment project in an urban area in Oslo, Norway (Jenssen 2005); (e) Urine separation and reuse project at the main building of GIZ in Eschborn, Germany (Winker and Saadoun 2011); and (f) Vacuum sewerage and greywater recycling in the office building of KfW in Frankfurt am Main, Germany (Klingel *et al.* 2005).

2.2 Logical framework

Rationale. To comply with the guiding principles of Section 2.1.1 and the principles of transdisciplinarity in Section 2.1.3, a stringent and practice-oriented methodology was required. From working in the consulting industry I learnt that the LFA can be an effective tool to design and implement sanitation development projects. Originally a method of project management, researchers used the LFA also successful in science. Based on those experiences I have used the LFA as the main method to design, to structure and to monitor this research.

Principle. The LFA is a goal-oriented method to analyse, design, monitor and evaluate projects, particularly development projects (Aid Delivery Methods Helpdesk 2004; Örtengren 2004; Boesen 2007). This method is used by governments and non-governmental organisations (NGOs) and multi and bilateral donor agencies. It is a core tool within project cycle management and well applicable to both research and development (McLean 1988; Gijsbers *et al.* 2000).

The LFA consists of a set of methods including the analyses of problems, of stakeholders, of objectives and of strategies, or activity and resource scheduling. The key instrument is the Logical Framework Matrix that is a document while the LFA is the methodology. Usually the matrix consists of four columns and rows used to summarise the key elements of a project plan. It includes four elements: (1) project's hierarchy of objectives in form of a project description or intervention logic; (2) indicators to evaluate results; (3) sources of verification to describe how the project's achievements will be monitored, evaluated and reported; and (4) key assumptions as external factors critical to the project's success (Aid Delivery Methods Helpdesk 2004).

Through its focus is on objectives, the LFA is highly practice-oriented. Although critically discussed (Smith 2000), it is widely accepted by donor organisations, e.g. EuropeAid and KfW Bankengruppe as well as by researchers. Especially complex research requires a logical framework; e.g. ecological research (Ford 2000). In agricultural and natural resources research logical frameworks were used in the form of the LFA (Horton *et al.* 1993; Farrington *et al.* 1997; Gijsbers *et al.* 2000). However, as well in sanitation, the LFA was assessed as being particularly suitable to design sustainable sanitation projects, such as ecosan; it gives the opportunity to involve all stakeholders in planning processes, thus allowing for consideration for all aspects of sanitation (Kvarnström and Petersens 2004).

Application in this research. Here, I used the LFA as a method to specify the key components and logical links, and to detail the expected results as the outcome of this work. So I used the LFA to place this research in a larger context thus showing its possible impact.

I considered important arguments of the LFA critics, e.g. the arguments of Smith (2000), i.e. (a) too complex outputs, (b) one-sided interpretation of problems and (c) difficulties in managing unexpected effects. However, concentration on clear and applicable results, comprehensive discussion of the key problems in sanitation in the starting phase of this research and enough space for new and unexpected findings brought more advantages than disadvantages for this research.

To develop the Logical Framework Matrix, I transformed the research objective and the four research questions given in Section 1.2 into purpose and expected results (see Table 2.1).

Table 2.1: Translation of research objective and questions into purpose and results

Original		Translation
Research objective:	→	*Purpose (specific research objective):*
To provide a professional management strategy for large-scale sustainable sanitation		Professional management strategy for large-scale sustainable sanitation provided
Research questions:		*Results (expected):*
1. What is a suitable management strategy for large-scale sustainable sanitation?	→	*Result 1*: Management strategy for large-scale sustainable sanitation developed
2. What are the key factors to assess management needs in a sanitation system and the impact of the strategy implemented?	→	*Result 2*: Key strategic indicators and rating criteria developed
3. How can the developed strategy be used for decision-making and planning?	→	*Result 3*: Analytical tool for assessing management needs and planning management actions developed
4. How can the developed strategy be applied in real-world projects?	→	*Result 4*: Strategy applied to a real-world case

Table 2.2 is the Logical Framework Matrix of this research. It contains the overall objective and the purpose of research, as well as the expected results from Table 2.1. It further contains indicators to monitor the achievement of results and purpose during and after this research and the sources of verifications to indicate where and how the results are documented in this dissertation. Finally, the matrix provides assumptions as factors outside this research that may affect it. The assumptions correspond to the limitations of this research described in Section 1.3.

Table 2.2: Logical Framework Matrix of this research

Description of research	Indicators	Sources of verification	Assumptions
Overall objective: To contribute to the scientific basis for sustainable sanitation and its large-scale implementation in practice	• Research on sustainable sanitation increased • No. of large-scale sustainable sanitation projects increased	Published papers on sustainable sanitation research and reports on sustainable sanitation projects	
Purpose (specific research objective): Professional management strategy for large-scale sustainable sanitation provided	Dissertation completed, approved, published, and presented	Publication and presentation of dissertation	• Focus on developing countries without regional restrictions • Cooperation between the AWW and GFA active • Involvement into IPSWaT programme
Result 1: Management strategy for large-scale sustainable sanitation developed	• Strategic framework analysed • Objectives to large-scale sustainable sanitation analysed • Strategic areas and key strategic actions identified	Dissertation, Section 3	• Strategic framework is the underlying theoretical structure of this research • Strategy sets forth a vision for both systems and services
Result 2: Key strategic indicators and rating criteria developed	• Key strategic actions analysed • Key indicators and rating criteria developed to assess management needs and the success of actions implemented	Dissertation, Section 4	Indicators and rating criteria tested in a case study
Result 3: Analytical tool for assessing management needs and planning management actions developed	• Software tool developed which is handy and applicable to use standard software • Use of the tool introduced	Dissertation, Section 5 and data file	• Input to the tool are the indicators and rating criteria • Assessment possible for planned and existing projects • Tool supports both planning and decision-making
Result 4: Strategy applied to a real-world case	• Management needs in the case assessed using the tool • Strategic action plan identified using the tool • Implementation concept developed with milestones, time schedule and budget	Dissertation, Section 6	• Site assessments possible or necessary data available • Implementation concept developed as desk study

2.3 Processes

I carried out this research using four processes related to preparing, designing, developing and reporting as illustrated in Figure 2.3 which also illustrates the major tasks and output for each process.

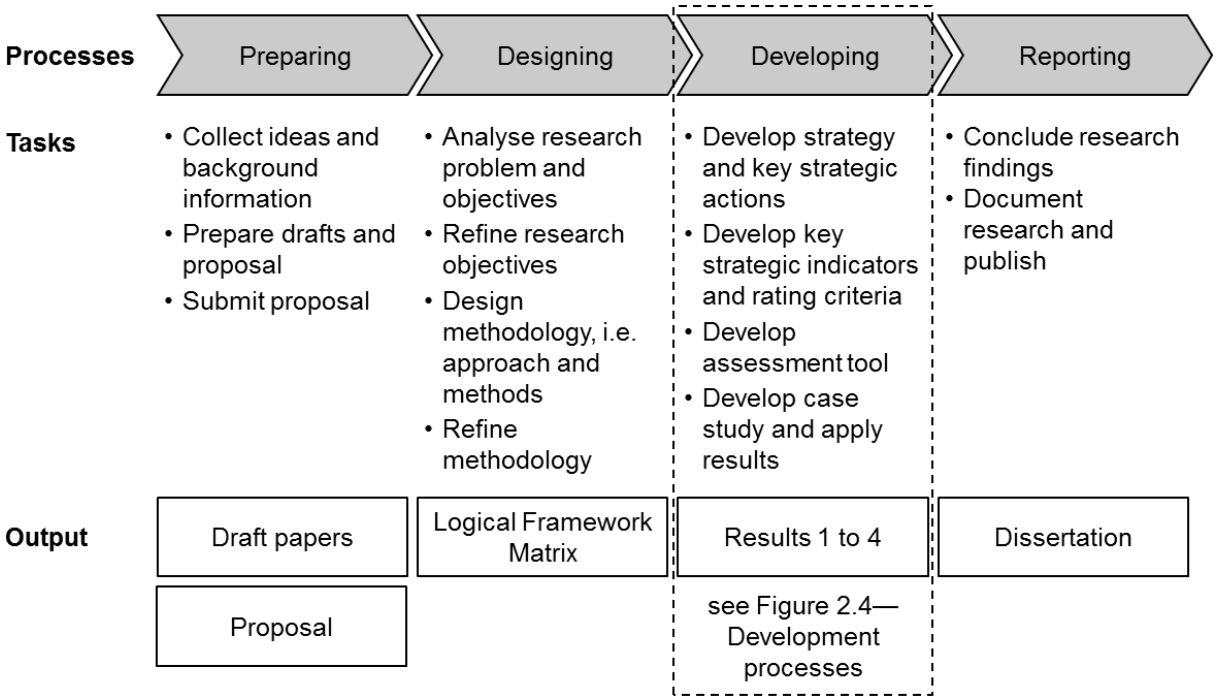


Figure 2.3: Research processes with major tasks and output

Preparing included the creation of ideas and drafts, the collection and studying of literature and the definition of the research objectives. I set up scientific networks and knowledge exchange and therefore took part in workshops, seminars and international conferences including site visits to sanitation projects in Norway, Sweden and Germany. I took part in the diploma course Appropriate Sanitation in the Developing World by Ecosan Norway and the Agricultural University of Norway in Aas, Norway; the 14th Stockholm Water Symposium by the Stockholm International Water Institute in Stockholm, Sweden; the World Urban Forum by the UN Human Settlements Programme in Barcelona, Spain; and the seminar The German water industry with international orientation by DWA in Germany. Finally, I set up logistics and started fundraising. Output was a research proposal successfully submitted to the TUHH and the BMBF. The BMBF funded this research with an IPSWAT scholarship (see Section 2.1.2).

Also, two of my own studies provided ideas and motivation for this research: a comparison of water supply worldwide (Schlüter 2006a) and a wastewater concept for arid climates (Schlüter 2004) which was awarded the Huber Technology Prize 2003/2004 (Bischof 2004).

Designing was the identification of problems and objectives relevant to large-scale sustainable sanitation, based on scientific and practice literature. I developed a methodology and operationalised the research objectives and research questions using the LFA (see Section 2.2). Finally, I refined the initial ideas after gaining deeper knowledge about key management problems in real-world sanitation projects and systems in developing countries, as a result of my professional work.

Developing was again carried out in a chain of four processes; see Figure 2.4 which also illustrates the output of each process. Firstly, I developed a strategy which outlines courses of key management actions for large-scale sustainable sanitation. Secondly, I analysed the key strategic actions and developed an analytical framework with indicators and rating criteria suitable to assess management needs and the level of success of management actions implemented. Thirdly, I developed an analytical tool to support the application of the strategy in real-world projects. Output was an assessment scorecard and an easy to apply software model. Finally, I applied both strategy and tool to a model case in a developing country to check and optimise it (see Section 2.4.4). I carried out a management needs assessment and developed an implementation concept based on the outcome of the assessment. Figure 2.4 illustrates the four developing processes. It shows the four interlinked processes as well as the tasks and the expected output of each process.

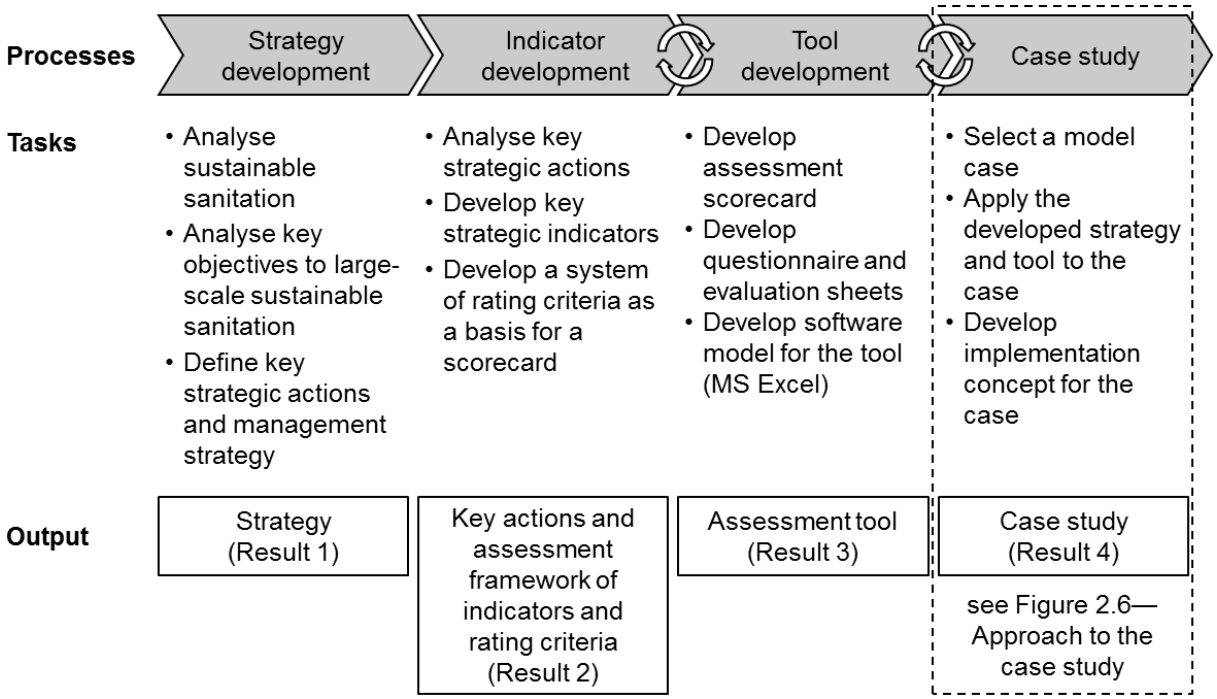


Figure 2.4: Developing processes with major tasks and output

Reporting was basically preparing the results and carrying out the final thesis writing. I documented all relevant aspects, i.e. introduction, methodology, results and discussion, and conclusions including recommendations for further research. Outcome is this dissertation; in addition, the tool is available as an Excel file.

2.4 Methods

To implement this research I used the LFA and a stringent process orientation as described in Sections 2.2 and 2.3. To implement the specific tasks, I used various methods from different disciplines predominantly engineering and economics.

2.4.1 Strategy development

The development of the management strategy required consistency. Kaplan *et al.* (2008) identified four steps of successful strategy development when they analysed strategic planning. Accordingly, managers should answer the following questions: (1) What business are we in, and why? (Clarify mission, values and vision); (2) Where are we going? (Define strategic goals); (3) What are our key issues? (Conduct strategic analysis); and (4) How can we best compete? (Formulate the strategy). Here, I oriented to this process of strategy development but adapted it to the context of this research. I assumed that this strategy would not be a pure business strategy but adapt to wider conditions such as upscaling innovative sanitation systems and building supportive institutional framework for service delivery, with utilities being part of it.

Strategy development was in five steps:

1. *Strategic mission, vision and values*—to affirm the purpose of the strategy, its future aspiration and to define how to realise the mission.

2. *Key strategic issues (strategic analysis, part 1)*—to clarify key issues of the strategy as basis for the analysis of the strategic objectives.

3. *Strategic objectives*—to define the most appropriate mission objectives that will drive the strategy.

4. *Strategic areas and key actions (strategic analysis, part 2)*—to operationalise the strategy with strategic areas and key strategic actions.

5. *Strategy map*—to formulate the strategy and give orientation for planning and implementing the strategy in a real case.

Step 1: Strategic mission, vision and values. Kaplan and Norton (2008) found that a sound business strategy requires first the understanding of the business mission, values and vision. Mission thereby refers to the purpose of an undertaking; here referred to the research objective as in Section 1.2. Values define how the mission is to be achieved; here according to the guiding principles of this research as in Section 2.1.1. Vision refers to the overall objective and guides the entire process of strategy development; here referred to the view of sustainable sanitation as analysed in Section 3.2.3.

Step 2: Key strategic issues (strategic analysis, part 1) were analysed to help clarifying the meaning of *sustainable sanitation* in the context of this research, i.e. management and institutional development. The analysis provided the base for defining strategic objectives and for translating it into key strategic actions. In this step I developed a definition of sustainable sanitation and corresponding figures to build on.

Step 3: Strategic objectives derived from the strategy's mission, vision and values, and the analysis of the key strategic issues in Step 2. I used three methods: analysis of problems, analysis of objectives and analysis of objective compatibility.

- *Analysis of problems (problem tree method)*—to identify key problems for large-scale sustainable sanitation with focus on management problems. The analysis provided negative aspects of unsuccessful sanitation projects mainly through a lack of professional management. Moreover, it set up cause and effect relations between the identified problems. To analyse the problems I used the common three steps methodology: (1) defining framework and the subject of analysis, (2) identifying the main problems faced by target groups and beneficiaries (what are the problems and whose problems are they), and (3) visualising the problems in a problem tree to identify cause–effect relations (Aid Delivery Methods Helpdesk 2004).

- *Analysis of objectives (objective tree method)*—to describe the expected situation of sustainable sanitation in the future once managerial problems have been solved and to verify the hierarchy of objectives in this work. I translated the problems identified in the analyses of problems into objectives or solutions expressed as "positive achievements" (Aid Delivery Methods Helpdesk 2004). The analysis comprised: (1) reformulation of problems into objectives that are innovative and practice-oriented; (2) checking means-end relations to ensure validity and completeness of the hierarchy; and (3) similar to analysis of problems, visualising the problems in form of an objective tree to identify cause–effect relations (see Figure 3.4). I revised some ideas and statements and adapted some previously anticipated objectives.

- *Analysis of objective compatibility*—to clarify the interrelations of the strategic objectives and support the development of the key strategic actions. The method is part of professional project management approaches and used at the stage of project planning (Resultance 2014). Objectives can generally be neutral, concurring, conflicting, identical and complementary. There were no identical, concurring or conflicting objectives and thus the set of objectives could be used for strategy development without being expected to conflict due to interrelations.

Step 4: Strategic areas and key actions (strategic analysis, part 2). Kaplan and Norton (2008) also found that specific and targeted initiatives are required to achieve the strategic objectives. I therefore translated the strategic objectives into key ac-

tions, and organised it according to strategic areas which resulted from the analysis of the key strategic issues in Step 2. The analysis of each key action is documented in *Result 2* (see Section 4). That section further details the analytical assessment framework comprising indicators, rating criteria and scores for each key action (see Section 2.4.2 for the methods used).

Step 5: Strategy map was used to give basic orientation for strategy development and for those who plan and implement the strategy. The map describes the main components of the strategy, i.e. mission, vision, values, strategic areas and key actions and gives basic information about the assessment framework. The map is adapted to the individual case where it is applied. Strategy maps were developed in a different context by Kaplan and Norton (2004; 2008). I used the strategy map mainly as an overview graphic of the strategy. The strategy map helped understanding the strategy during its development and its application in the case study.

2.4.2 Indicator and rating criteria development

The analytical assessment framework consists of 30 indicators and 120 rating criteria. It is to further operationalise the strategy, i.e. to make it measurable. I have developed a system that allows assessing management needs of a system or project as well as the impact of key actions implemented. To develop this system I analysed the 10 key strategic actions and developed key indicators as well as rating criteria based on the outcome of the analysis. The indicators and rating criteria are the basis of a scorecard, implemented as a software tool (see Section 2.4.3). I developed three key indicators for each key action. Each indicator has a score on a scale of 0 to 3. The rating criteria were designed to be assessment values on the one hand and as milestones for project implementation on the other.

The analysis of key actions was generally based on literature from both science and practice, e.g. scientific papers, dissertations, books, studies, project reports and fact sheets. While analysing I focused on key aspects and lessons learned. Furthermore, I considered findings from my own and other's practice work.

To find appropriate indicators and rating criteria, I developed rationales using the funnel approach (Petrina 2008). I started with a hypothesis or a statement on the objectives or both. Then I carried out three steps: (1) analysing the broad context, the perspectives and theoretical background of each key action; (2) describing the key aspects of each key action possibly using examples and data; and (3) analysing and discussing the information given (see Figure 2.5). Based on those rationales I formulated three indicators for each key action. Next, I analysed each indicator to find relevant aspects that help describe and verify it. I summarised the main aspects as rating criteria. Finally, I documented the indicators and rating criteria as a matrix in a table for each key action.

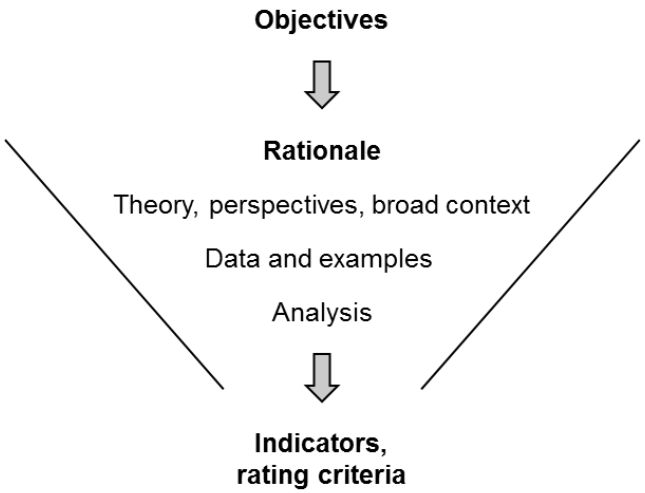


Figure 2.5: Funnel approach to identify indicators and rating criteria

The development of the indicators and rating criteria was also based on literature including research papers, practice reports, technical guidelines and books on management as well as on my own practice experience. Indicators, in particular, based on regulations and guidelines where possible, to provide an industrial and worldwide agreed foundation on the one hand and to avoid the development of new indicators from scratch on the other. Where applicable, I followed the nomenclature of the IWA (Matos *et al.* 2003). However, I developed new indicators where I did not find appropriate indicators in the literature.

The rating criteria are basically qualitative statements that cannot replace quantitative criteria of particular performance assessments. The rating can be difficult in practice because in some cases two or no answers can be correct. The users of the tool are thus asked to answer according to their own opinion and experience. The aim of the assessment is to identify management needs and thus crucial fields of action. The rating criteria can be used as milestones to plan the strategic management actions.

The strategy and analytical assessment framework comprise the following elements:

- *4 Strategic areas*—to follow the key strategic issues of sustainable sanitation and to give orientation to key actions. These are derived from the key strategic issues and the strategic objectives.

- *10 Key strategic actions*—to follow the strategic objectives, and provide an applicable management support framework. These are derived from the strategic objectives, and were assigned to the respective strategic areas.

- *30 Key strategic indicators*—to describe activities and actions as key to the achievement of the strategic objectives. The indicators were limited to 3 for each key action so they had to be key indicators. These are derived from the analysis of key actions.

- *120 Rating criteria*—to describe the indicators in detail and to prepare a scoring system which allows assessing and evaluating the indicators thus the respective key action. The criteria are derived from a corresponding analysis, and if possible, are based on known criteria from the sanitation industry.

2.4.3 Tool development

The assessment tool consists of a scorecard, a software model as an Excel file and instructions on the application.

Scorecard is the strategy as quantified information that helps to motivate and drive the impact of the strategy. It helps to assess management needs in a sanitation system or project and to evaluate implemented actions as corrective measures on the basis of the developed indicators.

For each indicator, I developed a criteria-based scoring system that allows rating the indicator on a scale from 0 to 3 in whole numbers with 0 meaning undesirable and 3 desirable. The full key to scores is given in Section 5.1. The rating of the indicators and distinction between individual scores is based on individual criteria (total 120 rating criteria). For each key action, I developed total scores as the arithmetic mean of the scores of the three related indicators, rounded to one decimal point. Those values are plotted in a radar chart to provide a brief graphic overview of the results of the assessment.

Furthermore, I developed a *Total Management Score* as the arithmetic mean of the total scores of all key actions also rounded to one decimal point. This score should not be the central result of the management needs assessment but be a useful value that enables the user of the tool to compare or even benchmark different systems pertaining to its management status.

Despite I analysed the compatibility of the strategic objectives, I did not analyse the interaction of the indicators and rating criteria. Other authors have analysed such interaction in multi-criteria approaches with methods such as cognitive mapping (Eden and Ackermann 1998), and used it (Mendoza and Prabhu 2003; Eden and Ackermann 2004). Here, however, indicators and rating criteria should be equally important and the tool should not take into account the relative importance of indicators (weighting) or a possible combined impact of indicators on the strategic objectives. I assumed that the tool would be helpful for decision support but not be able to make right decisions for decision-makers with true-or-false results. Users of the tool would be required to interpret the results according to needs, and weighting should be left to the user who may to take into account the specific conditions in a sanitation system.

Software model. The tool is implemented as one file in Excel format. The file consists of two data sheets, a questionnaire as the input sheet and an evaluation sheet. The strategic indicators and rating criteria in the questionnaire are identical with those in Section 4.

The software is designed to calculate a total score automatically for each key action after the individual scores of all related indicators have been entered. The software also calculates the *Total Management Score* after scores have been entered for all 30 indicators in the questionnaire. Furthermore, the software automatically plots the total scores of the key actions in a radar chart and the scores of the indicators as a bar chart in the evaluation sheet to illustrate the assessments results.

The software used is Microsoft Excel 2010 for Microsoft Windows. Other software models would have been applicable but I wanted to use a tool that can be applied worldwide which would be easy to handle. I designed the questionnaire and evaluation sheet as templates ready for printing and included a printed version ready for copying in Appendix A.

The analysis is a recommendation for designing a management support project. The rating criteria recommended in the evaluation sheet are the next best criteria for an indicator on the scale from 0 to 3. It can be seen as the next goal to be reached in the system, while planners of a project may define even more ambitious goals.

Application of the tool. This tool enables informed experts to quickly assess, implement, and monitor management needs and interventions in a sanitation system or project. The tool is applicable worldwide. It is in English and allows considering local conditions independent from the level of development of a country. It can easily be translated into other languages as there are brief comments on its use that act as an application guideline. Also the tool can easily be adapted to other fields of application by maintaining the existing structure, e.g. water supply, waste management, irrigation, and agriculture.

2.4.4 Case study development

The case study was to test and refine the prior results of this research and demonstrate how it can be applied to real-world projects.

The subject of the case:

> Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region.

I defined a model region for a large-scale sustainable sanitation project in the Middle East based on realistic data from both research and practice.

The case selection was based on four reasons:

- I considered the case to be appropriate because in real projects others showed that there are options to conventional sanitation in developing countries, e.g. using constructed wetlands, i.e. “technologies are available” according to the consensus of experts of the IWA (2006). Pilot projects have been successfully implemented in Syria (Mohamed 2004; Mohamed *et al.* 2005; Münch *et al.* 2009) as well as in other Mediterranean countries (Masi *et al.* 2008), see also Section 6.1.1. So there was a basis for upscaling the technology in the region with room for a supporting management strategy which did not yet exist.

- I obtained data and further information on water institutions and operations in developing countries in arid and semi-arid climates during my professional work with GFA, e.g. in Syria, Yemen and India (Rajasthan).

- I received technical and logistical support by GFA and local firms particularly ARBEET for Engineering & Consulting, Damascus.

- I established contacts to various water sector stakeholders in different developing countries which were necessary to obtain further data and information on sanitation in those specific regions.

The study was a desk study in four steps:

1. *Initial situation*—to describe the case with background information and define a model region with realistic data including my own professional experience. Previous studies in Syria brought helpful indication of the needs and conditions for implementing sustainable sanitation in a developing country especially with a semi-arid climate. Since 2009 the situation in Syria, however, has changed substantially due to war and other developments, so that it would have been difficult to apply the previous data in the case study.

2. *Strategy formulation*—to apply the strategy to the case study. It included the definition of mission, vision and values in the case and the development of a strategy map as an adaptation of the general strategy map in Section 3.6. Part of the strategy map is a reference to the strategic action plan that I developed later in the implementation concept. Furthermore, the strategy formulation includes a description of areas of importance related to the strategic actions, based on the outcome of the management needs assessment.

3. *Management needs assessment*—to apply the analytical assessment framework consisting of indicators and rating criteria, and the tool. It comprised the analysis and assessment of the case data in a desk study using the developed tool. The outcome of the management needs assessment led to implications for an imple-

mentation concept of required management actions, presented in the strategic action plan (work breakdown structure as objective tree). The questionnaire and evaluation sheet completed with the case data are provided in Appendix B.

4. *Implementation concept*—to show how the outcome of a management needs assessment can be translated in a concept for implementation. The concept bases on strategy formulation including the strategy map and the outcome of the management needs assessment. It provides a strategic action plan and translates the assessment results in a defined project as a basis for further project planning, including an estimation of the project costs.

Figure 2.6 illustrates the approach to the case study with the four basic steps as described above and the three detailed steps of the implementation concept. In practice, the strategy formulation, management needs assessment and strategic action plan are recurring steps to consider the progress made in implementing the strategy.

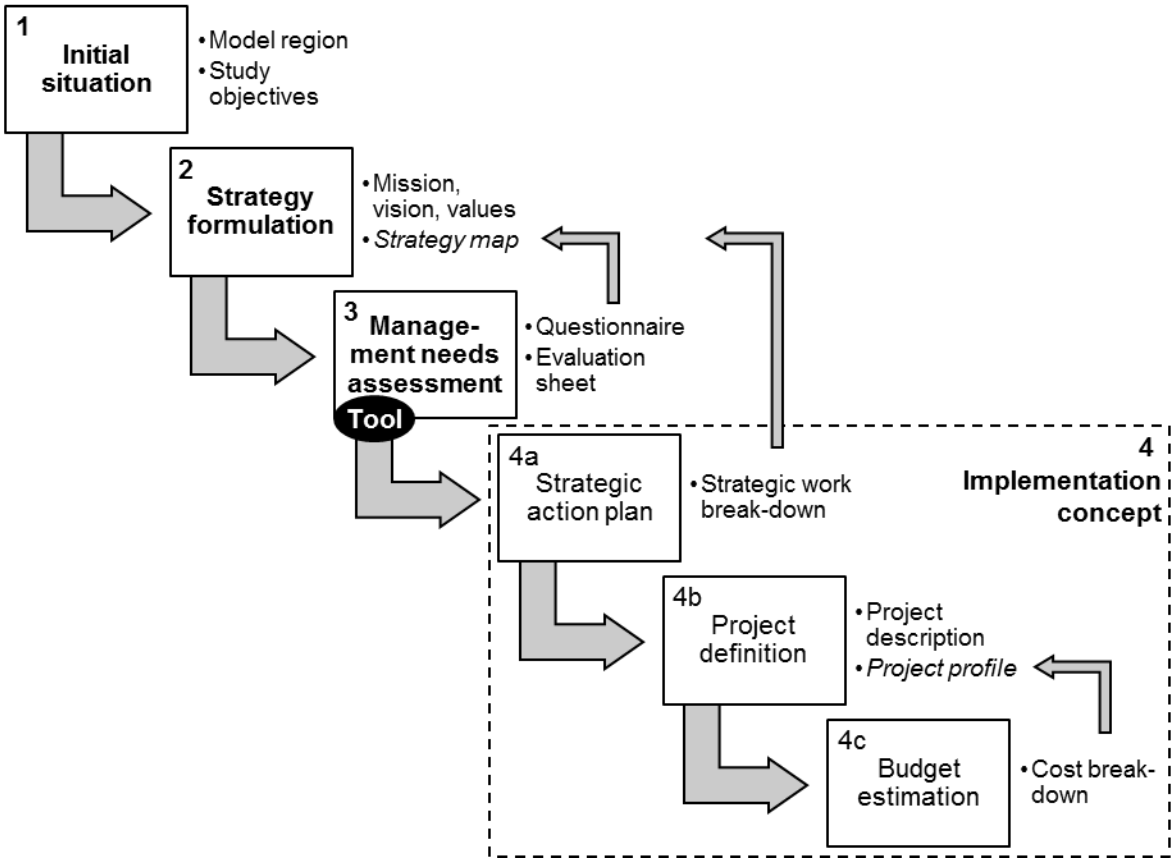


Figure 2.6: Approach to the case study

Project definition as a method of project management is recommended by professional project management associations (Resultance 2014). Applied to the case study it brought statements on project title and project No., a description of the major project objectives and expected results as well as assessments of the project context including key stakeholders and project risks, illustrated in corresponding portfolios.

Further elements are communication, coordination and organisation of the project as well as project phases and milestones illustrated in a plan together with an estimation of the project cost development over the project duration. I did not plan the project in detail which would have required the elaboration of a detailed project plan including a full description of all work packages as well as a detailed planning of activities, staffing and costs which is part of later stages of the project preparation. An alternative method to project definition is the elaboration of an LFA (see Section 2.2, and UNEP *et al.* 2004 for application in sanitation). However, as I used the LFA to plan this research (see Section 2.2) I did not use it again in the case study. Finally, a one-page *project profile* summarises the defined project as recommended by the project management associations.

Data collection included key data from professional assignments on site. As part of a feasibility study and other projects with GFA, I analysed the water and wastewater industry in developing countries between 2006 and 2009. However, I used only the data that was published or officially accessible; other I assumed based on comparable figures. Collection of data was difficult and time consuming and required patience. Assessment of that data was also problematic as much data was old, incomplete or incorrect which made comprehensive analyses difficult. Finally, data had sometimes been documented in Arabic. Translation of it was time consuming and endangered mistakes in correctness. For this research it was an advantage to gather data from professional analyses which led to better data than any other gathered from research missions. This approach made this research also practice-oriented and more appropriate to real-world needs.

Site visits were conducted with the TUHH and GFA in developing countries, e.g. Syria in 2006 and 2007. I gained insights to the country's framework for sustainable sanitation and in particular the emerging situation. I visited water and sanitation utilities and projects as well as irrigation and housing areas influencing the planning of sanitation systems around Damascus. The purpose of those visits was to familiarise and observe the existing situation to understand the data better, and to prepare for interviews and discussions. Other site visits took place in Egypt, Jordan, Yemen, India (Rajasthan), Serbia, and the Republic of Macedonia.

Interviews and discussions meant both formal and informal interviews and discussions with decision-makers, managers of water and wastewater utilities, section heads, engineers and consultants from private industry, donor representatives as well as residents. The purpose of those dialogues was to gain the views of stakeholders about the existing situation, problems and areas of need in sanitation. During those discussions I collected data on the water industry in the countries, such as performance data of utilities. I also learned about the expectations and estimations of stakeholders regarding future development in sanitation, especially those of utility managers having gained experience from onsite work.

Stakeholder analysis was used to identify and characterise major stakeholders of the case study as different groups have different concerns, capacities and interests. Using the stakeholder analysis allowed a better understanding and considered the differences in analysing the problems, setting objectives and defining approaches. Aid Delivery Methods Helpdesk (2004) recommended five steps to carry out stakeholder analyses in development projects: (1) identify the general development problem and opportunities to solve it; (2) identify groups having significant interests in a project; (3) investigate roles, different interests, relative power and capacity to take part, e.g. strengths and weaknesses; (4) identify the extent of cooperation or conflict in relations between stakeholders; and (5) interpret findings of the analysis and incorporation of relevant information into project design. I modified this sequence of steps slightly, while aiming at answering the core questions. In the implementation concept I illustrated the identified stakeholders in a portfolio with an estimation of the individual relations of impact or power and potential for conflict.

2.4.5 Further methods

Analysing and citing literature. The literature analysed comprised publications from both science and practice. Amongst others books, scientific papers, dissertations, sector papers, fact sheets and project reports. While analysing the literature I focused on key aspects and lessons learned. For documentation and citation of literature I built up an electronic literature database. I therefore used first Reference Manager and later Citavi 4 Pro as software tools. The citation style is based on the instructions for authors for *Water Science & Technology* by IWA Publishing (2016).

Dissertation structuring and scientific writing. The structure of this dissertation basically follows the “IMRAD” method, i.e. structuring in sections on introduction, methods, results and discussion (Day and Gastel 2011). However, I included the discussion in the sections on the results and concluded the research in a separate section as recommended for *Water Science & Technology* by IWA Publishing (2016). Furthermore, I tried to follow the common rules on *scientific writing* (see European Association of Science Editors 2015). To improve my own writing and editing skills, I took part in seminars and used different guides, in particular the guides of Barker and Manji (2002), Gustavii (2008), and Day and Gastel (2011). I also consulted the guides on style of *The Economist* (2016), the European Commission Directorate-General for Translation (2016) and the Publications Office of the European Union (2016). To meet formatting challenges, I considered the hints of Nicol and Albrecht (2010) and DIN Deutsches Institut für Normung (2011).

Personal involvement in studies and projects. During the period of this research I was involved in more than 10 studies and projects in water and sanitation. This experience enhanced the practice-orientation of this research and reflects the transdisciplinary approach (see Section 2.1). My own practice experience from working with a

consulting firm in international development cooperation provided valuable information on real-world sanitation projects that cannot be reviewed in libraries. During that work it was possible to gain data, knowledge and experiences from insights into sanitation development projects in the Middle East, Africa, Asia and south-eastern Europe. Also many fruitful discussions with professionals from all over the world evolved. Moreover, active participation in studies and projects during the time of this research, allowed me regular monitoring of this research to reflect, prove and revise my approach and methodology accordingly.

Communication and feedback. I carried out this research in consultation with other researchers and practitioners to communicate and obtain feedback to improve the methodology and results. I discussed with colleagues from the AWW and GFA, with IPSWaT participants as well as with colleagues of a DWA working group on novel sanitation systems, in which I took part during this research (see Section 2.1.3). I also discussed with other sanitation experts from Germany and abroad, e.g. at national and international conferences and seminars. In addition, I discussed with people who were not very familiar with the subject of research topic but were able to provide critical thinking and ideas from other fields and disciplines. These discussions brought input to ideas while allowing me to reflect, review and receive impulses.

3 Strategy development

This section provides, *Result 1,* a management strategy for large scale sustainable sanitation and the discussion of it. It comprises the strategy development including the analysis of the key strategic issues and strategic objectives as underlying theoretical structure. The strategy comprises 4 strategic areas and 10 key strategic actions with a focus on management and institutional development. It sets forth a vision for both sanitation systems and services, and integrates the two with the idea of sustainable development. A strategy map gives an overall picture of the strategy.

3.1 Strategic mission, vision and values

The basic idea behind this strategy is that sustainable sanitation on a large scale requires more than appropriate technologies and guaranteed investments; it also requires professional management and supportive institutional framework (see Section 1.1). The guideline for the development of this strategy includes general statements on mission, vision and values:

Mission: Management strategy for large-scale sustainable sanitation.

Vision: Sustainable sanitation implemented on a large scale.

Values: Scientific foundation, transdisciplinarity, business orientation and applicability.

The mission statement refers to the purpose of an undertaking or project or system as in the case of sanitation. Here, it refers to the research objective as in Section 1.2. The vision statement refers to the overall objective of an undertaking and is to guide both strategy development and its implementation. Here, it refers to the overall objective of this research as in Section 1.2. The statement on values defines how the mission should be achieved. Here it is reflected by the guiding principles of research as in Section 2.1.1. Those statements build the first step of the strategy. According to Kaplan *et al.* (2008), they need to be affirmed or reaffirmed during for every case.

3.2 Key strategic issues

The term *sustainable sanitation* is mentioned often in scientific papers and practice reports. While there are definitions of it, e.g. by SuSanA (2008), its understanding is often left open to the interpretation of the reader. Here, sustainable sanitation is basically understood as the provision of sanitation services to users in achieving the goals of sustainable development. To be specific, the analysis of the terms sustainable development and sanitation is required. The consolidation of both leads to a specific understanding of sustainable sanitation that the theoretical framework of this strategy gives.

3.2.1 Sustainability

Definitions. The first idea of *sustainability* was developed as a concept of nature-oriented forestry (Gottschlich and Friedrich 2014). In 1713, in the context of an expected shortage of wood in Europe, Hans Carl von Carlowitz called for a "*nachhaltende Nutzung*" (sustainable use) of wood (Grober 2013). Forestry should pay attention to the regrowth of wood as a responsibility for future generations. The first idea of sustainability was thus primarily a nature-oriented economic principle, but other aspects of today's sustainability considerations have not been included (Hahne 2013).

Sustainable development was the first internationally acknowledged definition of sustainability as a wider principle. It is documented in the *Brundtland Report* by the World Commission on Environment and Development (1987):

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

In their definition, which was developed without reference to the definition of Carlowitz (Gottschlich and Friedrich 2014), the commission's experts acknowledged that all people have the same rights and equal development opportunities need to be ensured among the present generation as well as between present and future generations. The definition is thereby more a concept and specific criteria must be derived from it to apply it to concrete projects in science and practice.

Later researchers and practitioners understood sustainable development as a balance of social, economic and environmental goals—the three-sector perspective (Robinson and Tinker 1995; Clayton and Radcliffe 1996; International Council for Local Environmental Initiatives 1996; Hardi and Zdan 1997; Bossel 1998). The German Council for Sustainable Development (2015) developed a generally business oriented Sustainability Code comprising 20 criteria which also relates to the commission's definition and the three-sector perspective.

Adapting the idea of sustainable development to the case of sanitation and taking into account the complex challenges in sanitation (see Section 1.1.1); a more specific definition of it is needed, especially for the development of practice-oriented management strategies.

Particular perspectives of sustainable development include further goals, e.g. institutional (UN General Assembly resolution 55/2; Sachs 1999; Valentin and Spangenberg 2000; Van der Vleuten-Balkema 2003), or health (Malmqvist *et al.* 2006b). Such additional goals are necessary to develop solutions for complex problems better, e.g. infrastructure for complex human-environment systems such as sanitation.

However, comprehensive analyses of sustainable development do not only show the possible need for more goals. It also show that the commonly used three-ring view can lead to approaches where the three sectors are seen separately, only partially connected and therefore not integrated (Giddings *et al.* 2002). Social, economic or environmental goals may be of priority then; a balance of all goals cannot be achieved. Such an approach would lead to undesirable and unsustainable development. An agreed conclusion is that sustainable development should evolve without prioritising a specific sustainability goal (International Council for Local Environmental Initiatives 1996; Hjerpe 2005). Moreover, it should integrate all relevant elements and sectors. Sustainable sanitation, which represents a complex human-environment system, therefore requires more than technical or economic feasibility.

Application in this research. To develop this strategy, I used the three-ring perspective on sustainable development as a basis to create a new view of sustainable sanitation.

3.2.2 Sanitation

Definitions. Generally, sanitation covers all conditions affecting health and the environment, e.g. water, wastewater, hygiene and human health. Specifically, sanitation and its system boundaries are defined differently (Larsen and Gujer 1997; Hellström *et al.* 2000; Van der Vleuten-Balkema 2003; Bracken *et al.* 2004; Drangert 2004; Evans 2005a; Malmqvist *et al.* 2006b, IWA 2008a, 2008b; Lennartsson *et al.* 2009). The Sanitation 21 task force of the IWA called for sanitation systems that minimise or remove health risks and negative impacts on the environment; a sanitation system therefore (IWA 2006, modified):

- collects excreta;
- transports it to a suitable site, stores it for treatment, or both;
- treats it;
- reuses it, discharges it to the environment, or both.

On behalf of the German development cooperation Merdes *et al.* (2008) translated sanitation into German as *"Siedlungshygiene und Abwassermanagement"* while they also used the more general translation *"Sanitärversorgung"*. They focused on two major aspects of sanitation hygienic conditions in a settlement and wastewater management. In the English translation of the publication Merdes *et al.* (2009) defined sanitation as: (a) secure, affordable and dignified access to sanitation facilities; (b) sustainable wastewater and waste management that protects people against infection and preserves the environment; and (c) awareness of hygienic behaviour.

Other experts defined sanitation with focus on the specific actions to be undertaken respective to its specific objectives and with focus on the specific elements of the system. Evans (2005a) defined sanitation as interventions that improve the man-

agement of excreta, usually the construction of facilities such as latrines. Researchers of NETSSAF (2008) defined it as a system that "considers all components required for the adequate management of human wastes: the users of the system, the collection on household level, transport, treatment, and management of end products". Furthermore, the researchers defined the three main elements of a sanitation system as products, processes and flowstreams. Tilley *et al.* (2008) defined sanitation "a battery of actions that all aim to reduce the spread of pathogens and maintain a healthy living environment […] specific actions related to sanitation include, wastewater treatment, solid waste management and storm water management". Tilley *et al.* (2014) defined sanitation in an even more goal-oriented way, as "means of safely collecting and hygienically disposing of excreta and liquid wastes for the protection of public health and the preservation of the quality of public water bodies and, more generally, of the environment".

Application in this research. The above definitions provide an understanding of the principle and the objectives of sanitation which I agree with. However, the development of this strategy requires a view of sanitation that takes into account its different actions especially the differences between technical and managerial actions. I therefore developed the following definition:

> *Sanitation* is the sum of all technical and managerial actions enabling the collection, transport, treatment or discharge and reuse or disposal of wastewater and associated streams; it protects human health and the environment.

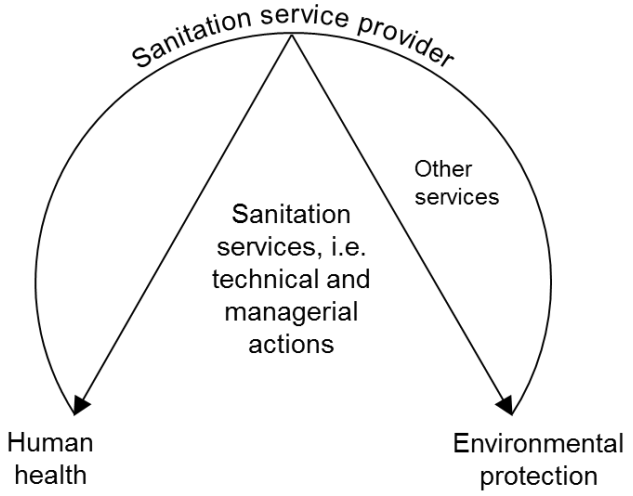


Figure 3.1: View of sanitation service provision—towards human health and environmental protection

Sanitation services are the heart of every functioning sanitation system. Services generally comprise technical and managerial actions, while service provision becomes a key role after the physical sanitation infrastructure has been constructed and commissioned and people have started using the system. Figure 3.1 illustrates

that view. It builds a conceptual framework for sanitation service provision towards the two major objectives of sanitation, human health and environmental protection. It further illustrates the sanitation service provider and services comprising technical and managerial actions, while the service provider may deliver other services as well.

Sanitation systems consist of three basic elements; organisation, technology and users—adapted from a model for urban water and wastewater systems (Malmqvist and Palmquist 2005; Malmqvist *et al.* 2006b). However, to develop a holistic management view of a sanitation system I consider institutional framework as equally important as institutions influence the development of each element. Also, supportive institutional frameworks are crucial to the development of large-scale sanitation systems, especially non-conventional systems (Söderberg and Johansson 2006; Dombrowsky 2008; Johansson *et al.* 2009; Pfeiffer 2009a; SuSanA 2009); although the implementation of non-conventional systems requires certain drivers and promoters (see Section 1.1). Figure 3.2 illustrates this view of a sanitation system; however, in a broader view that includes the goals of sustainable development.

It is considered that sanitation systems evolved over time from different steps of innovation (see Section 1.1.2 for the major system innovations that are relevant for the development of this strategy). The described view of a sanitation system, however, is considered to be valid for all types of sanitation systems.

3.2.3 Sustainable sanitation

Definitions. Researchers and practitioners define *sustainable sanitation* differently. Some definitions are of general character, others include additional goals. Moreover, some authors developed their definition over the years taking into account changing challenges and perspectives in sanitation.

Larsen and Gujer (1997) related the sustainability of both sanitation and water supply systems to the various functions. A sustainable system should thereby: (a) guarantee urban hygiene, (b) assure drinking water of good quality and in sufficient quantities to allow use for personal hygiene, (c) prevent flooding and allow drainage of urban areas, (d) integrate urban agriculture into urban water management and (e) provide water for pleasure and for recreational aspects of urban culture.

Van der Vleuten-Balkema (2003) defined sustainability with a focus on technology and services where services are considered more important than technology. Hence, sustainable technology would not threaten the quantity and quality of resources and have lowest costs with respect to physical, socio-cultural and economic environments. It would require a balance of costs with respect to resources in a way that the contribution to local and global problems is minimised, but known and accounted for.

Mara *et al.* (2007) considered four fundamental principles of sustainable sanitation: (1) human health, (2) affordability, (3) environmental sustainability and (4) institutional appropriateness. They used these principles to develop a sanitation selection algorithm as a guide to identify the most appropriate arrangement, especially in poor rural and peri-urban areas in developing countries, considering all available sanitation arrangements including non-conventional and low-cost solutions.

Experts of SuSanA (2008) recommended designing or improving sanitation systems taking into account sustainability criteria in five categories (modified): (1) health and hygiene; (2) environment and natural resources; (3) technology and operation; (4) financing and economics; (5) socio-culture and institutions. The experts further defined that "the main objective of a sanitation system is to protect and promote human health by providing a clean environment and breaking the cycle of disease […] in order to be sustainable, a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources".

Malisie (2008) assessed the sustainability of sanitation systems specifically for Indonesia on five hands-on criteria: (1) preventing disease: capability of destroying or isolating faecal pathogens; (2) being affordable: accessibility for the world's poorest people; (3) protecting the environment: prevention of pollution, return of nutrients to soil, and conservation of water resources; (4) being acceptable: being aesthetically flawless and consistent with cultural and social values; and (5) being simple: robustness for easy maintenance with limitations of local technical capacity, institutional framework and economic resources. As this definition includes specific elements that relate to the specific context of the project in Indonesia (e.g. required robustness), I understand it not only as a definition of sustainable sanitation but also of appropriate technology for the given context.

Lennartsson *et al.* (2009) considered a sanitation system and related services to be sustainable if they: (a) protect and promote human health, (b) do not contribute to environmental degradation or depletion of the resource base, and (c) are technically and institutionally appropriate, economically viable and socially acceptable.

Application in this research. The strategic framework requires a specific definition of sustainable sanitation with a focus on management and institutional development. Section 1.1 documents that many sanitation systems in the world cannot be considered sustainable. Technology and services are too often seen as separate from the society, economy and environment, e.g. wastewater fees are not affordable for poor people, i.e. social deficiency; sanitation service providers do not cover O&M cost, i.e. economic deficiency; or sanitation technology is designed without suitable adaptation to local conditions which leads to limited function thus environmental pollution, e.g. water-based sewerage in water scarce regions, i.e. environmental deficiency.

To be sustainable on a large scale, sanitation requires the integration of actions for each element of the system, and a holistic view overcoming barriers between disciplines. Sustainable sanitation is an integrated system that is more than technically appropriate and economically feasible. Balancing social, economic and environmental goals for sanitation means that all elements of a sanitation system organisation, technology and users as well as its institutional framework evolve from social, economic and environmental relations.

While acknowledging the definitions above, I define sustainable sanitation here with a specific statement for *value adding by reuse* and a link to *business opportunities* according to the guiding principles of this research (see Section 2.1.1). My definition thereby combines the views of sustainability and sanitation as described in Section 3.2.1 and Section 3.2.2:

> *Sustainable sanitation* is the sum of all technical and managerial actions enabling the collection, transport, treatment and reuse or disposal of wastewater and associated streams balancing institutional framework, organisation, technology and users under social, economic and environmental goals; it protects human health and the environment and adds value by the reuse of resources.

Figure 3.2 illustrates a new view of a sustainable sanitation system that relates to the above definition. It shows the sanitation system with its three elements; organisation, technology and users as well as the institutional framework which applies to all elements and combines it. Furthermore, it integrates the sanitation system with the three goals of sustainable development; social, economic and environmental. This new view of sustainable sanitation forms the conceptual framework for the management strategy.

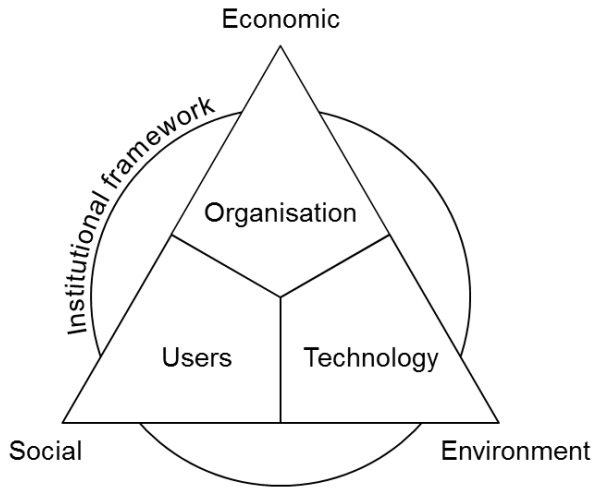


Figure 3.2: New view of a sustainable sanitation system—integrating institutional framework and the major elements of a system organisation, technology and users, as well as the major goals of sustainable development

The integration thereby relates to the whole system, i.e. each goal of sustainability applies to each element of the system as well as to the institutional framework. This does not mean that the individual sustainability goals are allocated to the individual system elements as the figure may suggest, although, there may be a major relation between the individual goals and elements as illustrated, i.e. social and users, economic and organisation, and environment and technology.

In other views, researchers considered other elements as part of a sustainable sanitation system, e.g. Bracken *et al.* (2004) who considered “health”, and Malmqvist *et al.* (2006b) who considered “socio-culture”. However, I consider human health as one of the social goals of sanitation and not as an element of the system. Human health will be reached when all elements of a sanitation system work together. Socio-culture is often seen a sum of institutional and user related aspects without making clear the differences between them. Bracken *et al.* (2004) distinguished three aspects in social criteria: cultural acceptance, institutional requirements and perceptions on sanitation. Although such aspects are crucial to the success of sanitation systems, clear differentiation between social, cultural and institutional questions is necessary in practice. Institutional questions relate to political, legislative and administrative criteria rather than social criteria. Social questions pertain to user concerns including health and affordability for all people while cultural questions pertain more to human behaviour reflected amongst others in the *human factor* and in awareness questions.

Other aspects are the resilience, reliability and flexibility of a sanitation system, hence the ability to adapt to changing conditions. That can refer to climate change, resources availability, or population growth or decline. Moddemeyer (2015) called, in this context, for designing more resilient water systems that meet extreme, uncertain conditions. I agree with that; only reliably functioning systems can achieve the objectives of sustainability, and resilience and reliability ware important aspects to the development of the management strategy. Flexibility again can refer to *internal* developments which I consider here such as innovation or technology adaptation. Both system and institutional framework need to be flexible enough in allow the integration of new approaches or technology, e.g. which are successfully proved for adaptation to changing local conditions in pilot projects.

To summarise, there is wide agreement that human health and environmental protection are the two major goals of sanitation. It is widely agreed that the perspective with social, economic and environmental goals is a suitable foundation of reliable systems for the present and future generations, i.e. sustainable systems. This strategy takes that into account and includes many other important aspects discussed. However, the basic idea is that all goals can only be reached through the integrated development of the elements of a sanitation system and the institutional framework and through a professional management of the service provider on a daily basis.

3.3 Strategic objectives

Sustainable sanitation requires the integrated development of all elements of a sanitation system by actions that balance social, economic and environmental goals (see Section 3.2.3). The development of objectives and key actions requires rethinking. Sanitation systems must be considered holistically and integrated with more aspects than appropriateness of technology and guaranteed investment. Although in different perspectives, other authors promoted a shift in thinking towards new approaches in the water and sanitation industry, e.g. Malmqvist *et al.* (2006b) for an urban water context, and Schertenleib (2005) for a household-centred environmental approach.

Key problems. The first step to identifying strategic objectives to large-scale sustainable sanitation is to analyse the major problems. This analysis was performed using a problem tree (see Figure 3.3). The figure illustrates key problems to sustainable sanitation on a large scale, their underlying causes, and their effects.

Key objectives. The second step to identifying the strategic objectives is to create an objective tree (see Figure 3.4). This analysis corresponds to the analysis of problems; it is basically a translation of problems into the desired future situation. The objective tree thereby provides a summary picture of the desired future situation of a sanitation system, where a management strategy has been successfully implemented. It includes the indicative means by which ends can be achieved. It also presents the effects of each key action above, and its causes below. The tree provides a summary of real-world situations and keeps the analysis of objectives firmly based on priority problems. Both analyses are based on arguments from theory and practice. Arguments from theory take into account the theoretical findings from the above analysis of sustainable sanitation. Arguments from practice are used to derivate concrete actions taking into account real-world needs.

According to the objective tree in Figure 3.4, four main objectives need be achieved for sustainable sanitation on a large-scale: (a) institutional framework supportive, (b) management of system professional, (c) infrastructure appropriate and (d) overall financing of the project guaranteed.

Practitioners and researchers of the IWA (2006) considered appropriate planning and design, and overall financing as priority objectives for both conventional and non-conventional sanitation projects. I consider supporting institutional framework and professional management of the sanitation system as additional objectives keeping in mind the need for better management in sanitation particularly in developing countries (see Section 1.1). Strategies that are based on both objectives are, though, important to a holistic approach for large-scale sustainable sanitation.

Actions of management are considered so-called *soft-engineering* actions. They support the development of (a) supportive institutional framework as well as

(b) professional management of the three elements of a sanitation system organisation, technology and users, i.e. in detail (b_1) effective organisation, (b_2) effective technology and (b_3) cooperative users. The main objectives a and b including b_1, b_2 and b_3 are analysed in Section 3.4. Additionally, there are total 10 sub-objectives, analysed in Section 3.5.

In development projects on sanitation, management actions are usually measures that accompany the technical and so-called *hard-engineering* part of project preparation and implementation. Engineering thereby includes planning and design, procurement and construction or construction supervision as well technical training related to machines and other technical parts of the infrastructure.

The two objectives c and d are not studied in this research. Both objectives, however, have also to be followed when implementing sustainable sanitation on a large scale. Often stakeholders in the sanitation industry consider procurement and construction or construction supervision as management actions. However, in the practice of development projects those actions usually belong to the *hard-engineering* part of its implementation and I follow that approach here.

Furthermore, I analysed the interrelations and coherency of the strategic sub-objectives. As there are no identical, concurring or conflicting objectives, the set of objectives can be used for the development of key strategic actions according to the strategic vision and mission without being expected to conflict due to interrelations.

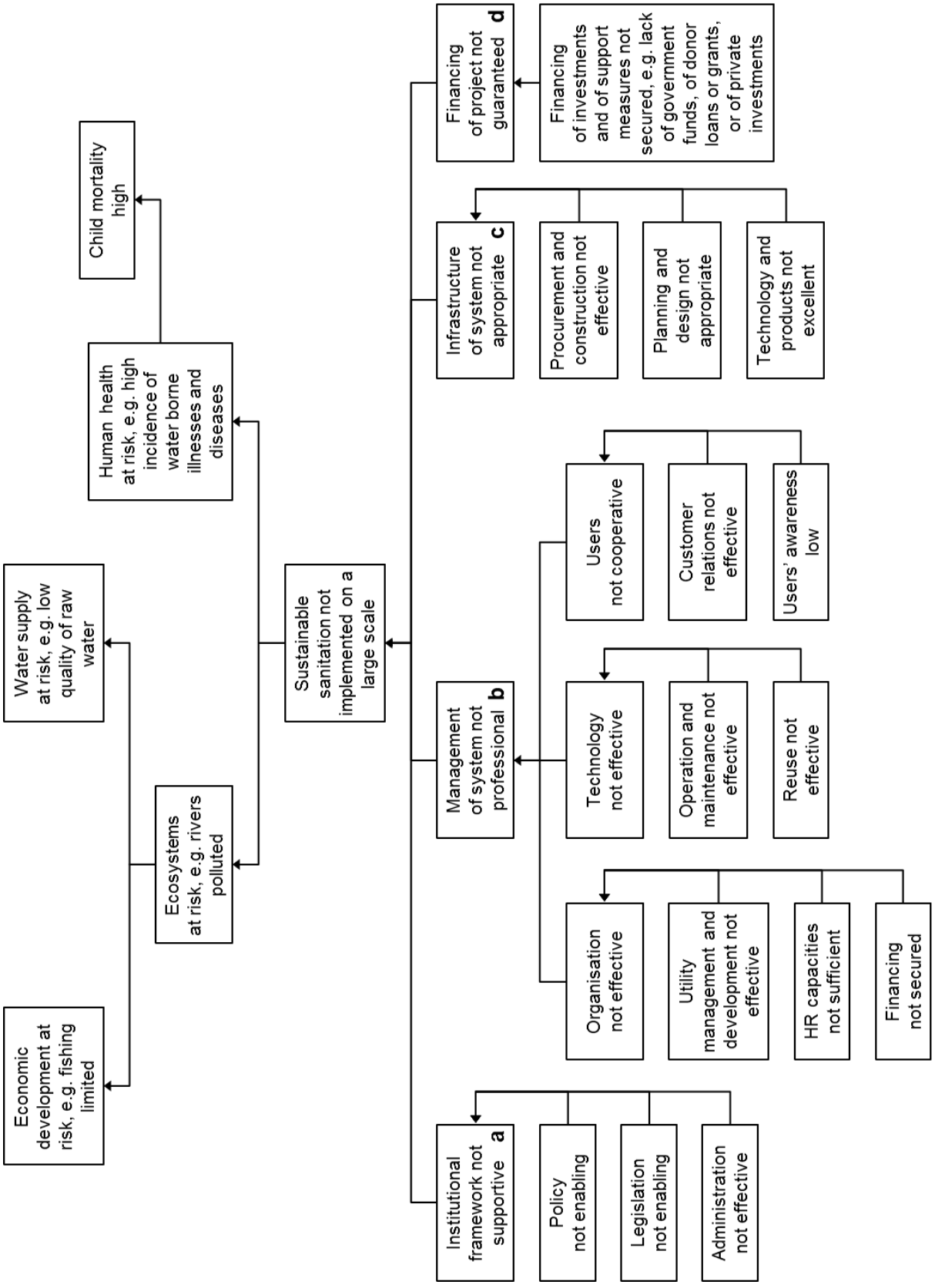


Figure 3.3: Key problems to large-scale sustainable sanitation: (a) institutional framework not supportive, (b) management of system not professional, (c) infrastructure of system not appropriate, (d) financing of project not guaranteed.

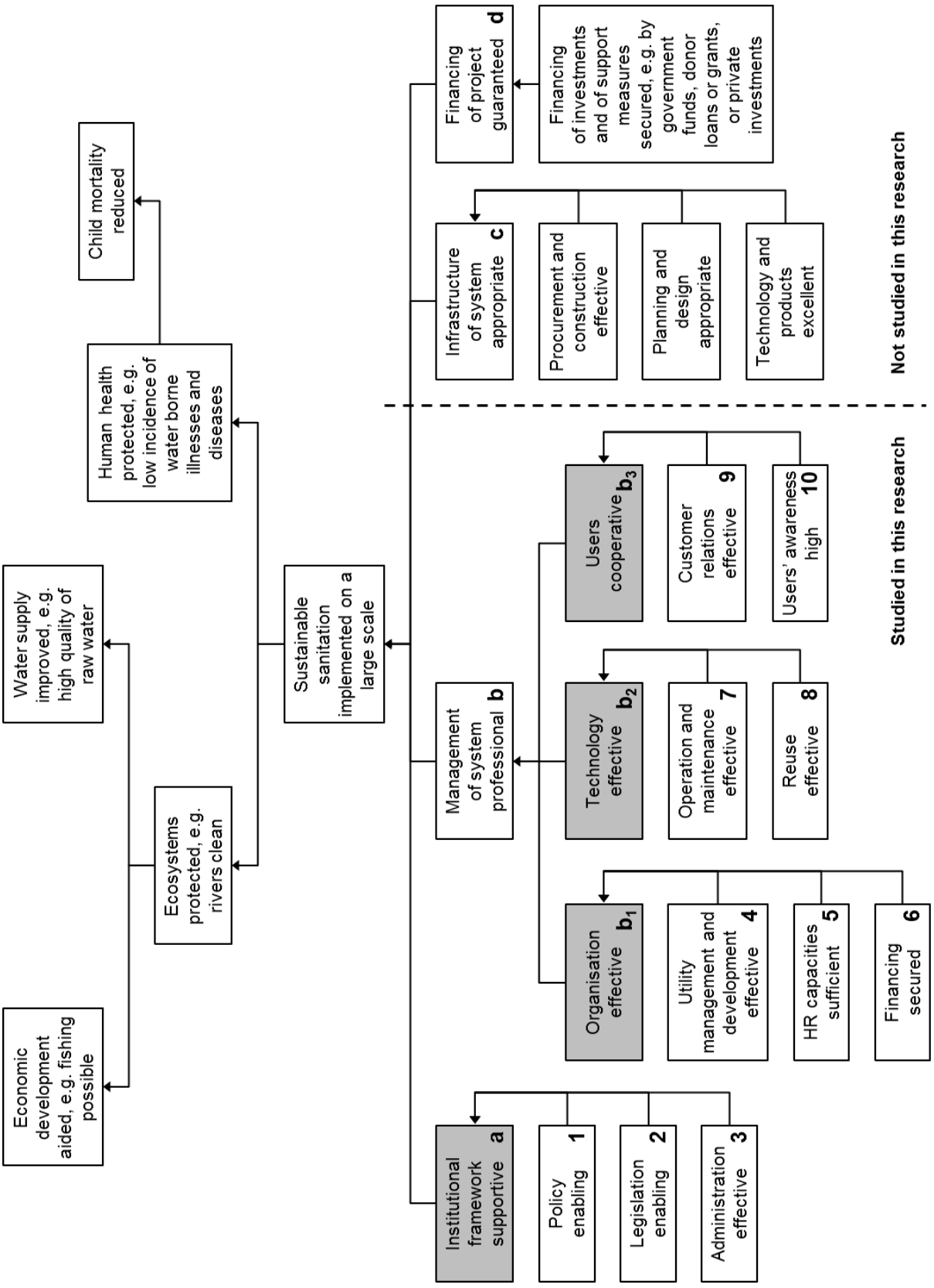


Figure 3.4: Key objectives to large-scale sustainable sanitation: (a) institutional framework supportive, (b) management of system professional, (c) infrastructure of system appropriate, (d) financing of project guaranteed; this research is about a and b. Shaded fields indicate the elements of a sanitation system; sub-objectives are numbered 1-10.

3.4 Strategic areas

Translation of strategic objectives into strategic areas. To operationalise the strategy, the main objectives are translated into strategic areas (see Table 3.1) based on the vision of objectives of sustainable sanitation on a large scale relating to the institutional framework and the elements of the sanitation system, organisation, technology and users (see Figure 3.4).

Table 3.1: Translation of strategic objectives into strategic areas

No.[a]	Strategic objective	No.	Strategic area
a	Institutional framework supportive	→ 1	Institutional framework
b	Management of system professional	→ n/a	n/a[b]
b_1	Organisation effective	→ 2	Organisation
b_2	Technology effective	→ 3	Technology
b_3	Users cooperative	→ 4	Users

[a] Numbers as in Figure 3.4.

[b] This objective is achieved by the subordinate objectives as in Figure 3.4 and therefore not intended as strategic area.

The strategic areas are:

- *Strategic Area 1: Institutional framework*—to make institutional framework supportive for large-scale sustainable sanitation through enabling policy and legislation and effective administration;
- *Strategic Area 2: Organisation*—to make organisation effective for large-scale sustainable sanitation through effective utility management and development, sufficient HR capacities and secured financing;
- *Strategic Area 3: Technology*—to make technology effective for large-scale sustainable sanitation through effective O&M and reuse;
- *Strategic Area 4: Users*—to make users cooperative for large-scale sustainable sanitation through effective customer relations and high users' awareness.

For the rationale of the strategic areas, see Sections 3.4.1 to 3.4.4.

3.4.1 Strategic Area 1: Institutional framework

Objective: (a) Institutional framework supportive (see Figure 3.4).

Sub-objectives: (1) Policy enabling, (2) Legislation enabling, (3) Administration effective (see Figure 3.4).

Rationale. Institutions set the framework for sanitation and each system element (see Figure 3.2). Supportive institutional frameworks are thereby essential for both implementing and operating sanitation infrastructure and providing sanitation services to users. Many developing countries, however, lack the necessary institutional capacity to successfully plan and manage sanitation projects (see Section 1.1.3). And too often, institutional strengthening is not part of sanitation projects which focus on technical actions such as construction and project management (Kolsky *et al.* 2005; Björklund *et al.* 2009; UN-Water 2015; see also Section 1.1.3). Furthermore, I assume that insufficient existing structures with concurring or conflicting objectives and strong resistance to change can make the improvement of institutional framework more difficult than building it from scratch.

Saleth and Dinar (1999) analysed institutions in the context of water, consistent with the institutional economics literature. Basically, institutions are thereafter considered in a much broader sense than organisations. Institutions set rules and define what individuals can and cannot do, in effect, defining the scope of action for both individual and collective decision-making. Institutions are thereby influenced by a variety of factors such as historical precedents, constitutional provisions, political arrangements, demographic conditions, resource endowment and economic development. Since the influence of these factors is formalised into three inter-related aspects, i.e., legal frameworks, policy, and administrative arrangements, the authors conceptualised institutions as an entity defined interactively by three main components, i.e., law, policy, and administration. The authors specified this general perspective in the context of water, which I adapt here to the context of sanitation. Accordingly, sanitation institutions can be characterised in terms of sanitation law, sanitation policy, and sanitation administration, while it must be considered that sanitation institutions are also influenced by related legal, policy, and administrative aspects. Elledge *et al.* (2002) considered legislation and administration instruments of policy implementation. However, I consider the two separately, based on their specific impact on the implementation of sanitation projects. Consequently, I define three interrelated aspects: (1) policy, (2) legislation, and (3) administration.

Institutional arrangements change over time (Saleth and Dinar 2005). But, in practice, there is usually little scope for initiating substantial change in the framework of technical infrastructure projects. One reason is time for implementation. Institutional actions that change policy, legislation and administration usually require many years as stakeholders must be involved in decision processes and approval has to confirm proposals. The other reason is the focus of actions. Infrastructure projects usually require a strong technical set-up, e.g. consulting teams of engineers and economists and respective counterparts in beneficiary bodies. In countries where sanitation is a neglected industry, counterparts are limited in numbers and often lack adequate capacity. Also, infrastructure projects usually require high investments. Resilient institutional framework is necessary to avoid risks of project failure during implementation

and development technology has to follow existent laws and guidelines. So to fundamentally change institutional framework, comprehensive institutional strengthening programmes are necessary. This is acknowledged and considered by donors, e.g. the German development cooperation (Merdes *et al.* 2008). Also other government and donor officials have started to shift their attention from individual investment and TA-projects to larger institutional development programmes (see Section 4.3 for examples from Sub-Saharan Africa).

Despite the limited opportunities for affecting institutional change within infrastructure projects, institution management is, however, considered a key strategy for two major arguments. On the one hand project stakeholders can formulate demands; moreover, they can put pressure on the responsible authorities, especially when projects and investments are large in size and budgets. Government officials will acknowledge and support external and especially large private investments, at least for self-advertising e.g. having the next election in mind. On the other hand project stakeholders can at least start some initiatives in particular fields that relate to the particular project, e.g. inviting decision-makers from governments to capacity building processes, or aiming at a defined change of legal framework to introduce the sustainable technology options. Although there is little scope for major changes it is, at least for project designers, necessary to understand and assess the existing institutional framework and to adapt concepts of technology and implementation to the existing framework and against possible obstacles.

3.4.2 Strategic Area 2: Organisation

Objective: (b_1) Organisation effective (see Figure 3.4).

Sub-objectives: (4) Utility management and development effective, (5) HR capacities sufficient, (6) Financing secured (see Figure 3.4).

Rationale. Organisation relates to the specific body responsible for planning and operating a sanitation system, and to deliver services to users. Institutions, however, relate to the wider framework of sanitation comprising the fields of policy, legislation and administration (see Section 3.4.1).

Professional organisation of large-scale sanitation systems is rare in developing countries resulting in poor or even no service provision (see Sections 1.1.1 and 1.1.3). This also means that there is a lack of service providers and it becomes obvious that organisation management has to focus more on how to develop a sanitation service provider from scratch than on how to improve an existing one. There was an example in Damascus Rif Governorate that I observed in 2006. The area was officially named rural but in reality was peri-urban to urban facing an on-going heavy urbanisation process. Sanitation management mostly meant just cleaning sewers by un-

trained municipality labour staff. At that time no wastewater utility existed, although water authorities pushed the development forward over years. In this situation, which is transferrable to many parts of the world, existing water institutions and public administration must be reorganised to set up as an appropriate organisation for sanitation or at least a respective department within the existing authorities. Optionally, the provision of sanitation services can be outsourced to private or public–private service providers, which does not necessarily mean enterprises or companies but also self-organised user committees and other forms of organisation.

A study of the World Bank confirmed the lack of professional institutions and organisations in many developing countries. Kolsky *et al.* (2005) therein assessed that the capacity to design and implement large-scale sanitation programmes was scarce and needed substantial development in many places before upscaling, particularly for on-site sanitation could take place. Even if sanitation were to become top priority of governments, capacity for implementation would be limited. This situation has probably not totally changed since 2005.

Experts of DWA (2008) found that where organisational capacity is sufficient, organisational structures were optimised to conventional and central sewerage systems. The experts also found that the transition of existing to new organisational forms adapted to non-conventional, often decentral, systems face large technical and organisational difficulties and are usually time-consuming. A shift in thinking in responsible institutions is necessary to critically evaluate current structures and to test, improve and extend new approaches towards sustainable sanitation. In this respect, the integration of non-conventional systems into existing sanitation structures on a large scale is a particular challenge. Where systems compete with each other, such integration will be difficult. However, examples from Ethiopia (Meinzinger *et al.* 2008) and China (Lixia *et al.* 2008), but also from Germany (Jurga *et al.* 2005a; Werner *et al.* 2005) show that integration of autonomous projects on a large scale can work.

The experts of DWA (2008) also found that in developed countries, e.g. Germany, major obstacles occur to the integration of new and non-conventional systems when: (a) legal requirements for connection to sewer pipes cannot be loosened, (b) the requirements for wastewater treatment cannot be adapted, and (c) monitoring capacities of authorities are limited. Only institutional and organisational integration of the three sectors sanitation, waste and water supply and enhanced cooperation with agricultural users of treatment products will promote and enable the development and implementation of sustainable sanitation on a large scale.

Here, the focus is on the key aspects of the above considerations. By developing the strategic area of organisation I put emphasis on a sustainability approach, i.e. development of commercial services (economic goals) that are socially acceptable (social goals) and non-polluting moreover productive (environmental goals). Furthermore, I

concentrate on the integration of new and non-conventional sanitation systems. However, there is another reason behind that. Non-conventional sanitation systems that “close the loop“ of water and other resources will be, and in some regions they are, one of the limited options of sanitation in many countries; especially in those where water shortage becomes crucial or other obstacles do not allow for carrying on with conventional approaches to sanitation (see Section 1.1.2).

3.4.3 Strategic Area 3: Technology

Objective: (b_2) Technology effective (see Figure 3.4).

Sub-objectives: (7) O&M effective, (8) Reuse effective (see Figure 3.4).

Rationale. Technology is often seen as the core element of a sanitation system in sanitation projects while managing institutions, organisation and users is underestimated (see Section 1.1.3). This is true as only technology allows for safe discharge and treatment of human waste and the wastewater. The major emphasis is, however, put on the development and installation of the technical infrastructure such as toilets, sewers, treatment facilities and outlets. Professional O&M of the installed infrastructure is often fading out. In development projects especially consulting engineers tend to use blueprints for O&M measures to get projects finalised after long-time studies of technology options and facilities.

In developed countries, O&M of infrastructure can usually be secured through adequate wastewater charges which users are willing and able to pay and through staff who is adequately educated and trained. In developing countries, conditions for O&M of infrastructure are more difficult. Too many projects fail after closing when the first repairs are required to the installed facilities. One reason is the inadequacy of technology which has not been adapted to local conditions, e.g. high-technology systems in a low-technology framework or technology that requires high user participation in a framework where awareness of users is not raised thus people are not willing to cooperate. The last example refers to modern sanitation systems aiming at return of resources from wastewater and treatment processes.

To overcome such failures, professional strategies and actions of O&M must be planned and implemented accompanied by the necessary non-technical measures. Focus in projects on a large scale must first be on the set-up of effective processes of O&M, on standardisation of tools and routines, as well as on monitoring and control of service quality. Involvement of users in on-site sanitation systems is a key aspect when installing such systems.

In addition to O&M of infrastructure, professional management of reuse is necessary in reuse-oriented sanitation systems. Systems can be designed for reuse; e.g. for the

reuse of greywater for irrigation, of urine for fertilising or of energy for power supply (see Section 1.1.2). To develop adequate actions on reuse management, a shift in thinking about processes is necessary. Treatment processes turn to production processes which bring new requirements that are often neglected: customer satisfaction based on the quality of the reuse-products. Moreover, further services may be offered by a sanitation provider, e.g. for the delivery of the products, e.g. transporting water or fertiliser to fields. For such cases professional reuse management is required, comprising effective processes, logistics and quality control.

Furthermore, in practice the regular development of sanitation concepts and technology is essential to ensure sufficient adaptation of the existing systems to changing local conditions, e.g. caused by a fast-growing population, urbanisation or improvement of living standards thus claims and resources of users. Such development activities are, however, not considered as part of a management strategy. This strategic area focuses on both the management of O&M and the reuse of products generated from wastewater and treatment processes. Technology development to excellent products and services need to be considered in measures and activities for infrastructure planning, e.g. of new investment measures.

3.4.4 Strategic Area 4: Users

Objective: (b_3) Users cooperative (see Figure 3.4).

Sub-objectives: (9) Customer relations effective, (10) Users' awareness high (see Figure 3.4).

Rationale. User management generally aims at securing customer satisfaction, increasing revenue generation and raising the awareness of users. Usually focus is on health and hygiene, and environment. The basis for satisfaction is a continuous and high-quality service provision (see Section 4.7). Besides that, targeted user management is necessary. It requires professional customer relations management (CRM) based on service orientation, customer data and improved public relations to secure customer satisfaction. It also requires awareness raising comprising sensitisation of users for sustainable sanitation and hygiene, as well as for economic and environmental aspects. Awareness raising again requires communication with stakeholders and promotion of sanitation to unserved people.

Users are considered (a) users of sanitation services, i.e. users in the traditional sense who discharge their wastewater to a transport system or treat it onsite, and (b) users of products, i.e. users who reuse treated wastewater or other products from the system. Large-scale sustainable sanitation requires the professional provision of services to users combined with users' awareness of sanitation's impact and requirements. Actions must be integrated into project measures and business concepts of providers responsible for operation, maintenance and service provision.

Firstly, professional sanitation services require a business relation between the sanitation service provider and the people who use the sanitation service and products. Users must thus be considered customers. Appropriate activities must aim at effective customer relations thus managing such relations. Professional customer relations require a professional staff attitude that sees users as customers and effective business processes including corresponding procedures. Satisfaction of customers, measurable by requests and complaints is a core indicator for success. Marketing of innovative services and products is likewise important. Marketing is, however, considered an instrument of strategic utility management and therefore not mentioned separately here (see Section 4.4).

Secondly, awareness of users and the public is important to appropriate activities to enhance acceptance and improve image and cooperation. Communication with stakeholders, such as farmers using treated wastewater or fertiliser from treatment processes, is likewise important. CRM and awareness raising increase users' acceptance and satisfaction of sanitation, but also stakeholders' and the public's willingness to accept changes and cooperate. High satisfaction of customers again leads to improvements including better awareness of sanitation and more willingness to use sanitation where it is not the case. It also leads to adaption of behaviour to new systems and technologies, and more willingness to pay adequate prices for services delivered, which is necessary for financing O&M and capital and investments.

3.5 Key strategic actions

Translation of strategic objectives into key strategic actions. To build an applicable management framework, the key strategic objectives numbered 1 to 10 in Figure 3.4 are translated into 10 corresponding key strategic actions (see Table 3.2 and the list below).

The key strategic actions are:

- Key Action 1: Policy setting;
- Key Action 2: Legislation setting;
- Key Action 3: Administration setting;
- Key Action 4: Utility management and development;
- Key Action 5: HR capacity building;
- Key Action 6: Financing;
- Key Action 7: O&M management;
- Key Action 8: Reuse management;
- Key Action 9: Customer relations management;
- Key Action 10: Awareness raising.

The rationale for each key action is given in Section 4 which also provides key indicators and rating criteria to assess management needs in a sanitation system or pro-

ject. The developed indicators and rating criteria can also be used to plan and monitor management interventions; moreover, strategy implementation.

Table 3.2: Translation of strategic objectives into key strategic actions

No.[a]	Strategic objective		No.	Key strategic action
1	Policy enabling	→	1	Policy setting
2	Legislation enabling	→	2	Legislation setting
3	Administration effective	→	3	Administration setting
4	Utility management and development effective	→	4	Utility management and development
5	HR capacities sufficient	→	5	HR capacity building
6	Financing secured	→	6	Financing
7	O&M effective	→	7	O&M management
8	Reuse effective	→	8	Reuse management
9	Customer relations effective	→	9	Customer relations management
10	Users' awareness high	→	10	Awareness raising

[a] Numbers of strategic objectives as in Figure 3.4.

Integration of key strategic actions. Holistic strategies and effective action plans generally require the integration of all actions undertaken to implement or improve a system rather than the implementation of single actions. Sanitation strategies and actions specifically require the integration of all actions at all levels, i.e. local, regional and national, and the links between. A problem of many low-performing sanitation enterprises in developing countries, however, is the missing link. Different actions at different sector and administration level interfere with each other and hinder improvements. Actions focus inadequately, separately or both on the different elements of a system, and different administrative levels; e.g. legal frameworks that are set nationally, affect locally (e.g. human health) and regionally (e.g. water protection). To avoid opposing effects hindering the implementation, the actions undertaken to implement strategy have to be integrated at all levels.

Three cases illustrate these ideas in different perspectives (based on GFA 2009 and my own professional experiences):

> *Case 1:* A sustainable sanitation system ensures human health and environmental protection (see Section 3.2.3). Both are direct benefits at local level; health for users served, and protection for local nature. A functioning sanitation system, however, ensures also indirect benefits, e.g. protecting water bodies, e.g. rivers, thus improving the quality of the environment at regional level, e.g. downstream a river. Integrating actions at local, regional, national or even international level helps reaching specific goals at certain level, and overcome opposing effects.

Case 2: Laws and guidelines, as well as regulations are binding for sanitation service provision at local level. The institutional framework usually is, however, set at national level. Key actions for strengthening service provision at local level, thus, must be integrated with actions at national level, e.g. improving the legal framework where necessary. Without integration support actions at local level would probably fail.

Case 3: A sanitation utility has difficulties to improve its economic performance because of low revenues. One reason may be that the utility cannot introduce wastewater charges according to the actual cost for O&M as the national water policy does not plan or even restrict the introduction of adequate, e.g. higher and rising wastewater charges. It is difficult to implement a new or improve an existing sanitation system, even where external funds are available, e.g. from foreign donors, as funds are usually bound to the introduction of cost-covering tariffs. Therefore, strategic actions must integrate both, financial and legal aspects at utility and national level, respectively.

Finally, it is important to force the integration of key actions at early phases of project or programme planning, to achieve greatest impact. The integration has to be followed up during all steps of projects or programmes approval, implementation and evaluation. And, though important are the adaptation to specific needs of existing systems and the regular updating of both strategy and related key actions.

3.6 Strategy map

Figure 3.5 is a strategy map (Kaplan and Norton 2004, 2008; see Section 2.4.1) that gives orientation for planning and implementing this management strategy. It illustrates the strategy's components mission, vision, values, strategic areas and key strategic actions. It describes the analytical assessment framework and gives a reference to the strategic action plan as outcome of a management needs assessment (see Section 5). Key actions are numbered as in Table 3.2 and allocated to the strategic areas as in Figure 3.4. Mission refers to the research objective (see Section 1.2). Vision refers to the strategy's overall objective sustainable sanitation (see Section 3.2.3). Values define how the mission should be achieved, i.e. how the strategy has been developed and how it should be applied which relates to the guiding principles of this research (see Section 2.1.1).

Vision

Sustainable sanitation[a] implemented on a large scale

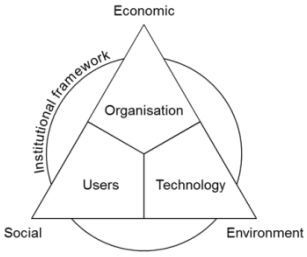
Mission

Management strategy for large-scale sustainable sanitation[a]

Values

Scientific foundation, transdisciplinarity, business orientation and applicability

Strategic areas and key actions



Strategic Area 1: Institutional framework	Strategic Area 2: Organisation	Strategic Area 3: Technology	Strategic Area 4: User
Key Action 1: Policy setting	Key Action 4: Utility management and development	Key Action 7: O&M management	Key Action 9: Customer relations management
Key Action 2: Legislation setting	Key Action 5: HR capacity building	Key Action 8: Reuse management	Key Action 10: Awareness raising
Key Action 3: Administration setting	Key Action 7: Financing		

Assessment framework

To assess management needs in a system or project and the impact of management actions implemented; evaluation of 3 indicators per key action (total 10 key actions and 30 indicators) each scored from 0 to 3 on the basis of individual rating criteria (total 120 rating criteria).

Strategic action plan

Required actions based on the outcome of the management needs assessment.

Infrastructure and financing strategies

(not studied in this research)

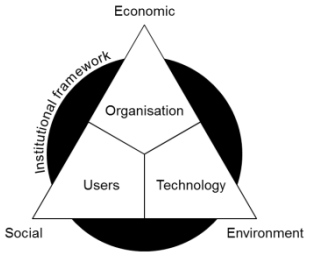
[a] Sustainable sanitation protects human health and the environment and adds value by the reuse of resources (see Section 3.2.3).

Figure 3.5: Strategy map

4 Key strategic actions, indicators and rating criteria

This section provides, *Result 2,* an analytical assessment framework consisting of 30 indicators and 120 rating criteria, and the discussion of it. It includes the analysis of the 10 key strategic actions as identified in Section 3. The analytical framework operationalises the strategy. It allows identify management needs in a system or project and monitor improvements. Each key action is associated with 3 indicators which can be scored 0, 1, 2 or 3 on the basis of qualitative rating criteria. The indicators and rating criteria were tested and improved in the case study in Section 6.

4.1 Key Action 1: Policy setting



Strategic area: Institutional framework.

Objective: Policy enabling for large-scale sustainable sanitation.

Indicators: (I-1) Responsibility of politicians, (I-2) Availability and design of policy, (I-3) Implementation of policy (see Table 4.1).

Rationale. The basis for large-scale sustainable sanitation is a political system taking political responsibility for the provision of sanitation services to all people balancing social, economic and environmental goals. Such a system requires trustworthy institutions and participating stakeholders who are in favour of improvements, e.g. institutional and technical change (Malmqvist *et al.* 2006b; Söderberg and Johansson 2006). It further provides a legal framework enabling sustainable solutions and allows for fair, open but effective decision-making processes. Sanitation policy is thereby a set of procedures, rules and allocation mechanisms providing the basis for programmes and services (Elledge 2003). In policy documents, politicians and stakeholders set priorities and allocate resources for implementation.

Sanitation policies must be transparent and accepted by all the relevant institutions. It must deal with the key factors for success as a prerequisite to the development of sustainable sanitation services. In practice, sanitation is often a part of policies of various industries. Often it is an integral part of water supply policy as well as of social, health, economic, environmental or local administration policy. The integration of all sanitation-related aspects in one policy is an advantage that helps accelerating improvements in sanitation especially in countries with low sanitation coverage. Holistic policy facilitates planning and implementing sanitation projects, as it will affect at lo-

cal level where projects are carried out. However, professional planning usually requires an analysis of the existing sanitation policy and the involvement of different institutions and administrative bodies.

Sound policies are a prerequisite to large-scale sanitation services; moreover, they are critical for scaling up successful pilot projects and improving services. Where accepted by all stakeholders and adapted to local needs, policies are an "expression of commitment" (Elledge *et al.* 2002) translating political responsibility into practice. Without policies in place, efforts to improve sanitation services remain local in scope and do not have the support needed to implement projects. Enabling policies must thereby not only have the right design, but also a sound framework for policy implementation. Furthermore, only those policies that are well communicated to stakeholders, set feasible and required time frames for implementation and have indicators to measure impact and follow up responsibilities, will affect all institutional levels.

Table 4.1: Indicators and rating criteria for Key Action 1: Policy setting

Indicator	Rating criteria			
	0	1	2	3
I-1 Responsibility of politicians	Sanitation not included in policy	Sanitation included in policy but actions and follow up measures not documented	Sanitation included in policy, actions and follow up measures documented but enforcement of responsibility inadequate	Sanitation included in policy, actions and follow up measures documented, responsibility enforced based on independent monitoring
I-2 Availability and design of policy	Sanitation policy not available	Sanitation policy available but not accepted by all stakeholders or not approved or not gazetted, or does not contain all elements	Sanitation policy available, accepted by all stakeholders, approved and gazetted but does not contain all elements or does not affect all levels	Sanitation policy available, accepted by all stakeholders, approved and gazetted and contains all elements, and affects all levels
I-3 Implementation of policy	Sanitation policy not implemented	Sanitation policy implemented but not communicated to stakeholders, and no concrete commitments documented or responsibilities not defined and not monitored	Sanitation policy implemented, communicated to stakeholders but no concrete commitments documented or responsibilities not defined or not monitored	Sanitation policy implemented, communicated to stakeholders, concrete commitments documented, responsibilities defined and monitored

Key to scores:
0—Undesirable: dramatic scope for improvement;
1—Poor: significant scope for improvement;
2—Satisfactory: some scope for improvement;
3—Desirable: limited scope for improvement.

I-1 Responsibility of politicians. All stakeholders in a sanitation system have the responsibility to meet the challenges in sanitation. Experts of UN-Water (2008c) specified that: Business leaders can embrace improvements of sanitation in a “corporate social responsibility”. Teachers and educators can take up sanitation as part of “healthy” learning. Individuals can join or lend support to NGOs working in sanitation. Journalists can contribute to awareness raising and thus to more acceptance of sanitation. Users can take action in changing behaviour and systems at their individual level. However, more than all other stakeholders, politicians bear the main responsibility for sanitation as they are responsible for policy setting and implementation and hence for creating a supportive institutional framework to which all other stakeholders must relate.

At the international level, representatives and especially leaders of multinational organisations can support sanitation by promoting it on many occasions: conferences, business meetings, diplomatic meetings, donor consultations and country programme discussions as well as in concrete projects in the field. Donors’ representatives of official development assistance can and should promote sustainable sanitation in their discussions and negotiations with decision-makers in the beneficiary countries.

At national level, governments have the responsibility to develop enabling laws and amendments to policies and legislation and to start necessary reform processes in institutional framework towards effective institution and management systems. Institutional plans and strategies should thereby contain concrete actions for reforming policies, legislation and financing frameworks, institutional roles and capacities, as well as enhanced management instruments required to deal with priority sanitation questions while linking to other national and international plans or strategies (Global Water Partnership 2006).

The experts of UN-Water (2008c) stated that when bringing political will, politicians and related departmental staff responsible for sanitation and related fields can work to ensured “fair share of attention and investment” in sanitation. Related fields are, e.g. health, water, environmental protection, municipal infrastructure, housing, local administration, finance, gender and social affairs. Both politicians and staff can design processes of sanitation development, educate constituent groups about sanitation and seek and support sanitation initiatives. In countries where state and religions are not separated, religious leaders play a key role in promoting sanitation. On the one hand these leaders can promote sanitation in initiating a “discussion on values” towards human health and a clean environment with particular consideration of sanitation’s impact on both aspects and on the opportunities we have to follow up. On the other hand religious leaders can link up these discussions at a political level resulting in concrete action.

Cairncross (2004) described the role of the public sector when taking responsibility for the concrete action of marketing promotion. In promoting marketing approaches (see Section 4.9) governments should not relieve itself of the responsibility for sanitation and leave it to the local building trade. She further stated that governments and local governments have a particular role. The public sector must: (a) understand existing demand for sanitation, and what limits it, (b) overcome those limits, and promote more demand, (c) stimulate development of the right products to meet that demand, (d) support the development of a thriving sanitation industry; and (e) regulate and coordinate the transport and final disposal of wastes.

A political system must allow for an independent measurement of political responsibility on the basis of clearly defined indicators. Moreover, enforcement of either lacking political will or failures in implementation must be possible. Suffering from unimproved sanitation is not just disabling to people, it is withholding one of people's human rights (Cairncross 2004; Centre on Housing Rights and Evictions *et al.* 2007).

I-2 Availability and design of policy. An enabling sanitation policy affects at national and local level but also links up to relevant policies at international level. Enabling national policies motivate local action while international policies act as orientation and benchmarks. Although sanitation policies in developing countries often focus on national questions, e.g. the general environmental condition or overall health indicators, sub-national policies are though essential, especially in large and decentralised countries. State, provincial, and local governments play a significant role in implementing policy when they have the necessary resources to plan and implement sanitation programmes and projects on a large scale. An example is the Total Sanitation Campaign in India (Government of India, Ministry of Rural Development, Department of Drinking Water Supply, Rajiv Gandhi National Drinking Water Mission 2007; World Bank 2010) where strong state departments develop and implement sanitation strategies on a large scale (see Section 4.3).

Figure 4.1: Elements of a policy enabling large-scale sustainable sanitation

An enabling policy for large-scale sustainable sanitation includes many different aspects depending on the particular local conditions. But ten elements are relevant for most local conditions (Elledge *et al.* 2002; UN Economic and Social Council 2004; Evans 2005a; GFA 2009; compiled, modified):

1. *Political will*—referring to the political support by politicians, government officials, and representatives of influential organisations; support can be manifested in public statements, the passage of legislation, the setting-up of relevant institutions and the provision of resources to carry out sanitation-related policies or in other ways (Elledge *et al.* 2002). It is also important that politicians acknowledge and state their responsibility for acting towards sustainable sanitation even to allow for meeting the challenges that exist worldwide (see Section 1.1.1).

2. *Stakeholder participation*—referring to the ideas that stakeholders, especially those who are in favour of improvements such as institutional and technical change, which should take part in sanitation development and service provision. When stakeholders have not been included in formulating policies and making informed decisions, politicians cannot expect proper follow up of policy purposes. Policy should, therefore, also plan stakeholders' capacity building at each level, individual, collective, institutional.

3. *Legislation setting*—meaning that to be effective, policy needs a legal basis. Such basis includes laws, legislative acts, decrees, guidelines and regulations (see Section 4.2). While laws define the general legal framework, legislative acts, decrees, regulations and guidelines provide more detailed guidance. Legislation has to focus on a wide range of subjects, amongst others minimum standards, e.g. water quality, environmental monitoring, customer service levels, water availability and asset conditions, but also design standards, and sometimes advise on the practices of service provision. Politicians must adapt legislation carefully to local conditions and not just copy from other countries or regions.

4. *Sanitation coverage*—expected over time and being a key element in policies of many developing countries. Sanitation services are usually designed to serve the needs of specific population groups. National sanitation policies are more likely to be effective if they are specifically directed at such groups when it can be shown that they are underserved in comparison with other groups. Thus, selecting the target population involves not only statements of priority but also meaningful action programmes and budgets (Elledge *et al.* 2002). In this regard, gender and poverty are two aspects to be considered.

5. *Performance targets*—as operational and financial performance targets for service providers but also as minimum levels of services. Operational and financial performance is a precondition for sustainable service provision. Performance targets help improving services continuously, including benchmarking. The level of

service is usually determined by costs, economic status of communities and households, and willingness of users to pay for services. To sustain sanitation, politicians must agree on and document minimum levels of service.

6. *Economic instruments*—such as user charges, subsidies, incentives or fines helping to sustain services and implement policy goals. The key element is a tariff system allowing wastewater fees to directly cover a growing portion of the recurrent cost of the service provider. Only providers that generate enough cash can operate and maintain systems and improve services, expand the system, attract external funding and contribute to release of limited public funds. However, tariffs must be affordable for all users and thus be designed in a fair tariff structure. Subsidies and incentives to communities, households and service providers allow an opportunity for creating and promoting appropriate sanitation infrastructure and services. Fines are charged for enterprises and people using unsafe and endangering sanitation practices.

7. *Health goals*—considering the impact of unsafe handling, disposal or use of human excreta or wastewater, and from living in polluted housing areas. Policies should include all relevant health concerns in relation to sanitation, especially diarrhoeal rates, infant mortality, helminth infections or cholera epidemics (Elledge *et al.* 2002). Essentially, health-related information and awareness raising activities should be demanded in the policy.

8. *Environmental goals*—to acknowledge the environmental impact of sanitation in both negative and positive perspectives, politicians must stress the respective environmental goals in sanitation policy. Negative impact such as environmental pollution from missing or inadequate wastewater treatment and respective discharge of pollutants to the environment has priority in policy statements. However, politicians should also stress and even promote the positive impact on the environment which can arise from reuse-oriented sanitation systems.

9. *Administrative setting*—meaning that sanitation policies must regulate the responsibilities of the different administrative or institutional stakeholders. Moreover, it should aim at modern, integrated approaches that allow for holistic sector management (see Section 4.3).

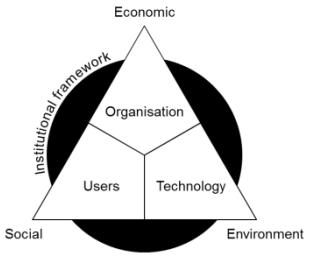
10. *Promotion of innovations*—meaning that the enabling policy should promote sustainable technology and management procedures, e.g. by including incentive structures. For many countries conventional approaches to sanitation are not the right way. The promotion of innovative technology and management towards sustainable sanitation is indispensable when considering the obstacles that new and non-conventional approaches face in practice, as opposed to politicians' intention in papers and speeches.

I-3 Implementation of policy. Implementation of an enabling policy for large-scale sustainable sanitation starts with communication. Policy makers should communicate sanitation policy to all stakeholders including users of a sanitation system. They should obtain concrete commitments from players at all levels including accurate information from sound monitoring and seek agreement on what steps are urgently required and who will take responsibility for them (UN 2008).

National policies are usually to be implemented through local actions within a predetermined time frame, e.g. of 2, 5 or 10 years. Pertaining to projects, service providers will have to do work in line with criteria, possibly with a certain incentives structure. Although national monitoring systems are often weak, they are the basis for planning for progress and policy formulation (UN General Assembly 2009). For accountability a supervisory or regulating authority should monitor the performance of the service providers in delivering sanitation services to people. Users should be able to follow the monitoring results; if the main performance parameters are published in press and on the internet, transparency and public awareness can be supported.

The results of such monitoring should then relate to political commitments. Possible obstacles and failures in policy implementation must be identified in detail by independent evaluators. The monitoring results should be prepared for publication and recommendation to provide a foundation that allows for political enforcement of responsibilities. In many countries such enforcement will be difficult as often sanitation is not in the focus of public institutions, or political responsibility or positions are not based on performance, but on political arguments.

4.2 Key Action 2: Legislation setting



Strategic area: Institutional framework.

Objective: Legislation enabling for large-scale sustainable sanitation.

Indicators: (I-4) Design and enforcement of legislation, (I-5) Flexibility of legislation, (I-6) Regulation of ownership (see Table 4.2).

Rationale. In many developing countries sanitation policy appears on paper but it is not effectively implemented (Water Supply and Sanitation Collaborative Council and Eawag 2005; Boesen 2007; Connor *et al.* 2012). Action plans and programmes aim-

ing at implementing sustainable sanitation on a small and a large scale, e.g. pilot projects, are often unrealistic, not feasible or not successful. Furthermore, inadequate involvement and commitment of stakeholders has often led to failure in the reform implementation (Seppälä 2002).

So policies and policy statements must result in respective legislation. Legislation may include laws, legislative acts, decrees as well as guidelines and regulations. While laws represent the general legal framework, legislative acts, decrees, guidelines and regulations provide more detailed guidance to executing players. The key objective of legislation is the set-up of responsibilities and rights of different stakeholders involved. Legislation must define which stakeholder has the main responsibility for creating legislative acts and clarifying who has authority to implement and enforce it. Respective administrative arrangements support this process.

Sustainable sanitation requires an appropriate and up-to-date legislation that progressively affects technical design, implementation arrangements and service management towards the goals of sustainability. Ownership of land and assets is one central aspect. It is a precondition to planning financially sustaining sanitation projects. But also the financing of infrastructure and services whether internal or external needs clear legal commitments. Without appropriate legal framework, sanitation programmes and projects will fail in meeting their objectives.

Indeed, sustainable sanitation can evolve from legislation. Johansson and Kvarnström (2005) assessed regulatory frameworks in Sweden, Mexico, Uganda and South Africa. They found that in those countries large opportunities were created for action to sustainable sanitation. With a focus on *ecological sanitation* they identified several chances; amongst others: Legislation can, when enforced, serve as a platform for promoting the implementation of sustainable sanitation. Chances arise by developing and reforming existing legislation, sometimes only by changing the practice of how local laws and rules are enforced. The inclusion of criteria to recycle nutrients in legislation will provide openings for *ecological sanitation* systems that conventional systems will have difficulties to fulfil. And a flexible legislation based on principles rather than technology would allow households to start changes by themselves, as long as they remain within existing legislation.

Kramer *et al.* (2007) developed a guide for decision-makers on the legal requirements to wastewater reuse in the Mediterranean countries. According to the guide, legal standards should be realistic in relation to prevailing local conditions, affordable for users and enforceable for responsible bodies (Kramer *et al.* 2007, based on Kamizoulis *et al.* 2003). The authors also proposed an inventory of relevant laws and regulations on local and national level which should include specific legislation on water reuse, regulations on environmental protection, irrigation water quality standards and health standards as well as all agencies and authorities having jurisdiction.

Table 4.2 gives the indicators and rating criteria identified for this key action with an interface to I-3: Implementation of policy (see Section 4.1); thus, related measures require particular coordination with measures on I-3.

Table 4.2: Indicators and rating criteria for Key Action 2: Legislation setting

Indicator	Rating criteria			
	0	1	2	3
I-4 Design and enforcement of legislation	Sanitation legislation not available	Sanitation legislation available but not adapted to local conditions, outdated or not enforced	Sanitation legislation available, adapted to local conditions, up-to-date and enforced but reuse of wastewater and associated streams limited	Sanitation legislation available, adapted to local conditions, up-to-date and enforced, reuse of wastewater and associated streams possible
I-5 Flexibility of legislation	Sanitation legislation not available	Sanitation legislation not flexible, adaptation and non-conventional projects almost not possible	Sanitation legislation flexible, adaptation possible but very time-consuming, non-conventional projects limited to small scale	Sanitation legislation flexible, adaptation possible within common project time frame, non-conventional projects possible on a large scale
I-6 Regulation of ownership	Ownership of assets not regulated	Ownership of assets not passed to service providers or responsible authority	Ownership of assets passed to service providers or responsible authority, status of ownership registered but status not regularly updated	Ownership of assets passed to service providers or responsible authority, status of ownership registered and regularly updated in asset register

Key to scores as in Table 4.1.

I-4 Design and enforcement of legislation. Legislation of sanitation includes a wide range of subjects. Important subjects are minimum standards such as water quality, environmental monitoring, customer service levels, water availability or pressure. Other subjects are asset conditions, design standards or advice on practices of service provision. Relevant legislation does not only include aspects of water supply, sanitation, environment and health, but also of agriculture because sustainable sanitation systems aim at the reuse of wastewater and associated streams (see Section 1.1.2). Sometimes more fields are relevant, such as urban and rural development, business administration, e.g. when private industry participates. Accordingly, conflict with legislation in other industries may affect the ability of service providers to deliver its services but also project implementers.

In designing a legal framework for large-scale sustainable sanitation, politicians must therefore set up effective regulatory mechanisms or approach sanitation legislation in an integrated manner, or both, possibly in an integrated water resources manage-

ment (IWRM, see Section 4.3). They should thereby define a *systems approach* to sanitation such as IWRM as well as the institutional, technical and legal set-up required to manage water and other resources efficiently. Moreover, politicians should carefully and regularly adapt the legislation to local conditions and by no means just copy from others applied in countries that face different frameworks. This refers to the local, regional and state level within a country.

In general, politicians design national legislation to meet overall national sanitation objectives. Practitioners on the ground must further ensure that current and future sanitation activities comply with the relevant national and local laws, guidelines and regulations. The creation of an appropriate legislation meeting both perspectives can be time-consuming, especially in countries lacking any proper legal settings. For sanitation, it is thus suitable to set up more generic rather than project specific legislative arrangements. However, a flexible and project-focused adaption of the legal framework should be permitted, e.g. where non-conventional sanitation systems are promoted. Decreeing limited exceptions to the existing legislation for specific projects is an option as shown in pilot projects worldwide (Werner *et al.* 2004a).

Werner *et al.* (2004b) stated that planning and implementing conventional sanitation systems tends to be highly centralised, hierarchical and bureaucratic, severely limiting opportunities for the participation of a range of stakeholders, while often policy and legal framework only allows government organisations to deliver services. Such a legal framework makes it difficult to scale up non-conventional solutions.

An investigation in 11 Latin American countries showed that most countries lacked proper legal regulation of wastewater reuse in agriculture (Johansson and Kvarnström 2005). This also suggested that the recycling of nutrients from waterborne systems was not covered by the legislation in these countries. The authors summarised five further barriers to legal frameworks: (1) non-compliance with the existing legislation and regulation of sanitation systems; (2) lack of capacity and resources to meet up to the implementation deficit created; (3) weak institutions and lack of political will for sanitation which makes it difficult to enforce and follow up existing legislation; (4) out dated legislation and lack of harmonisation of laws which makes interpretation difficult for local authorities; and (5) the perception of human excreta as waste and the lack of incentives for reuse in the existing legislation.

So legislation towards sustainable sanitation must define the role and responsibilities of the stakeholders, detail provisions regarding management and quality monitoring including institutional responsibilities and contain minimal standards for health and water protection. Standards and codes at national or municipal level should thereby be formulated according to international standards, e.g. IWA, the WHO or the Food and Agriculture Organization of the UN (FAO). Furthermore, the legislation should be adapted to local conditions, kept up-to-date and in particular, full reuse of wastewater

and associated streams should possible. When enforcement mechanisms are effective, such legislation can create excellent opportunities for sustainable sanitation projects.

I-5 Flexibility of legislation. To implement sustainable sanitation on a large scale, it is necessary to understand the existing legal framework, improve it if necessary and make it flexible for innovative solutions. A legal framework also needs to be consistent, complete and adapted to international standards, e.g. regarding the use of treated wastewater in agriculture and the justification of investments in new treatment stages (Stoll and Schönewald 2004).

The Water Utility Partnership (2003) recommended to base an assessment of the legislation on "what's not strictly prohibited under current legislation" rather than to "what's specifically allowed"; e.g. private participation may require changes in the law to enable the changed allocation of responsibilities but also the new institutional arrangements. Common questions regarding the reuse of wastewater are: (1) "What are the rights and responsibilities of different stakeholders", (2) "Is the use of wastewater governed in legislation" and (3) "Does a defined jurisdiction exist on the use of wastewater"(all WHO 2006b) as well as (4) "How to proceed with a restrictive legal framework and standards for re-use elements" (Stoll and Schönewald 2004).

Experts of DWA (2008) found that implementing non-conventional sanitation systems in particular requires a change of legislation, although in practice every legislation has room for interpretation which stakeholders should try to use. However, the Water Utility Partnership (2003) highlighted that adaptations of the framework towards sustainable sanitation may then be accommodated within existing legislation using existing institutional structures but requiring a change of specific legal acts.

When considering recent development towards sustainable sanitation in science and practice, it must be acknowledged that legislation often becomes quickly out dated, especially when politicians designed it too specifically. This refers especially to countries facing fast-changing conditions, e.g. due to heavy population growth in urban centres. Broad design based on a consensus of all stakeholders and regular adjustments of the legal framework is required to overcome those obstacles, especially when considering slow decision-making processes in many countries hindering fast enough adjustments.

I-6 Regulation of ownership. Ownership is a special but important aspect in the frame of legislation setting for sanitation projects especially in developing countries. Where the status of ownership is uncertain when stakeholders start planning and implementing sanitation projects, significant obstacles are created for project implementation but also for service provision and the opportunities for stakeholder participation. Two aspects can be distinguished, land and assets.

Land ownership is a precondition for successful implementation of sanitation projects. In particular, large-scale projects require the timely acquisition of land. Engineers must design sewer lines and treatment sites and therefore know where to plan and construct. Land is especially required for WWTPs, dump sites or reuse areas, which is particularly relevant to projects on a large scale where required areas usually increased with a rising population.

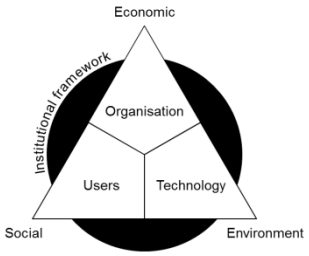
Land use planning is an instrument to keep respective areas from development or cultivation. Especially in rapidly growing urban and peri-urban centres stakeholders of sanitation projects can face tremendous problems in acquiring land areas. Urbanisation puts huge pressure on land prices. If sites are not reserved early on in the project stage, rising costs can make the financial and economic calculation of projects difficult. Furthermore, restrictions of land use via land use plans are often not followed and partly public areas are even repossessed; e.g. in Kenya it is a common landowner's opinion that he can use his property as he wants and the unlimited use of a property is basically claim to the entire population; restrictions are *de facto* not been implemented (H. Heidtmann, personal communication, 3 February 2016)

Moreover, where preparation of projects takes a long time, e.g. where feasibility studies last years in rapidly urbanising areas, the planned treatment sites may be no longer available for procurement when the project starts. A personal example from peri-urban Damascus, an area that faced heavy urbanisation processes in 2009, made it clear that attention to ownership early on during project preparation can overcome these barriers (see Section 6).

Asset ownership is likewise relevant to securing the finance of service provision, thus for sustaining O&M of sanitation systems once constructed. Assessing the ownership of assets and transferring it to the service provider where necessary, is one of the first steps required in sanitation projects. Substantial contracts must be elaborated and passed in line with further measures aiming at a professional and sustainable asset register, asset management and valuation. Financial success can only be secured when all costs and values are included in the balance sheets of service providers. Ownership of assets passed to the service provider or the responsible authority should be registered and regularly updated, i.e. an asset register should be in place.

But ownership is not only relevant for projects or for service providers. Only where ownership rights are documented, will stakeholders take control and responsibility of sanitation projects. Staykova (2006) reported from Vietnam that asset ownership was a concern, especially in rural water projects where consumers provided 60% of the initial capital costs to build the systems. However, the institutional arrangements for the project left those consumers outside and it was unclear how the consumers could participate better.

4.3 Key Action 3: Administration setting



Strategic area: Institutional framework.

Objective: Administration effective for large-scale sustainable sanitation.

Indicators: (I-7) Integration of sectors and administration, (I-8) Autonomy of service providers, (I-9) Regulation of service provision (see Table 4.3).

Rationale. Effective administration can increase opportunities for the implementation of sustainable sanitation. In turn, ineffective administration can hinder the implementation of sustainable sanitation projects, especially of projects on a large scale and those projects that require non-conventional approaches.

Cordova and Knuth (2005) assessed a lack of political motivation in public administration as one of the major structural barriers to large-scale dry sanitation projects in Mexico. So dry sanitation projects face a significant withdrawal of political support where they are in conflict with government administration. Moreover, such withdrawal of support can be enforced by the effects of political economy, a nexus between local politicians, local administration and land brokers steering urban development. This particularly refers to urban areas. The need to provide services in exchange for votes often takes precedence over existing master plans, more rational planning processes or both (Bracken *et al.* 2008; see also Lüthi *et al.* 2011). These all are major obstacles for large-scale sustainable sanitation. The consequence is that the existing administrative set-up needs to be carefully assessed during project preparation. The promotion of innovative approaches and also effective coordination and execution of projects contribute to closing gaps in sanitation service provision.

To develop appropriate institutional arrangements for effective sanitation administration, governments must consider carefully where specific responsibilities should lie in the future and what arrangement provides effective use of talents and financial resources. Some could argue that the public sector, with its ultimate accountability to the population, should determine the overall policy and technical bodies such as ministries or commissions, basic health and safety standards. Many water and sanitation experts argue that the public sector should retain ownership of the basic water or sanitation infrastructure to ensure control in times of crises and the government should specify basic requirements and safeguards for the poorer members of a na-

tion. These roles relate to setting overall priorities and retaining ultimate control. These arguments are valuable and taking the historical and cultural aspects into account, they are understandable. However, many professionals started to ask whether the public sector is best equipped to manage large utilities in a commercial way. Moreover, for many developing countries the question comes up as to whether a government should be arbitrating on its own activities.

In practice, the re-structuring of existing administrative structures is difficult and time-consuming and usually overburdens sanitation projects; and often even the discussion about it. This especially refers to developing countries where resistance to change is great, e.g. in Kenya, Tanzania, Uganda and Zambia. There, Richards *et al.* (2008) found that decision-makers at government level, development organisations and other stakeholders have shifted their attention from supporting individual investment and TA-projects to supporting the development of sector framework and the provision of services. Despite efforts, government officials usually had little understanding of reform processes. So policy advisors and development organisations supporting the reform processes needed to follow up results which have not been achieved as well as delay in implementation. However, the situation in other developed countries is usually not so different; resistance to change occur where jobs and responsibilities are questioned.

Another aspect is the political importance of water and sanitation which can hinder changes in existing procedures and structures. Instead of focusing on extensive administrative re-structuring it is much more appropriate for most sanitation projects to approach administrative development in a process-oriented way. Individual change indicators should thereby be oriented to the management, business and supportive processes; essentially to sustainable service provision (see Section 4.4).

To change or to propose change in administration and organisation, the specific local requirements to sustainable service provision must be considered. Rudolph *et al.* (2005) defined five important aspects: (1) Technical standards and minimum requirements with thresholds for wastewater, e.g. the WHO standards for the safe use of wastewater, excreta and greywater according to legislation as well as to standards for planning, construction and operation of facilities; requirements for documentation and operational organisation can result which are reflected in the organisation structure. (2) Prohibition and obligations, e.g. from disposal restrictions as far as organisational requirements for the public administration or the sanitation service provider result. (3) Economic conditions as requirements for the development of water fees and wastewater charges, to which organisation structures have to adapt in documentation procedures but also in the setting of cost structures. (4) Taxes, especially where a different taxation of water supply and sanitation has significant impact on practice. It can happen that organisational structures of service providers do not orient to the technical-economical optimum but to the necessity of reducing tax burdens, e.g. by a

separation of water and sanitation business, of assets and operation, or of old facilities and new investments; and (5) other duties such as wastewater charges or water extraction fees as far as they are relevant for the organisational setting.

The development of institutional framework with scope for individual projects that are different from daily approaches can allow for a stepwise implementation and adaptation of existing structures. In addition, successful pilot projects can highlight options not only from the technical view but from the development of institutional frameworks as well.

Table 4.3: Indicators and rating criteria for Key Action 3: Administration setting

Indicator	Rating criteria			
	0	1	2	3
I-7 Integration of sectors and administration	Sanitation not reflected in administration	Sanitation reflected in administration, but responsibilities unclear and coordination mechanisms ineffective	Sanitation reflected in administration, responsibilities clear, coordination mechanisms effective, but IWRM not fully implemented	Sanitation reflected in administration, responsibilities clear, coordination mechanisms effective, IWRM fully implemented
I-8 Autonomy of service providers	Sanitation service provision not delegated to local service provider	Sanitation service provision delegated to local service provider, but provider has almost no autonomy	Sanitation service provision delegated to local service provider but provider has limited autonomy	Sanitation service provision delegated to local service provider, provider has full autonomy
I-9 Regulation of service provision	Sanitation service provision not regulated	Sanitation service provision regulated on the basis of a legal mandate but not for systems of all scales or regulatory institution has no autonomy or no enforcing power	Sanitation service provision regulated on the basis of a legal mandate but not for systems of all scales or regulatory institution has limited autonomy or limited enforcing power	Sanitation service provision regulated on the basis of a legal mandate for systems of all scales, regulatory institution has full autonomy and enforcing power

Key to scores as in Table 4.1.

I-7 Integration of sectors and administration. Major obstacle to effective administration in the sanitation or water industry is a fragmented administrative set-up that consists of different institutions with overlapping functions and responsibilities. In most developing countries, responsibility for sanitation is divided among different ministries that are involved in sanitation, e.g. ministries of urban or rural development, public administration, public health, environmental protection, irrigation and agriculture. Lack of coordination between institutions makes rational management of sanitation even more unfavourable. Accordingly, fragmentation among these different administrative bodies leads to a mixture of institutional setting accompanied by different, and not unusually, inconsistent legislation. Moreover, this mixture means that

stakeholders do not have clearly defined responsibilities which are a big challenge to the experts that plan and implement sanitation projects. Sanitation projects are usually planned along institutional lines. So planning makes a sector-wide approach with crosscutting issues difficult under a fragmented administration. But not only planning and implementation of investments or infrastructure suffer from such institutional und organisational weaknesses. The provision of sanitation services suffers from it too. Fragmentation of sanitation in regard to administrative and technical aspects resulting in different targets and framework makes service provision less effective. Bracken *et al.* (2008) assessed that such weaknesses in the intuitional framework can even create potential for political conflict among national, regional and municipal levels of government, especially for urban conditions.

IWRM helps overcome above weaknesses of administrative integration. In most countries sanitation institutions are water institutions setting up frameworks for water supply and sanitation. Sanitation is, however, seldom considered in other disciplines. Ideally, water supply and sanitation are approached through integrating water resources management (European Commission 1998; Agarwal *et al.* 2000; Black 2003; Neubert *et al.* 2005; UN-Water 2008b).

The Global Water Partnership defined IWRM as (Agarwal *et al.* 2000):

> "... a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."

This definition focuses on the process-oriented and coordinative character of IWRM and its sector-overlapping perspective. The main maxim is integration through coordination at different levels.

Dombrowsky (2005) assessed three different levels: (a) horizontal at level of the river basins, e.g. among authorities of neighbouring states, (b) horizontal among different water-use zones, and (c) vertical among different administrative levels. However, Huppert (2005) argued that the Global Water Partnership made no clear difference between "inter-sectoral management-integration" and just "coordination" of independent resources management areas. Furthermore, there should be made a clear difference between "management" and "development". The reason is that in many developing countries, IWRM is based rather on the development of approaches than the management of it. Although the understanding of IWRM concept is subject to debate (Kluge 2005) and different organisations still promote different definitions—most of them evolve more from a specific area of interest (Huppert 2005)—the concept of IWRM and especially the general definition of the Global Water Partnership is widely acknowledged by scientists and practitioners.

However, it is a difficult task to put theory in practice. A survey of UN-Water (2008b) showed that, although acknowledging the concept of IWRM, many countries still had a long way to go in meeting all the targets of the IWRM targets 2007. The survey investigated 104 countries: Out of the 104 countries, 27 are developed countries, i.e. member states of the Organisation for Economic Co-operation and Development (OECD) or the EU, and 77 are developing or transition countries. In the developed countries advances were recognised on almost all major problems, although with much room for further improvement. Out of the 27 developed countries only 6, i.e. 22% had national IWRM plans fully implemented while further 10 countries, i.e. 37% had IWRM plans in place or partially implemented. The report also indicates that developed countries need to improve on public awareness campaigns and gender mainstreaming. In the developing countries, the survey showed recent improvement in IWRM planning processes at national level, although implementation has not been well put forward. Out of the 77 developing countries only two countries, i.e. 3% had IWRM plans fully implemented and 17 countries, i.e. 22% had IWRM plans partially implemented—in Asia three countries, i.e. 33%, in Africa eight, i.e. 38% and in America five, i.e. 43%. African countries were behind the Asian and American countries on most aspects; however, African countries were more advanced on stakeholder participation, subsidies and micro-credit programmes. Asian countries were more advanced on institutional reforms, but behind in institutional coordination. Although the survey showed high potential for further improvement, significant changes were recognised in comparison with earlier surveys in 2006.

To overcome technical barriers to IWRM, the creation of one central organisation with the responsibility of water resources management for all purposes, drinking water, sanitation and irrigated agriculture is recommended. Such institution takes over responsibility for all related policies, associated programme development, the implementation of such programmes and the regulation of it. A step to integrated management practices is the introduction and follow up of effective coordination mechanisms among relevant institutions (Dombrowsky 2005; Kluge 2005). Recommendable is the identification of a lead institution, such as a ministry dealing with planning or infrastructure, or a “line agency” (Elledge *et al.* 2002) such as a national department for sanitation or a national wastewater company.

Since the main goals of sanitation are human health and environmental protection (see Section 3.2.2), it should be approached holistically taking into account both goals. Holistic approaches require the integration of technical, financial, institutional and sectoral questions (UNEP *et al.* 2004). Technical integration means that the full range of available, environmentally sound technologies is considered while selecting the most appropriate option for the existing economic situation. Institutional integration implies that all organisations that could contribute to the solution are involved and have appropriate roles in the planning process. Sectoral integration requires that interrelations between sectors are taken into account and discrepancies resolved to

achieve synergy and balance. Especially sanitation, water supply and solid waste should be treated in an integrated way taking into account inter-sectoral relations.

UNEP *et al.* (2004) documented that at the elementary level, water should not be delivered into an area unless appropriate means to handle wastewater generated in that area are in place or planned. There is general agreement to this statement, although it is only correct for waterborne sewerage systems. Optionally, service providers can start to implement water free sanitation systems which, in such situation, would bring a great advantage to those people that otherwise would be left unserved, e.g. because of financial limitations (Cordova 2001). Water supply systems can be designed in a step-by-step approach, possibly as pro-poor systems, e.g. using water kiosks (Snell 1998; Klawitter *et al.* 2009; Blume *et al.* 2015). From an institutional perspective water supply, sanitation and waste management should be integrated but also related sectors such as agriculture or public health, to ensure an effective administrative set-up for sustainable sanitation.

In addition to the above aspects, strong and professional leadership, either political or technical within the administration is essential for supportive institutional framework setting and effective policy implementation (GFA 2009). Especially in political systems characterised by highly hierarchical personnel structures, professional leadership is not a daily occurrence. Other key aspects of administrative responsibility include the availability of financial resources and staff, sound management and clearly defined sanitation targets and projects.

I-8 Autonomy of service providers. Sustainable sanitation requires an effective administration that delegates the responsibility for service provision to a local service provider that can be either public or private. In both cases the service provider should have fully autonomy. Government authorities remain responsible for policy and legislation setting, strategic and sector planning and setting up regulatory controls.

According to UNEP *et al.* (2004) autonomous service providers:

- take part in overall development planning;
- have management and operational autonomy, leaving them free to meet agreed targets by effective means;
- be permitted to raise funds from sources suitable to their needs;
- develop their own cost-recovery policies and procedures;
- have autonomy in matters of human resource development (HRD).

To delegate, responsibilities must be clearly defined, consistent and reflected in legislation. UNEP *et al.* (2004) also stated that an effective regulator is based on appropriate regulations and standards and that delegation requires reliable and updated information. Pertaining to the implementation of sanitation projects on a large scale and thus to the setup of new service providers, it is especially necessary to delegate

administrative competences for planning and operation of the sanitation systems as well as the ownership form overarching water authorities to the service provider.

Strengthening community development to build strong local user groups and communities can thereby play a key role. For example, the Total Sanitation Campaign in India (Robinson 2005; World Bank 2010; Government of India, Ministry of Rural Development, Department of Rural Development 2015), aiming to improve sanitation coverage mainly in rural areas, is designed community-led which is creating awareness particularly for sanitary facilities in houses and schools and for a cleaner environment. The Scaling Up Rural Sanitation Program, or Total Sanitation and Sanitation Marketing Project in East Java, Indonesia brought improved sanitation to over 1.4 million people in 2,200 communities and 29 districts within 5 years using a large-scale community-led approach that combined demand generation, sanitation marketing as well as strategies to build an enabling surroundings (Pinto 2013). In Jordan, Dombrowsky (2008) found that the institutional setting offered both opportunities and constraints to countrywide implementation of decentralised wastewater treatment and reuse. Administrative competences for planning, ownership and operation of public wastewater systems were with the national water authority but not the municipalities. However, the Jordanian government promoted private participation and transferred tasks to other entities including private operators and municipalities.

I-9 Regulation of service provision. Although policies for sanitation are available in many developing countries, they are often not well implemented caused by unrealistic action plans and inappropriate regulatory framework which exclude non-conventional and reuse-oriented solutions (Johansson and Kvarnström 2005). Thus, effective regulation of service provision towards sustainable sanitation is often underdeveloped and needs to be considered in a holistic management strategy.

Regulatory controls are basically to set minimum standards for service provision. The WHO drinking water quality standards, legally binding for the WHO member states, are to ensure basic public health needs with focus on secure water supply (WHO 2006a). With increasing economic development the standards have been spread to social and environmental objectives, e.g. monitoring of wastewater discharge and standard of water availability. Relevant for sanitation are the WHO guidelines for safe use of wastewater, excreta and greywater which take into account policy and regulatory aspects, wastewater use in agriculture, wastewater and excreta use in aquaculture, and excreta and greywater use in agriculture (WHO 2006b). These guidelines focus on diseases prevention and public health principles, especially in reuse oriented sanitation systems thus providing safeguards for the implementation of sustainable sanitation on a large scale.

Over recent years the role of regulation has grown in many countries to embrace economic and commercial objectives (OECD 2015). Economic regulation usually in-

tends to provide a commercial framework for the effective management of public utility services and protect the interests of users. Sanitation services in developing countries, however, are mainly decentralised; so improving services is a matter of improving decentralised infrastructure and small systems in unconnected settlements, which is not a problem for economic regulation but rather environmental regulation and policy (Groom *et al.* 2006). The authors also noted that in cities with centralised sanitation systems, which can be natural or legal monopolies, there is a role for economic regulation, mainly in setting tariffs and service standards, but also government contributions to financing the system reflecting its public benefits.

There is no universal model to set up a regulatory framework and set up regulatory institutions. The OECD (2015) found a variety of regulatory arrangements across countries which, amongst others, shows that countries must develop their own framework meeting their institutional, organisational, technological and cultural conditions. Approaches to regulation require emphasis on the first principles of regulation (considered to be coherence, predictability and credibility, and legitimacy and accountability), how they are best developed within legal instruments and organisations and how they can be applied in the specific country context (Ehrhardt *et al.* 2007).

There are four regulatory models besides self-regulation (OECD 2015, modified):

1. regulation by the government;
2. regulation by contract specifying the regulatory regimes in legal instruments (French model);
3. independent regulation with three dimensions of independence: decision making, management and financing (Anglo-American model);
4. outsourcing regulatory functions to third parties, which makes use of external contractors.

The set-up of a regulatory institution requires a legal basis or adequate legal framework (see Section 4.2). This can be challenging to projects as reforms must be implemented for the right duration and at the right time. Furthermore, a legal mandate is necessary defining the regulator's legal status and level of independency, as well as other aspects such as budgets, functions, organisation and competences. Political influence on regulatory institutions should be low; moreover, the public should be encouraged to follow the monitoring of basic services indicators (see Section 4.9).

In a survey of 34 water regulators in OECD countries most regulators showed critical functions and powers in four main areas (OECD 2015): (1) economic regulation, (2) data collection and performance monitoring related to water services; (3) enforcement of regulations and standards; and (4) customer management and protection. Pertaining to sanitation the OECD (2015) recommends a set of general regulatory functions including tariff regulation, quality standards for wastewater treatment, defining public service obligations/social regulation, defining technical/industry and

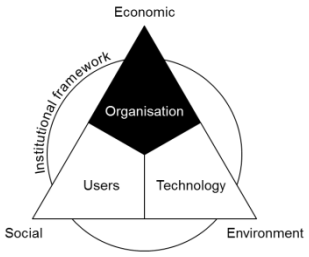
service standards, setting incentives for the efficient use of water resources, setting incentives for efficient investments, promoting innovative technologies, promoting demand management, analysing utilities' investment/business plans, information and data gathering, monitoring of service delivery performance, licencing operators, supervision of contracts with utilities/private players, supervising utilities' financing activities, carrying out management audits, customer engagement, consumer protection and dispute resolution, as well as advice and advocacy.

A particular challenge of sustainable sanitation in many developing countries is the regulation of small-scale service provision which has a big impact on the development of business opportunities. Small and smallest service providers in sanitation are usually private entrepreneurs or community groups constructing and operating latrines including emptying and cleaning, taking over logistic services in reuse processes such delivering urine as a fertiliser, or carrying out other sanitation related services; they have an important and sometimes exclusive role in sanitation, especially in urban or peri-urban informal settlements that are not otherwise served with professional sanitation services (Snell 1998; Bongi and Morel 2005; Hawkins *et al.* 2013; Blume *et al.* 2015). The acceptance of informal service providers and other small-scale providers that are not integrated into macro organisations (see Section 4.4) can, however, be problematic as minimum standards for service quality are not or cannot sufficiently acknowledged and enforced (Blume *et al.* 2015).

The successes in water supply show potential of small-scale service provision especially in poor areas. The Centre on Housing Rights and Evictions *et al.* (2007) assessed that small-scale service providers serve over 50% of water users in developing countries through kiosks, door to door delivery or operation of wells and springs. In sanitation, small-scale providers carry out mainly services such as latrine construction or emptying. Often, being informal, their business should be permitted by an independent regulatory institution. Optionally, governments can set up a public system of small-scale service provision in which providers serve as contractors or employees of the government (Centre on Housing Rights and Evictions *et al.* 2007). Blume *et al.* (2015) assessed further experiences in Sub-Saharan Africa with focus on pro-poor services.

In conclusion, a sanitation regulator needs to monitor and regulate small-scale service provision while advising utilities and other service providers to ensure quality and affordability of services for all users.

4.4 Key Action 4: Utility management and development



Strategic area: Organisation.

Objective: Utility management and development effective for large-scale sustainable sanitation.

Indicators: (I-10) Strategic planning and integration, (I-11) Processes and organisational functions, (I-12) Performance monitoring (see Table 4.4).

Rationale. Effective utilities are essential to provide sustainable sanitation services and successfully implement new projects including the upscaling of innovative pilots. The views on sanitation service provision and a sustainable sanitation system in Section 3.2 call to provide a basic service to protect human health and the environment, and thereby integrate the major elements of a sanitation system organisation, technology and users, and institutional frameworks in a sustainable manner. The basic idea in this key action is that only utilities with an effective management and development will be able to follow up the social and environmental goals of sanitation which is valid for both public and private utilities. Depending on the institutional setting (see Section 3.4.1) and the type of sanitation infrastructure, utility management and development must closely be coordinated with Key Action 5: HR capacity building and Key Action 6: Financing (see Sections 4.5 and 4.6, respectively).

Improving utility management usually starts with utility development as a part of organisational development respectively change management, often supported by independent consultants. Where a service provider exists, it must be improved and adapted to the new objectives. In many developing countries, however, there is a need for creating sanitation service providers from scratch. Usually after analysing the *status quo* and defining management needs (possibly using this research including the developed tool), a process of participative strategy development is required (Stage 1, see Section 2.4.1). Kaplan *et al.* (2008) advised on such a development in four steps: (1) crafting mission, vision and value statements, (2) defining strategic goals, (3) implementing a strategic analysis of external and internal factors and finding internal strengths and weaknesses as well as external opportunities and threads, and (4) formulating the strategy. Implementing the strategy means, according to the authors, (Stage 2) planning of the strategy, (Stage 3) aligning the organisation with the strategy, (Stage 4) planning operations, (Stage 5) monitoring and learning, and (Stage 6) testing and adapting the strategy. Strategy development and implementa-

tion should thereby be participatory to ensure that all employees understand and support the strategy and be enforced with committed leadership.

There are tools that have proved successful in the development of water utilities (DWA 2008; GFA 2009; compiled, modified): (a) developing a mission statement to identify with the utility and raise motivation; (b) explorating sites, interviews and discussions to analyse the context and collect information; (c) participation of staff to raise creativity, relate to customers, satisfy staff and strengthen efficiency; (d) workshops, round tables and working groups to analyse the situation and results, develop strategies, reflect processes and monitoring; (e) on-the-job training, coaching, workshops and seminars to improve qualification of staff and initiate change processes; (f) informative visits and guest courses to train and provide practice experience. The success factors of utility management and development, however, are a professional internal and external organisation structure, sufficient technical and management capacities, and effective monitoring. This includes strategic orientation based on professional tools and the integration of innovative projects. It also includes effective processes and organisational functions as well as performance monitoring.

Table 4.4: Indicators and rating criteria for Key Action 4: Utility management and development

Indicator	Rating criteria			
	0	1	2	3
I-10 Strategic planning and integration	Strategic planning tools not available, sanitation services not monitored, integration of projects limited	Strategic planning tools available, sanitation services monitored, but not improved for sustainability, coordination and monitoring mechanisms not effective, integration of projects limited	Strategic planning tools available, sanitation services monitored and improved for sustainability, but coordination and monitoring mechanisms not effective or integration of projects limited	Strategic planning tools available, sanitation services monitored and improved for sustainability, coordination and monitoring mechanisms effective and integration of projects effective
I-11 Processes and organisational functions	Processes and functions not developed, minor or no sanitation services delivered	Processes and functions extremely bureaucratic and control-oriented, not monitored or not regularly improved, or decision-making centralised	Processes and functions bureaucratic, or not monitored or not regularly improved, decision-making decentralised	Processes and functions unbureaucratic, monitored and regularly improved, decision-making decentralised
I-12 Performance monitoring	Performance of sanitation system not monitored	Performance indicators introduced, but performance of sanitation system not monitored or not documented	Performance indicators introduced, performance of sanitation system monitored and documented but data not integrated with MIS	Performance indicators introduced, performance of sanitation system monitored and documented, data integrated with MIS

Key to scores as in Table 4.1.

I-10 Strategic planning and integration. Strategic planning for sanitation services allows for adapting structures, processes and activities of a sanitation service provider to the expected service conditions in the future. It requires sufficient knowledge of the current situation and aims at short-term (e.g. one year), medium-term (e.g. a few years) and long-term strategies (e.g. more than a few years). Regular control of the efficiency of the provider and the actions undertaken requires performance monitoring (see I-12) and concrete milestones of development specified in planning documents (see I-3, Section 4.1). Planning for sustainable sanitation again requires the integration of the goals of sustainable development and of specific goals related to the particular service framework, e.g. pro-poor orientation. Strategic planning is essential to meet rapidly changing service conditions which, in fact, can be found in areas of heavy population growth in many developing countries.

There are five tools that have proved to be effective for strategic planning in the sanitation industry: (1) utility development plan, (2) business plan, (3) Balanced Scorecard, (4) marketing and (5) incentive functions. There are many further tools that have proved to be effective for organisation development of enterprises in other industries (Schaltegger *et al.* 2007). However, many innovative tools need to be substantially adapted to meet the special conditions of sanitation utilities and especially of those in developing countries.

Utility development plan is a key tool for the strategic planning of a sanitation utility (based on GFA 2009); it is basically a set of operational and commercial objectives that are to be achieved over a specified period starting from an agreed base according to the utility's strategy. It provides an analysis of the business conditions, it defines the business planning and it describes the strategic actions that need to be implemented. Furthermore, it illustrates the type and quality of sanitation services, the cost of services and the structure of the sanitation charges to cover the cost of services. Since utility development is a recurring strategic process, the plan should be updated regularly. Finally, the plan can be used to coordinate and communicate the business objectives of the utility with internal and external stakeholders and to report to authorities and regulatory institutions. The utility development plan thus is a proper tool to improve transparency and accountability of the sanitation services.

Figure 4.2 illustrates the basic elements of a utility development plan. The plan design is based on the design of conventional corporate development plans used in water and sanitation projects (GFA 2009). It illustrates the different elements of utility development including strategy development, utility analyses and business planning. This development plan also integrates the strategy and assessment tool of this research. So the business plan is organised according to the strategic areas and key strategic actions which can be easily adapted in practice. The tool can be used to support utility analyses. Support to institutional development will be optional depending on the goals and resources of the utility and related support projects.

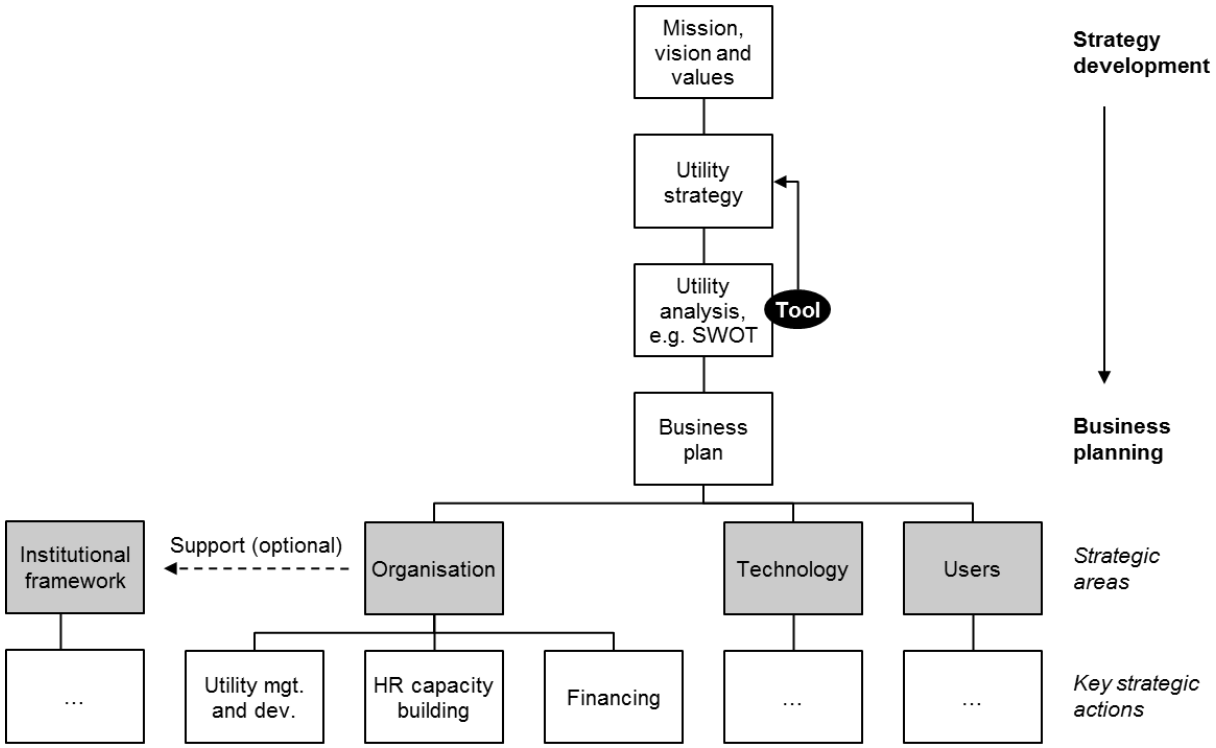


Figure 4.2: Basic design of a utility development plan integrating the strategy and assessment tool of this research

Business plan is part of a utility development plan; although in practice it is often seen separately (GFA 2009). The basis of the business plan is a comprehensive utility analysis (e.g. including a SWOT analysis which is a strategic planning method to evaluate the strengths, weaknesses, opportunities and threats; the tool of this strategy can also be used, see Figure 4.2). The business plan then describes the utility's policy and strategy, business trends, the utility's portfolio and core business areas including the short and medium term business objectives. It also describes the operational plan with milestones as well as performance assessment and monitoring advice; furthermore, responsibilities, risk analyses, cash flow analyses, profit and loss statement, financial planning and investment planning. The business plan is amongst others a planning and control tool of business development and needs to be updated annually. For the achievement of the objectives, indicators need to be defined which should be used in a management information system (MIS) and reporting routines.

Balanced Scorecard is an established, although advanced, strategic tool of corporate development and management (Kaplan and Norton 1996, 2008). Also water and sanitation utilities use it successfully, e.g. in Germany (Berger 2004; Stemplewski *et al.* 2005) and Brazil (Giacomini *et al.* 2013). The Balanced Scorecard is basically a performance management system which works well with business strategy (Kaplan and Norton 1996, 1997). It supports the planning and implementation of a strategy, e.g. in four steps: (1) planning of actions according to the strategy; (2) translation of strategic objectives into specific targets and short-term action plans; (3) creation of a strategy map to visualise objectives, actions, and resources needed (see Section 2.4.1);

(4) organising the strategy map according to strategic themes showing the primary components of the strategy (Kaplan and Norton 2004). It thereby requires specific targets and the right metrics to assess the cause-and effect links. Finally, this tool enables the targeting of critical processes according to their links with the strategic objectives and regularly measure status of the corporates, here considered as utilities, related to the strategy (Kaplan and Norton 1997, 2008).

The four traditional strategic perspectives of a Balanced Scorecard are financial, customer, process, and growth and learning (Kaplan and Norton 1996, 2008). The scorecard is thereby flexible and applicable to many types of strategies (Kaplan and Norton 2008), hence the strategic perspectives and scorecard design can be adapted (Stemplewski *et al.* 2005). Figure 4.3 illustrates a possible adaptation of it towards sustainable sanitation integrating the two additional perspectives "environment" and "development goals". For considering the Balanced Scorecard as a tool of performance monitoring, and for details on benchmarking approaches in the sanitation industry, see I-12.

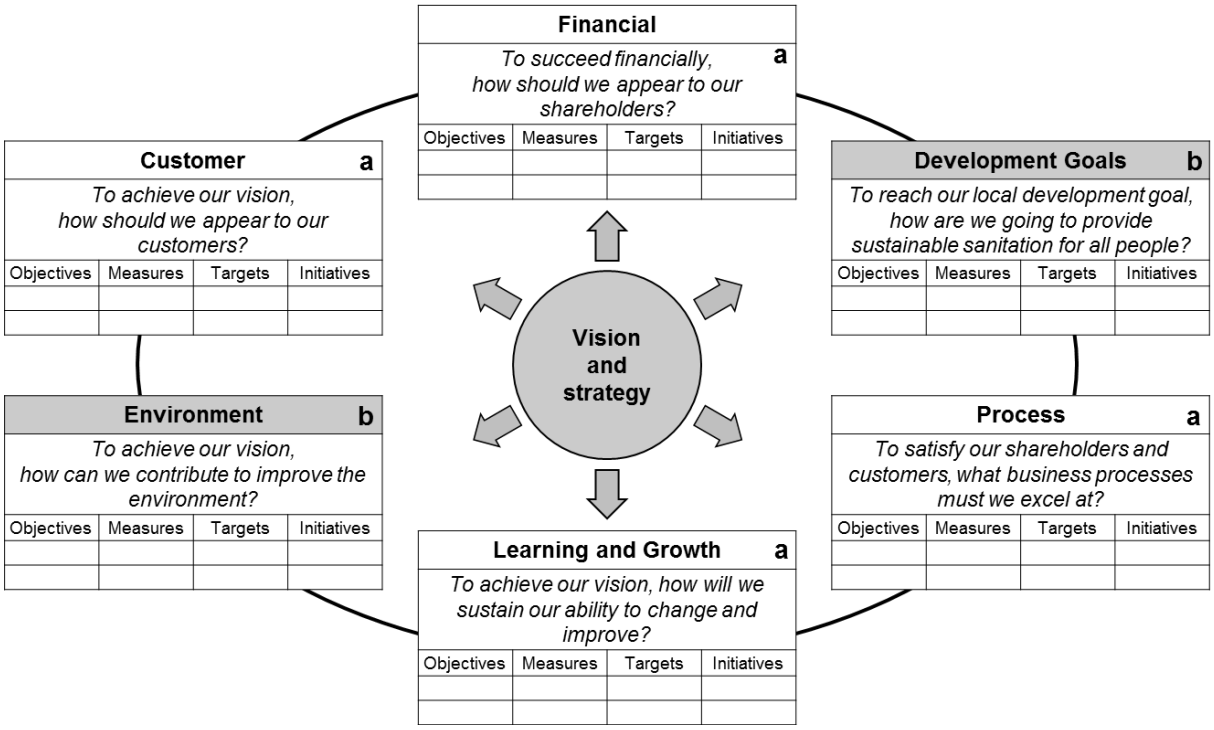


Figure 4.3: Balanced Scorecard integrating (a) four traditional perspectives of Kaplan and Norton (1996), and (b) two additional perspectives "environment" and "development goals" for sustainable sanitation

Marketing proved to be an excellent instrument for attracting users to connect to a sanitation system and for promoting behaviour change in the short and medium term, thus for scaling up sustainable sanitation (Cosgrove and Talafré 2009). Marketing is thereby not only information about sanitation products and services. Through offering excellent products and services at cost-covering prices that are affordable for all

people, providing effective logistics and promoting both products and services, marketing can develop a demand for sustainable sanitation and support the scaling up of sustainable sanitation systems even under difficult conditions where conventional approaches fail (Cairncross 2004; Obika 2004; UNICEF 2008). Furthermore, marketing can significantly contribute to the creation of a supportive framework for selling and using products in systems aiming at enhanced reuse of wastewater.

The basic principle of marketing is to reach and convince customers to buy products or services. Marketing is, however, demand-oriented. Although in the sanitation industry marketing is often approached from a user's or a producer's perspective, e.g. as a strategic tool of business development, it is at the same time a tool of CRM and therefore user management. Also marketing is an instrument to promote wastewater reuse (see Section 4.8) and to raise awareness (see Section 4.10). Marketing activities should promote both sanitation products and services to attract users adequately to invest in these products and services, i.e. mainly buying improved and sustainable toilets and paying adequate service charges. So marketing ensures that people choose to receive what they want and that they are willing to pay for it (Cairncross 2004). Customers then benefit from receiving improved sanitation services and producers or providers profit from generating revenues enabling them to finance O&M of the system. Financial opportunities again allow further developing and improving technology and services.

Incentive functions are usually incentive compensation systems, or internal incentive function, that can avoid shortcomings in payment systems which can often be found in the public water and sanitation administration in developing countries (GFA 2009). Such systems offer little incentive in addition to the ordinary salary to improve the performance readiness of staff, efficiency and quality of work collectively. The basis of effective incentive compensation systems is an approach that is performance oriented. Furthermore, an involvement of staff in decision-making, attractive jobs as well as education and training build more motivation among employees. Incentive taxes can be another type of incentive function which is not considered here as this key action focuses on management and development of a utility and taxes are usually governmental tasks (see Section 4.1). Where a sanitation utility is, however, a state organisation and development is closely related to the governing body, taxes can be an interesting external incentive function.

Integration of projects and services is likewise important to effective utility management and development and especially to the upscaling of non-conventional projects. Those systems, e.g. that are based on the ecosan approach (Werner *et al.* 2004b) are often decentrally organised integrating small scale initiatives with a high grade of stakeholder participation (Jurga *et al.* 2005a; Werner *et al.* 2005). In such projects users can exchange experiences and improve their individual systems or jointly organise operation and reuse. Decentrally organised systems can bring several ad-

vantages over centrally organised systems in both rural areas (particularly economically, Walther *et al.* 2013) and urban areas (Otterpohl 2002; Steinmetz 2009). However, there is a need for the central organisation of guidance, consultation, administration and regulation. Considering the high grade of autonomy in operating such systems, the underlying legislative framework as well as policy and regulatory aspects, the integration of micro-projects with overarching service providers or authorities is necessary. When integrating projects and services on a large scale, regulatory aspects come to the fore. The organisational aspects of the integration are distinguished for micro and macro organisations (see Figure 4.4).

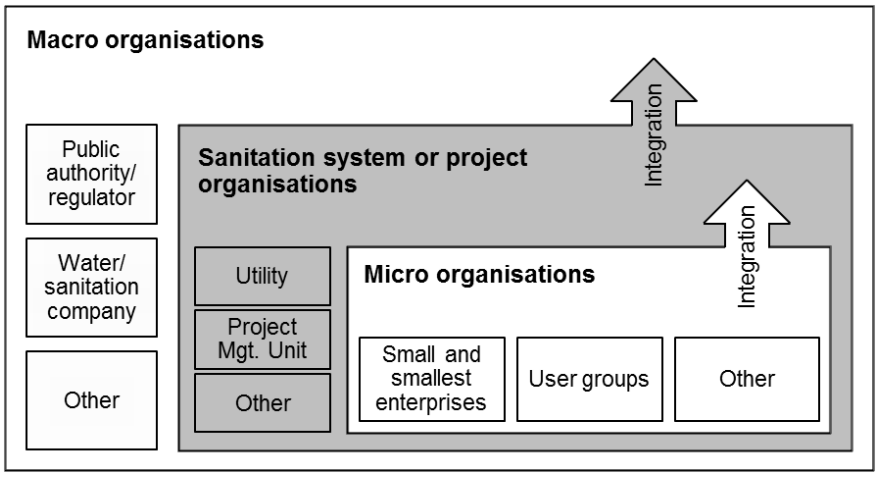


Figure 4.4: Integration of systems or projects with macro and micro organisations

Micro organisations include small and smallest enterprises but also user groups and organisations that carry out outsourced activities. Understanding the specific work of those organisations related to the specific service area which may vary from slums to rich districts is essential for a successful integration (Bongi and Morel 2005).

Snell (1998) found six success factors of small-scale service providers in sanitation: (1) entrepreneurial or commercial approach to competition and innovation to develop effective service or specialised customer relations; (2) multiple and indispensable roles played by community organisations; (3) technical innovation matters, from better and cheaper toilet designs, manhole covers and water storage tanks to new low-cost water purification technology; (4) investing in raising the awareness of the health benefits stemming from use of toilets rather than open defecation; (5) the ease of independent water production resulting from drilling of wells or purification of natural sources; and (6) the ability to offer instalment plans for payment of hook-up fees, removing a significant barrier to entry by new customers.

Macro organisations are such as larger public authorities or companies. Such organisations bear the overall responsibility for service provision in the project area. Private sector initiatives in the sanitation industry can function well, but the integration at macro level will be necessary to ensure quality control and regulation. Also to spread

knowledge and experience gained from specific and smaller projects, an “umbrella organisation” is usually necessary. Where responsible authorities or companies are not involved in projects, i.e. where projects are implemented autonomously, obstacles for further upscaling will arise. Only where large-scale projects receive substantial political and administrative support, will donors or private investors be attracted to finance larger investments. Such investments are usually the only chance to cover the high capital cost of investments of large-scale projects.

The integration of pilot projects into larger companies is a key for upscaling sanitation services, especially to the poor. The Office national de l'eau et de l'assainissement (ONEA), the state water supply and sanitation utility in Burkina Faso, e.g. showed how a large utility can play a major role in improving access to basic sanitation. Schäfer *et al.* (2007) reported that after carrying out a donor-funded pilot project, the utility started the large-scale implementation of basic sanitation in the capital Ouagadougou. Thus 45,000 sanitation facilities have been newly constructed or rehabilitated, entirely financed by the industry. Subsidies were generated by a sanitation tax and contributions by users. Those activities increased sanitation coverage from 7% to 45%, amongst others in public places such as schools reducing the risk of epidemics such as cholera. Although the exact numbers may vary, this example shows that strong utilities can play a key role in upscaling sanitation when they plan strategically and integrate pilot projects and initiatives successfully.

Blume *et al.* (2015) highlighted, based on long-term experience in Sub-Saharan Africa, that informal service providers and other small-scale service providers including NGOs and community organisations can hinder sector development where they refuse to integrate into professional larger systems, here considered as macro organisations. Integration is thus an important element of utility management and development especially in the framework of development.

Finally, the integration of projects at macro level also supports the implementation of integrated approaches such as IWRM (see Section 4.3).

I-11 Processes and organisational functions. Management principles of service providers in developing countries often adhere to public rules which are rather bureaucratic and control-oriented. The effects are centralised decision-making, low delegation of responsibilities, restricted flow of information, poor teamwork and lack of good staff. Building appropriate organisational arrangements is one of the crucial steps towards effective and sustainable management of service providers. It is, however, the most difficult, time-consuming and expensive. Substantial re-organisation of authorities usually raises non-technical but natural questions of positions, hierarchies and relations. It should therefore be left to larger institutional or sector reform programmes (Evans 2005a; Locussol *et al.* 2009) that usually provide more time, focus, resources and political pressure for the necessary change.

Practice shows that a better option for individual sanitation projects is to focus on the creation of effective business processes rather than on the general institutional and organisational arrangements (GFA 2009). Such an approach allows focusing on what functions are needed and not on which person must be placed where in an organisational chart. Building effective processes requires the definition of objectives with concrete results. Work plans for service providers and main departments have to be prepared and human and financial resources have to be developed in such way that concrete results can be achieved within the planned time frame.

Understanding of processes varies among disciplines. By processes engineers often mean the physical, biological and chemical processes of wastewater treatment. From an organisation and management perspective, processes are understood as a series of activities, workflows or assignments that receive inputs (e.g. resources) and deliver outputs (e.g. services). Main business processes of water and sanitation service providers are e.g. technical operation of sewer networks and WWTPs, accounting, billing as well as water fee collection procedures, although billing and fee collections are usually carried out by or in cooperation with water supply departments or providers and not by sanitation departments or enterprises. However, to manage sanitation holistically, more functions are relevant.

Processes in sanitation utilities are seen in three categories: management processes, business processes, and support processes. Figure 4.5 illustrates these categories and related processes. There are optional processes, e.g. metering and charges collection which can be carried out by or in cooperation with a water supply service provider and delivery of re-usable products which can be carried out by small scale subcontractors. Logistical services may be offered to external stakeholders e.g. delivery of urine as fertiliser to farmland.

Management processes are e.g. medium-term and annual planning, overall financial management, MIS, human resource management (HRM) and HRD, communication and customer relations. These processes usually occur at management level or at the headquarters of the service provider.

Business processes are core processes of a sanitation service provider, comprising the main business areas, i.e. construction, collection, treatment, utilisation and customers. Construction processes cover planning and design within existing systems, e.g. extensions, procurement as well as construction respectively construction supervision. Collection processes pertain to the O&M of collection facilities; treatment processes to the O&M of treatment facilities, but also to the disposal of wastes and residues. Utilisation processes (see Section 4.8) are not seen as separate processes in science and practice—they are new in this perspective. However, sanitation systems claiming professional reuse of water and resources also require professional processes of reuse, e.g. delivery services of reusable products. Although this process is

optional, new business opportunities can evolve around those enterprises that set up this process in a professional and service-oriented way. A service provider may, e.g. offer logistical services, e.g. delivery of urine as fertiliser directly to farmland to other stakeholders, e.g. farmers. Finally, customer processes, e.g. pertaining to customer services or metering and charges collection will be carried out by or in cooperation with a provider of the water supply—the transfer of sanitation charges assumed.

Support processes are such as quality control and laboratory, materials and vehicle management, the information technology and communication services, asset register and valuation and facility management. These processes offer high potential for outsourcing the service to small and smallest enterprises.

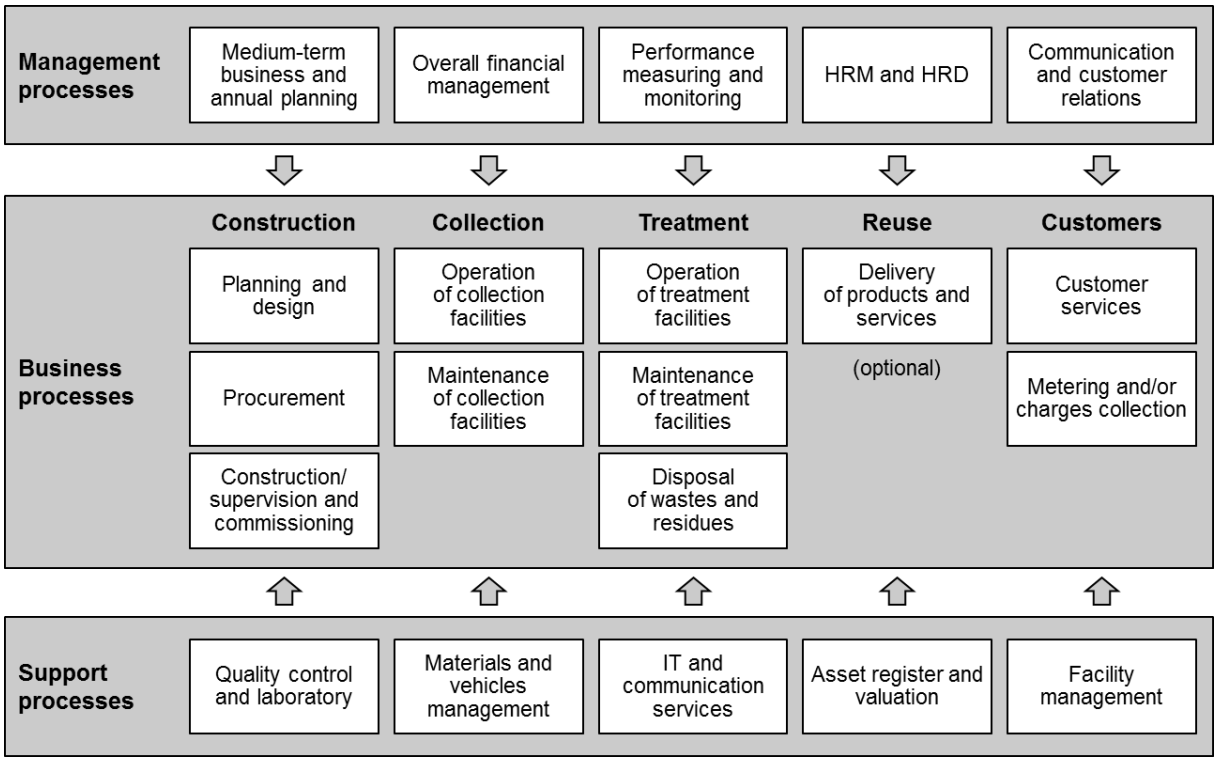


Figure 4.5: Main processes of a sanitation service provider (Lagemann and Schlüter 2006, adapted to this strategy)

The above processes may be described differently and in more detail. The focus here is, however, on the key processes which should be considered when developing a utility for sustainable sanitation in developing countries. Most projects lack resources in budget and time. It is therefore necessary to focus on the key aspects. Moreover, projects should strengthen the capacities of staff and promote a continuous self-development of the utility.

I-12 Performance monitoring requires performance indicators (PIs) which illustrate points of strength and weakness of a sanitation utility. They provide the base for institutional and management frameworks towards effective and sustainable sanitation services, being newly set up or improved. PIs can be used individually by the utility

but also by other stakeholders, such as policy-makers, regulators, financing bodies, customers and their representative bodies, quality certifying organisations and auditors as well as multi-lateral organisations (Audit Commission 2000; Matos *et al.* 2003). PIs should, however, be of interest to utility's managers at all levels and staff.

Matos *et al.* (2003, modified) proposed using PIs to:

- assist with strategic and structured planning;
- allow better quality and more timely responses from managers;
- allow simpler and more structured monitoring of effects of management decisions;
- provide key information to support a more pro-active approach to management, rather than reacting to apparent system or organisational malfunctions;
- highlight strengths and weaknesses of individual departments demonstrating their needs to improve productivity, procedures and routines;
- assist with implementation of total quality management regimes;
- allow the implementation of benchmarking routines, internally and externally;
- provide scientific, technical, financial and personnel information for auditing and predicting effects of audit recommendations.

The major purpose of using PIs is to evaluate the history service performance. This can be done either against previous time periods or similar organisations. Trends may show improvements or deteriorations in preventive corrective measures in time. Where new systems are being implemented, PIs may show whether the new systems achieve performance targets derived from comparable organisations. Utility managers may use PIs to monitor the development of performance while extensive data provision can lead to an incentive for proper monitoring, data recording and processing. It may help decision-makers focus on scarce resource allocations in service areas with a previous lack of data availability.

To assess the performance of a utility, it is necessary to consider the context for operation and relevant characteristics of the system and region. Sometimes a utility may identify internal indicators when adapting standardised definitions to avoid non-commensurate comparisons. This becomes especially necessary when new and non-conventional sanitation approaches are required, e.g. ecosan, where technologies and approaches are applied that are not fully covered by current guidelines and regulations thus calling for flexibility improvisation. Another reason can occur from the local development of new business processes, e.g. reuse of wastewater that are not covered by respectively existing regulatory framework.

PIs are expressed as ratios among variables, commensurate, e.g. %, or non-commensurate, e.g. €/m^3 (Matos *et al.* 2003). Individual PIs should be unique and appropriate in collection for representing all relevant aspects of sanitation service performance in a correct and balanced way, thus reflecting the managing activities of

the service provider (Matos *et al.* 2003). Furthermore, PIs should be clearly defined, with a concise meaning and a unique interpretation for each indicator, easy to understand even by non-specialists, easily auditable, self-explanatory and always related to well-defined areas and periods of time (Alegre *et al.* 2000; Matos *et al.* 2003; Alegre *et al.* 2006). Finally, each PI should help expressing the level of performance achieved in a certain area and throughout a given period of time, allowing for a clear comparison with targeted objectives (Matos *et al.* 2003).

An IWA task force has developed a PI system providing a framework for the O&M and rehabilitation of sanitation systems. The system has become the worldwide reference on performance measurement in the sanitation industry. It comprises six categories of PIs each considering the key indicators which are measurable individually (Matos *et al.* 2003):

- *environmental*—to assess environmental impact including compliance with wastewater discharge standards, intermittent overflow discharges and final disposal of solid wastes;

- *personnel*—to assess the personnel of an enterprise considering functions, activities and qualifications, training, health, safety and absenteeism;

- *physical*—to assess the capacity of sanitation assets for correct and safe operation according to service targets considering preliminary, primary, secondary and tertiary treatment, pumping capacity utilisation and automation, the degree of surcharging in sewers and the degree of control;

- *operational*—to assess O&M activities of an enterprise pertaining to sewers, ancillaries, pumps and pumping stations, as well as other mechanical or electrical equipment and to assess energy consumption, sewer and pump rehabilitation, inflow or infiltration or exfiltration, failures, wastewater and sludge quality monitoring, vehicle availability and safety equipment;

- *quality of service*—to measure the level of service provision including service coverage, flooding and relations with customers such as reply to requests, complaints, third party damage and traffic disruption;

- *economic or financial*—to assess the financial performance, providing an interpretation of the business management, indicating financial behaviour and ability to expand, consider revenues, costs, composition of running costs per type of costs or main function or technical activity, composition of capital costs, investments, leverage, liquidity and profitability.

Table 4.5 illustrates indicators that are often used in the sanitation industry. The indicators shown are not necessarily those that the IWA experts propose, and additional

indicators may be required for measuring performance of special services. For each indicator the table presents a common benchmark for developing countries utilities, based on actual performance of top 25% of utilities in the data base, except for service coverage which is oriented to the SDG. The table also presents the actual performance for utilities in developed countries providing an indication of what performance it is possible to reach. The indicators and performance targets are not comprehensive. The data indicate, however, that the best practice targets were achieved by 25% of developing countries utilities. The same targets can be achieved by others when strengthening utility management as well as institutional framework.

Table 4.5: Average performance of water and sanitation utilities in developed and developing countries, and best practice targets in developing countries

Indicator	Developed countries	Developing countries	
	Status 2001[a], 2015[g]	Status 2001[a], 2005[b], 2015[g]	Best practice target[c]
Service coverage sanitation (%, share of p with access to improved sanitation facilities)	96[g]	Developing regions 62[g], Least developed countries 37[g]	By 2030, achieve adequate and equitable sanitation and hygiene for all[h]
UFW (%)[i]	16[a]	> 45[b]	< 23[a], < 25[b]
Staff per 1,000 connections	2.1[a]	> 20[a, b]	< 5[a], < 6[b]
Bill collection period (months)	1.8[a]	18[b]	≤ 3[a, b], < 9.7[f]
Working ratio[e]	n/a	> 1[b]	< 0.7[a, b]
Connection fee (%, share of GDP/p)	n/a	5-60[a, b]	< 20[a, b]
Annual cost of 20 l water per d (%, share of GDP/p)[d]	0.036—0.120[a]	> 0.2[a]	n/a
Service water supply (h/d)	24[a]	< 12[a, b]	24[a, b]

[a] Tynan and Kingdom (2002).

[b] Janssens (2005).

[c] Based on actual performance of top 25% of developing country utilities (except service coverage).

[d] Water supply; highest quartile of utilities, i.e. those charging the highest prices; minimum water requirement set by the WHO (Tynan and Kingdom 2002).

[e] Working ratio is total annual operational expenses, excluding depreciation and debt service, to total annual pre-tax-collections from billing and subsidies; working ratio < 1 means covering all operating costs plus some or all capital costs (Tynan and Kingdom 2002).

[f] Top quartile sample achieved 9.7 months with clusters of two groups of utilities: one with ≤ 4 months and one with > 8 months (Tynan and Kingdom 2002).

[g] UNICEF and WHO (2015).

[h] Sustainable Development Goals, Goal 6, which also calls to end open defecation and pay special attention to the needs of women and girls and those in vulnerable situations (UN General Assembly 2015).

[i] UFW = difference between water supplied and water sold as percentage of water supplied capturing physical and commercial losses (Tynan and Kingdom 2002).

So performance monitoring is crucial to securing and improving the quality of services delivered. Performance objectives in developing countries should be, however, limited and well-focused to enable reaching certain standards (Wright 1997). It may be introduced through performance agreements on the basis of incentives (see I-1, Section 4.1). Such agreements may be on a short-term basis, e.g. one year to enable frequent assessment or on a mid-term or long-term basis with fixed points of assessment. Tynan and Kingdom (2002) proposed strengthening measures with a focus on customers, improvement of governance, provision of performance incentives for managers and the introduction of appropriate tariffs.

Wherever possible, PIs should also provide the basis for future *benchmarking*, i.e. the comparison of performance with best practice targets and similar utilities (Parena and Smeets 2001; Larsson *et al.* 2002; Cabrera Jr. *et al.* 2011). Sharma (2006) showed that utility managers and employees, politicians, regulators but also NGOs, private investors, donors and customers can use benchmarking to improve performance as well as support institutional reform, enhance accountability to customers and so improve services. Marques *et al.* (2011) concluded from an investigation of 50 water and sanitation regulators worldwide that 72% of the regulators applied benchmarking in the quality of service regulation which means the economic regulation of setting prices and tariffs.

In the IWA framework benchmarking is defined as (Cabrera Jr. *et al.* 2010):

> "... a tool for performance improvement through systematic search and adaptation of leading practices".

The new benchmarking approach thereby breaks with the former "metric" and "process" approaches (Cabrera Jr. *et al.* 2010, 2011). Focus is now on creating a model of performance assessment and improvement mapping most practices qualified as benchmarking in the water industry (Cabrera Jr. *et al.* 2010). According to the authors, the new framework allows regulatory activities to be accommodated (see I-9, Section 4.3), and helps solving a main problem of former approaches, i.e. integrating different projects focusing on different levels of detail within a service provider; with levels of detail being utility, function, process and task.

Formerly, IWA and others developed the approaches of *metric benchmarking* and *process benchmarking* (Kingdom *et al.* 1996; Larsson *et al.* 2002; Sharma 2006). Metric benchmarking is thereby a quantitative comparative assessment that enables utilities to track internal performance over time, compare this performance against that of similar utilities, and define target levels of performance (Kingdom *et al.* 1996). Process benchmarking involves at first identifying specific work procedures to be improved through a step-by-step "process mapping", and then finding external examples of excellence for standard setting and possible emulation (Kingdom *et al.* 1996). In metric benchmarking performance gaps and desired levels can be identified, whilst

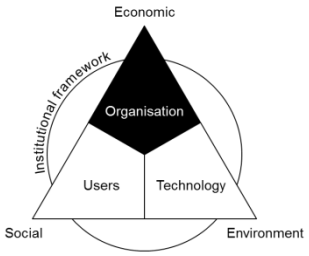
in process benchmarking, a roadmap for achieving the required improvement can be laid out by looking at best practices in the sector. Metric and process benchmarking thus complement each other. However, Bartsch (2007) showed the importance of ensuring comparability of the data base, particularly with respect to the set of indicators selected, while focusing on the technical, natural and legal framework.

Benchmarking has become a key tool in the water industry to promote and achieve performance targets globally (Cabrera Jr. *et al.* 2011). Large benchmarking initiatives are implemented nationally and internationally in developing and developed countries (Parena and Smeets 2001; Sharifian 2002; Andrews *et al.* 2004; Kiesl *et al.* 2005; Sharma 2006; Aquabench 2009; International Benchmarking Network for Water and Sanitation Utilities 2015). Möller *et al.* (2012) as well as Bertzbach *et al.* (2012) reported on 15 years successful benchmarking experience in the German wastewater sector towards performance improvement. Reality shows, however, that in developing countries the introduction of benchmarking will not be the first action to be undertaken when introducing sustainable sanitation projects on a large scale, or upscaling smaller projects. Professional benchmarking requires strengthened institutional setting and effective utility processes, which usually have to be improved first.

The basis for effective performance monitoring is an MIS (GFA 2009, modified): The system combines data from all relevant fields of the utility, e.g. financial, customer, technical and geographical. Together with the utility personnel, appropriate reports have to be defined for the various organisational levels. These reports have to take the requirements and targets of the business plan into account and assure that all levels receive the information relevant to them in time. The target of performance monitoring is then to enable the utility management to prioritise problems and make evidence-based decisions. Therefore, data entered in the software must be correct and control mechanisms have to be defined to assure its accuracy. The reports should enable monitoring performance against the approved business plan.

Minimum requirements of an MIS are (GFA 2009, modified): (1) collection and structuring of data and information—clearly arranged and intelligible data collection sheets, uncomplicated use to avoid mistakes, automatic check of data input sheets, and individual connection to existing information sources; (2) processing and analysis of data and information—production of high data quality as well as transparent and understandable compilation of tables and analyses; and (3) evaluation of data and information—usable for future benchmarking; sound and convincing standard evaluations, flexible for more, individual evaluations and open for a further data management with a data base.

4.5 Key Action 5: Human resources capacity building



Strategic area: Organisation.

Objective: HR capacities sufficient for large-scale sustainable sanitation.

Indicators: (I-13) Strategic approach to HR capacity building, (I-14) Status of HR, HRM and HRD, (I-15) Effectiveness of training (see Table 4.6).

Rationale. Barnes *et al.* (2012) defined capacity building in water and sanitation as "unlocking human and organisation potential" by creating enabling conditions, motivating people to act, and supporting them with necessary skills, tools and knowledge and resources. According to the authors it includes (a) enabling conditions at the sector level, (b) organisation development, (c) effective human behaviour, and (d) good practice. Building capacities is thereby essentially for promoting the ability of service providers to achieve their delivery objectives and mandates, here basically extending or sustaining sanitation services. This refers especially to service providers in non-conventional sanitation systems requiring paradigm shifts in thinking and action (DWA 2008). Capacity building becomes even more important considering the innovation in sanitation approaches and technologies (see Section 1.1.2) thus increasing and changing requirements of knowledge and the ability of staff.

The UN Economic and Social Council (2008) assessed that in 2008, about 90% of the sanitation and water service providers in developing countries were publicly managed. Although capacity building has received greater attention in TA-programmes worldwide they also found that much effort remains fragmented to accelerate progress in the delivery of sanitation services. This fact leads to the assumption that most public service providers lack necessary capacities to expand the provision of sustainable services. Although some public providers are effective, performance in the private sector is often better. This is recognised by the need to be well prepared for competition, e.g. to hire the best staff locally available but also by the common phenomenon in many developing countries that staff from public utilities when educated or trained well, tend to move to the private sector for better salaries or better working conditions. For example, in Syria, Jordan and Yemen engineers trained in specific fields, e.g. in the application of geographic information systems, tended to move from public organisations into private enterprises after completing the training, often abroad for much higher salaries, e.g. to countries in the Gulf region

(my own observations). To a large extent movement of labour creates big obstacles to the sustainable operation and service provision of public institutions and providers.

To be effective, capacity building objectives must be integrated into the strategic objectives and plans of the organisation as well as into the institutional set-up. While such integration will differ in each context according to the various needs and phases of implementation, certain general rules exist. Capacity building should occur at the institutional set-up at overarching level, at the organisational set-up at enterprise level and at the HR at individual level (see Figure 4.6).

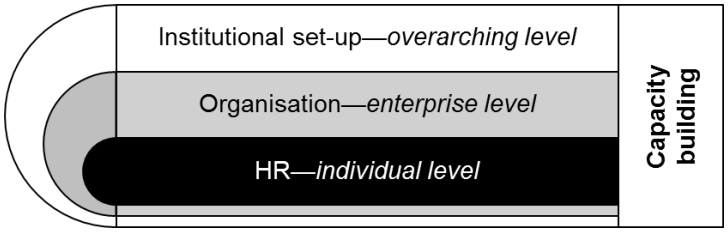


Figure 4.6: Conceptual framework for capacity building—this key action focuses on HR capacity building

Balancing the framework for capacity building requires a partnership of service providers and recipients (Bloch *et al.* 2000). Furthermore, it requires the commitment of stakeholders, strategic integration at the overarching level as well as time for implementation and impact. This key action is aimed at HR capacity building at the individual level because capacity building at the enterprise level and at the overarching level are reflected in other key actions including Key Action 4: Utility management and development and Key Action 3: Administration setting.

The first indicator thereby reflects the strategic orientation of HR capacity building in general, beyond the integration of capacity building with organisational development and HRD at enterprise level and with individual levels. In many countries HRD needs to be integrated with water sector questions and therefore with questions of institutional setting at the overarching level, thus with the sector strategy. This may also include the integration of effective systems and capacities for local research and development. HRD and training or education measures will be derived from the sector policy. However, this field is relevant to large capacity development programmes in a country rather than for specific capacity-building measures at project level. The second indicator considers the development of HR at enterprise level which is usually seen as a part of utility management (see Section 4.4). The third indicator aims at effective training at the individual level which includes the consideration of innovative training methods, such as the use of multipliers.

Table 4.6: Indicators and rating criteria for Key Action 5: HR capacity building

Indicator	Rating criteria			
	0	1	2	3
I-13 Strategic approach to HR capacity building	HR capacity building not carried out at local level	HR capacity building carried out at local level but activities not linked up with utility development strategy	HR capacity building carried out at local level, activities linked up with utility development strategy but not with sector strategy	HR capacity building carried out at local level, activities linked up with utility development strategy and sector strategy
I-14 Status of HR, HRM and HRD	HR extremely limited at necessary qualification, training rarely provided	HR limited at necessary qualification, training provided but not according to needs, HR not developed as overall concept	HR available at necessary qualification, training provided according to needs, but HR not developed as overall concept, or staff and career planning not performance-based or data not integrated with MIS	HR available at necessary qualification, training provided according to needs, HR developed as overall concept, staff and career planning performance-based, data integrated with MIS
I-15 Effectiveness of training	Training not provided	Formal or on-the-job training provided but training needs not assessed	Formal or on-the-job training provided, training needs assessed but training not monitored or not evaluated	Formal or on-the-job training provided, training needs assessed, training monitored and evaluated

Key to scores as in Table 4.1.

I-13 Strategic approach to HR capacity building. Long-term success of training depends on the orientation to demand and the integration with sector and utility strategies (GFA 2009). However, many sanitation projects have limited resources to develop and implement sector-wide training programmes. Sometimes there are separate projects as components of water sector programmes exclusively focusing on sector-wide approaches to HR capacity building. The link-up between HRD and training measures to a utility development strategy (see Section 4.4) and a sector strategy is important for integrating those tasks in smaller projects or the daily business of utilities. HR capacity building should thereby be demand-driven rather than supply-driven, i.e. meeting staff's real needs rather than providing set training courses.

Figure 4.7 illustrates the strategic approach to HR capacity building as considered in this indicator. Ideally a sector strategy provides sector objectives as well as strategic guidance and support in education and training to the utilities at the local level. The utility strategy or development plan provides job design and descriptions as well as training needs based on performance evaluation and training needs assessments. These are the basis of curriculum development as well as preparation and execution of training which is monitored and continuously evaluated to improve the curricula.

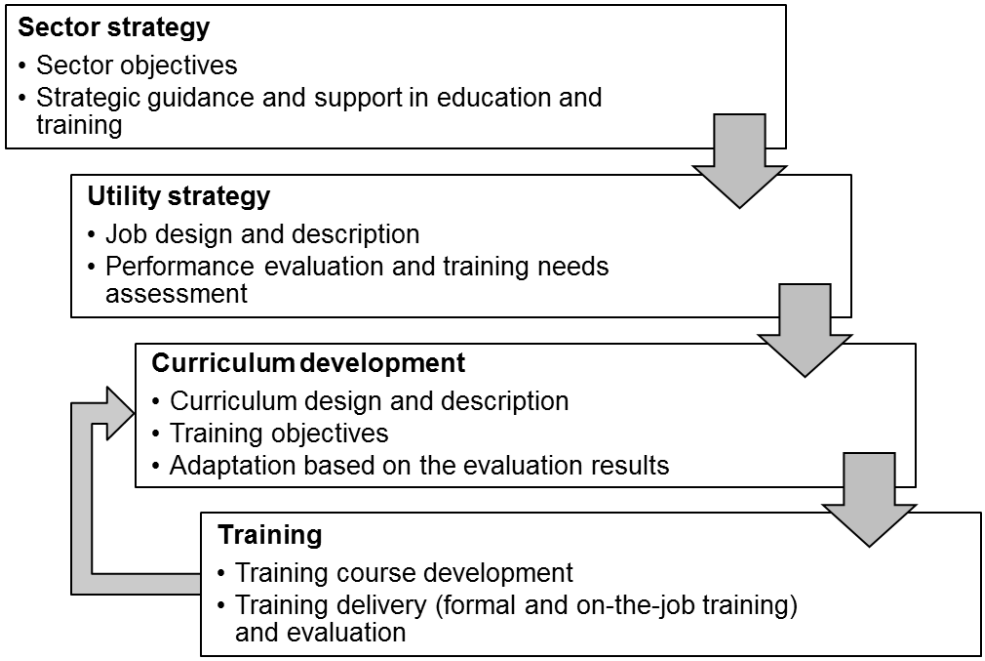


Figure 4.7: Strategic approach to HR capacity building

I-14 Status of HR, HRM and HRD. This indicator focuses on the availability of HR, how to manage it in daily business and how to develop it. The existence of qualified and motivated staff is a critical factor for the success of both the implementation of projects and the regular service provision. HR must be available with necessary qualification, e.g. certified personnel including technicians and academics. Furthermore, HR must be managed and developed according to personal and utility's needs and interest. HRM and HRD, professionally applied, optimise business and working processes; and reduce operating costs related to technical and administrative tasks.

A common problem of sanitation projects in developing countries is the lack of skilled personnel. Existing sewer networks are usually under the responsibility of municipalities. Many municipalities carry out, however, only limited O&M activities for the sewer network or no wastewater treatment activities at all. This, at least, refers to 90% of the wastewater in developing countries which is discharged untreated (see Section 1.1.1). Qualified personnel are limited. Personnel usually have to be recruited and trained from scratch where sanitation projects get implemented. New service providers or new sanitation departments need to be created or even new operation processes need to be organised. Moreover, consultation is required to support the management and execution of training.

Where sanitation organisations exist, departments are often understaffed. Besides the excessive stock of personnel that is found in many public water and sanitation authorities, often no adequately qualified staff exist, i.e. lack of skilled workers, mostly workers and auxiliary staff and staff is not assigned according to the actual needs of the service provider. Such a situation is characteristic for service providers with a high proportion of older employees. Often the motivation of staff is low; the main rea-

son being low salary. Further factors that demotivate staff are bureaucratic work processes and centralism and often inadequately equipped workplaces. As a consequence, productivity is low. Other problems are high absence and the escape of the better educated and younger employees who find better jobs in private industry.

The Association of Drinking Water from Reservoirs *et al.* (2008) reported examples from Germany demonstrating the various requirements for personnel of sanitation service providers resulting from the small size of many organisations. In most areas of Germany, sanitation is managed in a professional way in comparison with developing countries. In 2006, more than 6,900 sanitation enterprises existed; the proportion of private organisations was 10% in wastewater discharge and 12% in wastewater treatment. Out of all the WWTP operators, small-sized organisations, i.e. those treating wastewater for less than 10,000 inhabitants, represented about 68% of all WWTPs. To operate such small WWTPs, a small stock of personnel must take over a large variety of tasks, thus bringing a relatively wide but not necessarily high level of education. To operate large WWTPs, which represented about 32% of all plants in Germany in 2006, higher qualified personnel is necessary, e.g. engineers as directors; operation or chemical engineers or technicians as laboratory director. Responsible tasks of a treatment operator or an engineer as director usually consist of supervision of the treatment processes, organisation of work, management of staff as well as administrative work including reporting.

Often sanitation experts argue that the creation of jobs requires, in particular, non-conventional sanitation systems, e.g. for ecosan which brings a large potential for participation (Werner *et al.* 2001; Winblad and Simpson-Hébert 2004; NETSSAF 2006b; Panesar *et al.* 2006). Authorities in particular may consider the prospect of job growth as a motivating factor for action on sustainable sanitation (NETSSAF 2006a). Outsourcing services to the private sector is one option. However, as most sanitation organisations in developing countries are understaffed, focus should be on the development of appropriate management processes including necessary HR to strengthen the management capacity at the core of sanitation institutions.

Another problem is lack of motivation. In Jordan, e.g. motivation of personnel at public authorities was generally considered low in 2009, although the main reason is low salary levels (GFA 2009). Further de-motivating factors evolve from bureaucratic work flows, centralistic tendencies and poor equipment meaning that work cannot be carried out properly. As a consequence, problems arise from low productivity, high time debits and movement of the better educated or trained staff to the private industry or to other countries. Therefore, the introduction of an HRM is important. That includes the drafting of forward-looking strategies for staff recruitment needs and payment and the creation of a structured training programme. In addition, the introduction of performance-oriented salary systems and other incentives is required. In addi-

tion to that HRM includes staff planning, staff administration, staff change planning, e.g. recruitment or remuneration and resource planning.

HRD is an integral part of HRM. It is a systematic process of utility management that helps staff develop their qualifications, know-how and potential enabling them to fulfil current and future job demands (GFA 2009). HRD relates to personal qualification (education, training), career planning as well as job structuring (job enrichment, job enlargement). It includes short-term and long-term measures. Professional tools of HRD include training needs assessment, staff evaluation and training. The main link between HRD as the overall concept and training as part of HRD is performance management (GFA 2009). Managing performance means that individual staffs are assigned a clear role and function in their organisation as well as clear performance targets for their duties. Staffs should thereby be involved in setting performance targets, considering they have obligations but also rights for support. In this cycle, education and training relates to the request profile and the results of regular staff evaluations which determine the need for measures to further training or education.

Two other important elements of HRD are staff and career planning. These are based on the estimation how many employees, bringing which qualifications, will be are needed to achieve the business objectives. The knowledge is required for the recruitment policy but also for planning training measures. Career planning includes scenarios for the professional development of staff and shows the anticipated future requirements as well as resulting needs for training. This holistic approach to HRD has two main objectives: training measures correspond to the current requirements of the personnel capacity needs, and uniformly introduced staff assessment is in place (GFA 2009). Table 4.7 shows the principle of the training needs assessment, based on the comparison of current and targeted capacity of staff.

A computerised HR information system helps document and organise important information such as job descriptions, evaluations, training needs and participation in training measures (GFA 2009). Such a system is used in larger utilities and is therefore considered a core tool for the management of large-scale sanitation systems. The system supports the analyses of strengths and weaknesses of staff members, the identification of training needs to develop skills and the implementation of career planning. Information about certain groups of staff can be easily filtered. Basic information in the system comprises (GFA 2009): data of the service provider, such as staff resources or requirements, job and qualification description, job classification, utility's interests and demand, training needs assessments, training plans and training evaluation; and data of staff which can be linked up with its administrative data, e.g. personal data, qualification profile, career development, analysis of potential, staff's interests, training needs, participation in training and evaluation of improvements. The system can be linked up with systems of central or regional organisations, or both, e.g. to systematically implement measures of sector strategies.

I-15 Effectiveness of training. The aim of training is to improve the capabilities of personnel involved in the project activities through increasing knowledge, enhancing skills, modifying attitudes and increasing experience. Know-how transfer, on-the-job training and formal training are integral parts. For formal or classroom training of sustainable sanitation a wide range of curricula and guidelines exist (Panesar *et al.* 2006). Although formal training is approached often in projects and at utilities, on-the-job training is usually more effective in the short-term, especially at the beginning of projects.

The crux is, however, that many sanitation projects lack adequate budgets for training (GFA 2009). On-the-job training is usually cheaper than formal training. For budgetary reasons, but also for the technical reason of immediate impact, on-the-job training should constitute a major part of training, possibly delivered by consultants in short-term assignments. The training should thereby not only focus on staff members of the particular service unit of the project region but should also be offered to other relevant stakeholders to ensure a broad effect.

The basis of effective training, e.g. formal and on-the-job is an assessment of training needs taking into account the organisational set-up and staff requirements of the sanitation service provider. Assessment of training needs forms the basis for developing suitable training programmes and modules (see Table 4.7). An assessment of current and targeted qualification should reveal which qualification gaps of individuals have to be closed by respective on-the-job and off-the-job training measures. Various tools and methods are used to assess training needs: job description compared with capacity of recruited staff standardised questionnaires, and workshops, observation of daily routines and working procedures, existing documentation of working procedures and group or individual discussions. The selection of methods depends on the individual skills and knowledge of staff, and on the time frame available.

Table 4.7: Principles of training needs assessment—comparison of current and targeted capacity of staff (GFA 2009, modified)

Category	Current status	Target status
Profile, e.g. basic or expert knowledge, methodology knowledge, social capacity, personality	Qualification profile: (1) current qualification and capacity of staff at certain date; (2) information on job and general performance	Job profile: (1) general qualification, e.g. university degree, professional experience; (2) “soft” skills, e.g. communication, capacity to lead or to work in teams; (3) specific job requirements
Sources	Questionnaires, observations, personnel documents	Job and task description

Training is a process and it is rather unlikely that all training needs are covered and that the training programme is appropriate from the beginning. It is therefore necessary to monitor the training activities and results. Trainees, trainers as well as other

stakeholders have legitimate interests in knowing if the training has been effective and what the impact has been. Thus, the success of the training should be evaluated immediately after completion of the training. There are different ways to assess effectiveness and impact of training. Usually a combination of methods is used, e.g. questionnaires (before and after the training), presentations of trainees, demonstration in practice and assessment of work performance before and after training.

After the completion of training, trainers should collect data using questionnaires or similar tools regarding the benefits of training for operations and carry out supplementary interviews with a sample of participants in visits to their workplace. Furthermore, course sequences are recommended to allow interplay between theory and practice. Wherever this is not possible, the training should be followed up at workplaces or offer refresher courses. Although training is primarily aimed at skills required at the workplace it should also include further topics looking at the overall organisation to enable staff to looking beyond their current situation and hence affect the development of the entire organisation. However, such a training approach is usually left to later stages in the organisational development of service provider as often continuous improvement is not the primary goal. Furthermore, the corresponding processes must exist at the same time or must be adjusted accordingly. If good business processes exist, trained employees can fill it. Otherwise the training is useless simply because only knowledge was imparted. In this context, coordination with other key action is important in particular with Key Action 4: Utility management and development and Key Action 7: O&M management. Finally, the findings of the monitoring and impact evaluation should feed into the design of training modules as well as the regular development of training and HR capacity building programmes.

Effective training concepts should meet four conditions (GFA 2009, modified):

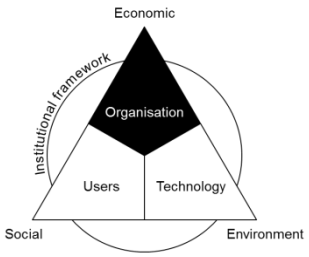
- *performance evaluation* is transparent and is based on the comparison of current and expected benefits according to job descriptions, targets, or both;
- *incentive system* relates to career development and performance appraisal and is composed of job position or function-based elements and of contingent elements in group or individual performance;
- *career planning, job classification, job description and performance invention* are logically connected and meet their current needs of the organisation;
- *HR information system* enables adequate and timely monitoring of training inputs at service providers with many staff members to support career planning and performance appraisal.

Training of trainers is thereby an effective method to accelerate HR capacity building. This has been well proved in development projects (GFA 2009). In that method eligi-

ble staff members are selected and developed as multipliers with specialised training of training methods and techniques. This method is the most effective at the lower the administrative level. At local level, many more staff members need to be trained in comparison with the regional or national level. Here, replacing external training input with input of multipliers can significantly reduce the costs of HR capacity building. At the national and regional level, where less staff members need to be trained, training can be direct and supplemented by individual coaching.

Finally, training approaches and materials that have proved to be successful should be standardised in training units to multiply their effects, e.g. at local level (Ghannam and Fuqaha 2009). Wherever applicable, the standardised training should be integrated in a sector-wide technical vocational education and training system to ensure strategic development.

4.6 Key Action 6: Financing



Strategic area: Organisation.

Objective: Financing secured for large-scale sustainable sanitation.

Indicators: (I-16) Commercial and financial management, (I-17) Revenue generation, (I-18) Affordability of products and services (see Table 4.8).

Rationale. Sustaining investments in sanitation basically means covering all costs for O&M and ensuring the affordability of services for all users. Covering all costs, however, is hardly achievable in many developing countries. Especially where high-cost systems have been implemented possibly even in areas of very low economic capacity and growth, revenues and public subsidies are usually found insufficient to cover the costs. Mugabi and Castro (2009) showed for Africa that many water and sanitation utilities struggle to cover even the operating costs of the existing systems and provisions for reinvestment cannot be made. Such a situation is crucial as donors and other investors will only invest in systems under the condition, that O&M of the infrastructure constructed can be financially secured.

H. Heidtmann (personal communication, 3 February 2016) noted that in the case of subsidising the investment costs, sustainable investment strategies can only be implemented with external support. The full subsidisation of a sanitation system means

that a new donor must be found by the end of the depreciation period to rehabilitate the system. This prevents sustainability. The assumption that donor funds will always be available is doubtful. It is therefore necessary to build sanitation systems in such way that they are feasible also in terms of investment in the future. Hence a pro-poor approach means that only low-cost systems for the poor are feasible. All other systems including high-cost non-conventional systems have to be considered as luxury systems that are subject to full cost recovery. I agree to his understanding.

Where financing cannot be secured, the impact on infrastructure and services is enormous. The result is a “stagnation cycle” of weak finances, asset deterioration, poor maintenance, poor services, customer dissatisfaction and low revenues (Cross and Morel 2005, see Figure 4.8).

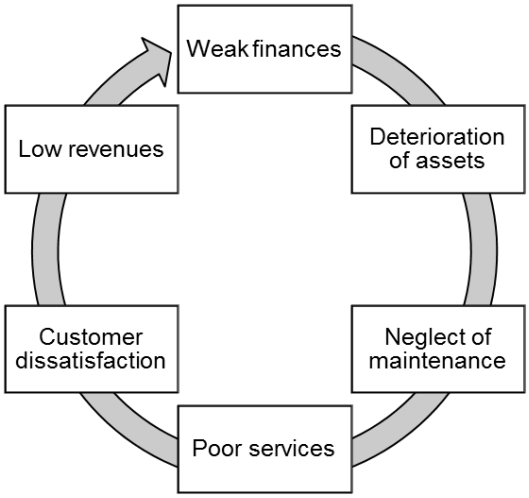


Figure 4.8: Impact of weak finances on infrastructure and services assessed as “stagnation cycle” of water and sanitation utilities in Africa (Cross and Morel 2005, modified)

Successful financing of sanitation services is based on effective processes of commercial and financial management and on sufficient revenues. Moreover, to promote, to market and to scale up new approaches and technologies, sanitation services need to be affordable for all users. Furthermore, innovative strategies of financing are required to introduce non-conventional sanitation systems with a greater degree of freedom pertaining to services and reuse. Another challenge of financing in developing countries is pro-poor orientation. Evans *et al.* (2009) showed that the successful upscaling of sustainable sanitation services does not only require the provision of funding to cover investments in infrastructure, but also the implementation of strategies to target investments for the poor.

Generally financing of O&M can be secured by external resources, internal resources or both. It is important to know which stakeholders will be responsible for financing the phases of a project. For example, who will finance design and construction of the infrastructure and who will finance its O&M. In developing countries external funds for sanitation projects are often limited, although donors usually seek opportunities to

invest where institutional and management framework promise successful projects. But experts also acknowledge that sanitation projects often lack the necessary interest of politicians and donors in comparison with water supply projects (Collenberg 2009; Pfeiffer 2009a) for which external funds are much more easy to generate.

Governments and future operators must secure the budgets for the O&M of infrastructure during the investment phase. Depending on the type of system, important factors are salaries, energy and provisions for reinvestments. In developing countries, many service providers do not cover the full operation costs hence rely heavily on public subsidies (Cardone and Fonseca 2003). Such a situation can bring both service providers and owners, usually municipalities, into budgetary crises. Budget constraints again can make services unaffordable for many users. Affordability for all users, however, is necessary to ensure willingness to pay as well as sufficient revenues. The World Bank (2012) underlined that if providers rely on public funds, they will focus on demanding those funds from the institutions on which they depend, rather than on their customers.

Effective actions on financing are based on a realistic picture of the financial status of a utility, on a clear analysis of the current and future costs, and on revenues related to the different operational activities. Possible support actions include (GFA 2009, modified): (a) upgrading financial management and planning including accounting; (b) introducing strategies for revenue collection; (c) minimising drawbacks of the technical system, e.g. treatment failures; (d) ensuring HR capacity building including HRD and HRM (see Section 4.5); (e) introducing an MIS and a financial information system (see Section 4.4); and (f) improving CRM including the introduction of databases that link financial and technical performance data (see Section 4.9).

There are many different criteria specifically developed for actions on financing. Hjerpe (2005) found five economic criteria that were used in water utilities in Sweden; total cost, benefits, efficiency, cost-recovery and affordability. Those criteria are well acknowledged in the water industry and are used to assess the financial and economic performance of a provider, as well as sometimes in benchmarking approaches (see Section 4.4).

In this strategy the indicators on financing are understood as guiding steps to improve the system according to the above principles (see Table 4.8). Focus is on the development of effective processes of commercial and financial management, on revenue generation in a holistic perspective, i.e. developing the field in different aspects including but not limited to cost-coverage, on further aspects of revenue generation such as new revenue sources, e.g. from selling new or reuse products, and customers willingness to pay, as well as on affordability of sanitation services to users which is especially important in low-income countries.

Table 4.8: Indicators and rating criteria for Key Action 6: Financing

Indicator	Rating criteria			
	0	1	2	3
I-16 Commercial and financial management	Processes of commercial and financial management not developed	Processes of commercial management developed to basic level with billing and collection but processes of financial management not developed or not effective	Processes of commercial and financial management developed with billing, collection and accounting functions but software support not effective, or data not integrated with MIS	Processes of commercial and financial management developed with billing, collection, financial and accounting functions, software support effective, data integrated with MIS
I-17 Revenue generation	Revenues not generated	Revenues generated but not to recover full costs of O&M, financing and major repairs, or many customers not able or not willing to pay	Revenues generated to recover nearly full costs of O&M, financing and major repairs, customers able and willing to pay but new sources of revenues not developed	Revenues generated to recover full costs of O&M, financing and major repairs, customers able and willing to pay and new sources of revenues developed
I-18 Affordability of products and services	Sanitation products or services not available	Sanitation products and services available but not affordable for all users and potential users	Sanitation products and services available and affordable for all users and potential users but criteria of affordability not assessed locally	Sanitation products and services available and affordable for all users and potential users, criteria of affordability assessed locally

Key to scores as in Table 4.1.

I-16 Commercial and financial management. Sustainable sanitation requires revenues that are cost-covering for service provision and prices that are affordable for all users. In most developing countries, however, the processes of setting prices, generating revenues and allocating revenues as financial resources to the specific business processes are underdeveloped. To meet this challenge is it necessary to introduce commercial principles based on transparent and effective financial management. Donor agencies acknowledge that in publications but also through the initiation of TA-projects as accompanying measures to investment projects (see Section 1.1).

Commercial management is generally a set of business processes within a utility. It is to generate profit that is necessary to cover all costs for service delivery, i.e. for O&M of infrastructure and for reinvestments. Business processes refer in particular to the administration of costs and revenues. Commercial management thereby aims at the creation of an effective operation cycle, which means that billing all customers and introducing appropriate charges allow generating revenues that are sufficient to improve service quality and increase customer satisfaction (see Figure 4.9).

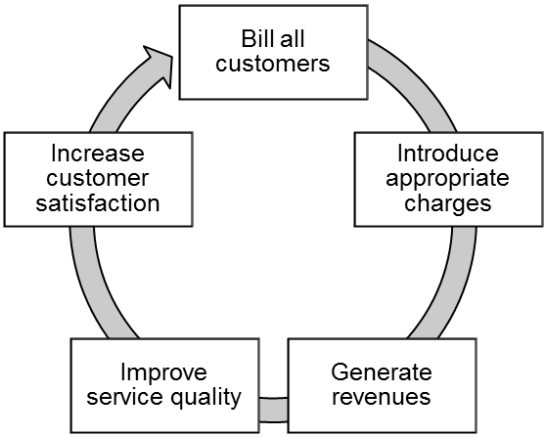


Figure 4.9: Operation cycle of commercial management

Experts of the UNPD-Word Bank Water and Sanitation Program described two basic ways of commercial management (Wright 1997). One way is using performance agreements that allow evaluating the performance of managers and workers according to criteria such as quality of service, productivity and efficiency. The key element is an incentive system that relates to the duration of the agreement. Further elements are increased managerial autonomy and rewards for managers and workers when agreed-upon targets are achieved. Short duration agreements, e.g. one year, can be assessed often and thus effectively. The other way towards commercial management is building independency of service providers with the highest degree of commercialisation, ensured through private enterprises (see Section 4.3).

The idea in this strategy is to improve the processes of commercial and financial management of a service provider (I-16) as necessary through targeted management support actions. Then revenue generation should be improved (I-17) while securing the affordability of products and services for users (I-18). This approach requires the integration of actions on utility management and development (see Section 4.4), HR capacity building (see Section 4.5), CRM (see Section 4.9) as well as awareness raising (see Section 4.10). Commercial management actions also aim at upscaling sanitation services where coverage is low, considering the social goals of sustainable development and the need for improved coverage (see Section 1.1.1). Evans *et al.* (2009) showed that upscaling sanitation, however, requires innovative, but pro-poor oriented financing strategies.

Where sanitation and water supply are managed through different organisations a close cooperation between both organisations is crucial. That is mainly to ensure transparent allocation of resources to the needs of each service which is particularly important where sanitation charges are included in the water fees. Usually, sanitation and water supply services are provided through one organisation (OECD 2010). So it is important to allocate the financial resources according to the different expenses of each business unit and process, to ensure cost transparency and sufficient financial resources for each activity.

Billing and collection of sanitation charges or water fees that include the charges are major actions of this key action. Where sanitation charges relate to water consumption, meter reading becomes important.

Meter reading, billing and collection is basically in four steps (GFA 2009, modified):

1. Read customer's meter and make entry in the billing system.
2. Produce customer's invoice; issue it to the customer and transfer it to the accounting system.
3. Enter customer's payment in the accounting system which transfers it to the billing system and clears the outstanding amount.
4. Produce reminder letter with the billing system if the customer has not paid.

Commercial procedures require billing and accounting software integrating the described cycle. The software should be interlinked to optimise the data output and minimise possible mistakes during the data input; it requires an interface to the customer information system (see Section 4.9). Also, appropriate contracts for sanitation services, e.g. latrine emptying are required with the same rules applied as for water supply services (Locussol *et al.* 2009); the provider must be allowed to disconnect non-paying customers, and it must be able to re-start the service upon payment.

Financial management is part of commercial management and includes both financial and accounting functions; it comprises five basic actions (GFA 2009, modified):

- *Cost accounting*—ensures cost transparency. Management decisions can only be based on a realistic picture of a utility's situation. Therefore, the cost and revenues must be related to the different operational activities of the utility. This does not only refer to the distinction between water and wastewater but also to O&M of the rainwater network and to construction services for third parties if applicable to the particular service provider. In projects supporting management, guidelines on implementation and accounting standards should be reviewed, adapted or developed in a first step, while the staff of the service provider should be trained on the job. In a second step, a workshop on accounting procedures and systems can be organised. The aim of such workshop would be to obtain a complete overview of all relevant information to be provided for proper accounting. The information needs and the set of report formats that have to be created need to be defined. Later the reports should relate to an MIS to include actual data from the billing and accounting software.

- *Cash flow management*—is an integral part of financial management. This refers to all incoming and outgoing cash of the utility, including receivables and payables. This means that in addition to all cash income and payments all invoices to be paid and all invoices not yet paid by customers have to be taken into account. All receivables and payables have to be assessed according to their date due.

- *Debt management*—is based on cash flow management. This is important to the sanitation service provider. The aim of dept management is to reduce the utility's debts by increasing collection efficiency and reducing total debts measures of disconnections, awareness campaigns and as a last measure, writing-off. Payment behaviour of the customers can only be improved by good service quality on the one hand and disconnection of customers who do not pay their bills on the other. At the same time, as most customers are willing to pay for good services, customers with high outstanding bills should be disconnected and unauthorised customers should be taken to court.

- *Asset management*—is essential to the financial management of every service provider but it is even more important to manage the infrastructure assets in a large scale projects. A detailed survey and valuation of all assets within the service of the project area is necessary to prepare asset and management information. The result is an asset management plan which includes technical, operational and financial data. Such a plan determines the actual value of the assets, i.e. necessary to calculate depreciation as part of the overall production cost and will help determining the cost of O&M as well as of future rehabilitation and replacement requirements.

- *Investment planning*—ensures management decisions made on medium-term operation and financial plans and not on day-to-day management, which in practice are too often prioritised over strategic investment and long-term management decisions. Pro-poor investments should be planned according to the strategy's vision and monitored through effective strategic tools (see Section 4.4).

Where commercial and financial management processes include those functions effectively, the foundation is laid for sufficient revenue generation. Beyond that, transparent cost accounting has to ensure the allocation of revenues to the business processes of sanitation. As sanitation charges are usually linked to water fees, it is necessary to integrate billing, collection and accounting with the provider of water supply services where different organisations operate sanitation and water systems.

I-17 Revenue generation. Secured financing is essential for sustainable sanitation (see above). Besides effective commercial and financial processes, key to financing are sufficient revenues and their stability or liability, covering the cost of providing the services to users. Sufficient revenues lead to strong finances, improvement of assets, better maintenance, good services, customer satisfaction and hence to high revenues (see Figure 4.8). Covering the cost of those measures is, however, not everything. Properly calculated revenues enable the upscaling sanitation of sanitation services to unserved people; and it attracts external funds and enables the release of public funds.

Revenues can generally be generated by user charges, selling of products and services, and funds or subsidies, e.g. from the government or municipality. Often revenue generation is done by or in cooperation with the water utility in the service area depending on the organisational status of the sanitation service provider (see Section 4.4) which requires excellent coordination and allocation.

Here, key aspects of revenue generation are considered to be: (a) cost recovery, (b) charges and tariffs (see also I-18), (c) revenues from further sources, e.g. from selling products and services (see Section 4.8) and from sanitation related government funds or taxes, and (d) willingness of users to pay. Other requirements for revenue generation are effective commercial and financial management processes including billing, collection, financial and accounting functions; as considered in I-16.

Cost-recovery is basically the ratio of all revenues and all costs of service provision. Costs thereby relate to investment costs and to the level of efficiency of the service provider. It includes the costs for O&M, major repairs and financing. Cost-recovery being above 100% means profits; being below 100% means losses, which requires subsidies. In developing countries, many service providers do not cover the full operation costs hence rely heavily on public subsidies (Cardone and Fonseca 2003). However, revenues hardly ever significantly contribute to sanitation costs, especially in low-income regions.

Charges and tariffs are key elements of a sustainable sanitation system. A tariff system must allow for sanitation charges to cover the cost of related service provision. Only providers that generate enough cash can operate and maintain the systems and expand services. Sanitation services are paid for by users and taxpayers or by external assistance. To clarify who should pay what proportion it is necessary to know the overall costs of water and sanitation services provision on a sustainable basis. Full cost recovery from users is therefore a necessary long-term aim for both water supply and sanitation. Charges for sanitation should thereby usually be higher than for water supply to acknowledge the higher costs for sanitation. Nevertheless, not all users should have to pay the same sanitation charges. Individual affordability of water and sanitation charges should be ensured by appropriate tariff structures; uniform tariff structure for a whole country is not sustainable as service levels, sanitation costs, and the ability to pay usually vary widely (see I-18).

Table 4.9 gives different wastewater charges in Germany and south-eastern European countries. The data indicate, while taking into account the service values given below, that there is a significant correlation between appropriate tariffs and service standards, although the specific dependencies are more complex.

Table 4.9: Considerable differences in wastewater charges for households in Germany and south-eastern European countries

Country	Wastewater charge (€/m^3)
Germany (2005)	2.28[a]
Albania (Durres, 2003)	n/a[b]
Bosnia and Herzegovina (range and Sarajevo, 2001)	0.01—0.15 and 0.15[c]
Bulgaria (range and Sofia, 2003)	0.06—0.31 and 0.28[d]
Croatia (range and Zagreb, 2003)	0.37—1.5 and 0.56[e]
Republic of Macedonia (range and Skopje, 2006)	Included in the water tariff (ranging from 30% to 50% of the tariff, i.e. 0.05—0.10)[f] and 0.1 in Skopje[g]
Romania (Bucharest, 2003)	0.05[h]
Serbia (Belgrade, 2006)	0.06[g] (25—80% of the water tariff)[i]
Montenegro (Podgoridca, 2006)	0.09[g]

[a] Average tariff 2005 (Association of Drinking Water from Reservoirs *et al.* 2008); increased by 10.1% over the period 2005—2013 (Association of Drinking Water from Reservoirs *et al.* 2015).

[b] Wastewater tariff was introduced only shortly before (Rohde 2004, cited in Speck 2006).

[c] Acic 2004, cited in Speck (2006).

[d] Consisted of sewerage tariff and tariff for treated wastewater; rate of the latter can be set in accordance with BOD content of wastewater (Speck 2006).

[e] Croatian Waters, cited in Speck (2006).

[f] My own assessments based on fieldwork in the Republic of Macedonia in 2007 and unpublished tender documents (Schlüter 2007b), exchange rate: €1.00 = MDK 60.

[g] Speck (2006); Serbia and Montenegro considered as the former state union.

[h] Platon and Dulcu 2003, cited in Speck (2006).

[i] My own assessments based on fieldwork Serbia in 2007 (Schlüter 2007a).

In Germany, in 2005, according to the Association of Drinking Water from Reservoirs *et al.* (2008), a wastewater charge of €2.28/m^3 based on water consumption enabled a very high performance in sanitation. With a connection degree of 96% to the public sewage network, the country held a top position as compared with other European countries; 90% of the population were connected to WWTPs meeting highest European Union standards (biological wastewater treatment with nutrient elimination, third purification stage). The wastewater of households which were not connected to central sewage systems was treated by decentralised plants or the like, so that the degree of connection to WWTPs was estimated as almost 100%.

According to the findings of Speck (2006) and my own assessments in 2007, sanitation services were much less developed in south-eastern Europe countries. In Albania, wastewater was not treated despite rather high connection rates to sewage systems, while wastewater charges were hardly applicable before 2004. Wastewater charges in the Republic of Macedonia ranged from €0.05 to €0.10/m^3 in 2007 but

only 10% of the generated wastewater was treated. The situation in Serbia, Montenegro, and Bosnia and Herzegovina was similar (only 10% of the wastewater treated). The situation was slightly better, although still insufficient, in Croatia and Bulgaria with treatment rations of 20% and 31% respectively. Although detailed price comparisons in the water and sanitation sector need to consider many other aspects (Schlüter 2006a, 2006b) and the situation may have improved, it becomes obvious that with too low revenues, the sanitation coverage and European Union standard of service provision cannot be reached and large efforts to full cost recovery are necessary. The examples indicate that management strategy needs to focus on improving the relation of cost and services appropriate to the local conditions taking into account the user's ability and willingness to pay.

Revenues from further sources can be generated from funds, taxes, pollution charges or from selling of products and services, e.g. enhanced reuse products and services (see also Section 4.8). Revenue generating from reusing wastewater can thereby play a key role as reclaimed water can be considered an asset with an economic value in many regions but especially in water scarce areas such as the Middle East and Northern Africa (Bahri 2008). Accordingly, the economic value of reusing water makes a public health and safety contribution and brings environmental benefits compared with the cost of wastewater discharged into the environment. Furthermore, the reused water can be considered as a product aligned with respective services which bring benefits to farmers, e.g. of reduced crop restrictions compared with higher treatment levels or benefits of increased reclaimed water availability for irrigation compared with seasonal storage requirements.

The OECD (2010) identified key trends according to which OECD countries increasingly used charges for abstraction and pollution between 2000 and 2010. In some countries pollution charges were tailored to environmental challenges and used as an incentive to reduce pollution, while in most countries those charges tended to be used as revenues to cover administrative costs for information and calculation systems. The organisation also argued for subsidies in certain cases where solid economic tariffs exist. They should, however, be transparent, targeted, limited over time, and intentional: (1) to compensate for market failures, by rewarding water and sanitation providers for supplying public goods, e.g. public health, and external benefits, e.g. avoidance of groundwater depletion; (2) to promote the consumption of merit goods, e.g. household sanitation and hygiene; (3) as transnational measure to enable tariffs to rise gradually and to deal with concerns about affordability; and (4) to provide services at below normal cost to vulnerable user groups, e.g. the very poor.

Best practice, besides the users pays principle is the "polluter pays principle"; the core principle of the European Union environment policies requiring that a polluter of water bodies bears the burden of the external costs and not the public. The aim is to promote environmental protection and to generate revenues from polluters.

Willingness to pay, finally, needs to be ensured by improving services and raising awareness thus convincing users of the adequate sanitation charges. That includes: (a) the creation of effective customer communication and services with complaints management and assessment of customer satisfaction (see Section 4.9) and (b) the implementation of awareness campaigns including promotion of sustainable services, as customers need to know their duties and rights (see Section 4.10).

I-18 Affordability of products and services. Adequate charges and prices are necessary to finance sanitation infrastructure and services. Where sanitation services are sustainable, different charges and tariff structures reflect the different financial needs of providers, thus the different costs of sanitation. The UNEP Finance Initiative and Stockholm International Water Institute (2005) argued that, as in most countries, economic development continues and income rises per person, both providers and households will probably have to absorb the costs of new sanitation needs.

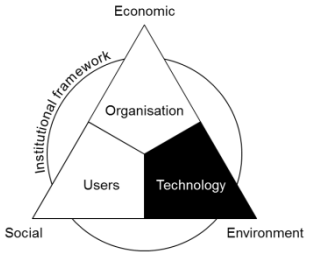
However, following the social goal of sustainable development (see Section 3.2.1), all users must be able to afford sanitation services. Therefore, fair prices of sanitation products are necessary, e.g. of toilets and socially balanced tariff structures. Pfeiffer (2009b) concluded from both long-term experience in developing countries and a donor's perspective that only affordable sanitation systems can be sustainable.

Affordability and the criteria to measure affordability need to be assessed locally (OECD 2009). Thereafter, affordability requires flexible solutions in different areas to deal with local affordability challenges and the support of local service providers. National or international criteria of affordability may not reflect the share of income spent on sanitation by households. The actual share could be much higher, e.g. where unserved households rely on emptying services for septic tanks which charge prices higher than those for sewer connection. In these cases charging for sanitation at levels above international thresholds but below actual spending on sanitation, would represent improvement. International criteria also do not take account of the willingness and ability of local population to pay for improved services. This can be important in developing countries where willingness to pay for improved sanitation services may be higher than expected.

Willingness and ability to pay for sanitation services should also be assessed locally. Cardone and Fonseca (2003) reported that both are often just assumed, based on income levels or demographic indicators. But many researchers indicated that those who are often assumed to be unwilling or unable to pay actually are, where provided with different technological and financial options along with awareness about possible impacts and implications of options and prices. Furthermore, once benefits are understood, financing mechanisms can be generated to ensure affordable costs for all users.

The OECD (2009) confirmed that striking a balance between the financing needs of providers and affordability of services for low income households is often the key challenge in tariff setting. However, I argue that before setting tariffs decision-makers must ensure that the sanitation system installed meets the abilities of the users in the service area. Implementing a high-cost system in low income areas will disable users to pay cost-covering charges or tariffs. That again will lead to insufficient revenues thus to the destruction of the system (see Figure 4.8).

4.7 Key Action 7: Operation and maintenance management



Strategic area: Technology.

Objective: O&M management effective for large-scale sustainable sanitation.

Indicators: (I-19) Processes of O&M, (I-20) Standardisation of tools and procedures, (I-21) Monitoring of O&M (see Table 4.10).

Rationale. O&M is essential for every functioning infrastructure system and so for sustainable sanitation. At the same time it affects the selection of technology for planning and investment (IWA 2006). Inadequate O&M, in turn, is a common reason for both project and system failures especially in developing countries (see Section 1.1.3). Sanitation projects which have been successfully completed with infrastructure installed, may fail after a few years where no professional management framework for O&M has been set up. One indicator for system failure is reduced treatment efficiency in plants; others are leakages in sewer pipes or clogging.

Basic reasons for failure are often the same as in other industries with large-scale projects in developing countries. Lagemann (2001) found in a large-scale irrigation project in Peru too low budgets for O&M, lack of machines and tools, insufficient capacities of staff, inadequate degrees of autonomy of services providers, and a lack of strategies for preventive maintenance measures. Such reasons can also be found in other developing countries in the sanitation sector (GFA 2009). In this strategy, aspects of HR capacity building, financing and utility autonomy are considered in other key actions (see Sections 4.3, 4.5 and 4.6), while this key action focuses on the technical management aspects of O&M.

Müllegger *et al.* (2012) developed guiding principles for designing sustainable O&M to ensure long-term functioning of a sanitation system; it is not particularly for large-scale systems but based on worldwide experiences especially with non-conventional sanitation systems in schools, households, public areas and at institutional level of sewer management.

Those principles are (Müllegger *et al.* 2012, modified):

- O&M level is closely linked to ownership and to the understanding of technology and it's function;
- O&M is required for sanitation technology to function;
- different technologies are different steps in the sanitation system which requires different staff and responsibilities;
- O&M service management requires defined roles and accountability, and appropriate support and training;
- cost recovery based on institutional responsibilities and effective mechanisms.

This strategy aims at the set-up of professional O&M management and the monitoring of its effectiveness. Large-scale sanitation systems thereby usually require higher standards of O&M than small-scale systems. Large systems are usually more complex often applied in rapidly changing urban or peri-urban areas. Small-scale systems are less complex often applied in rural areas. Moreover, small-scale systems can usually be run with a higher level of autonomy, e.g. by community, but integrated with higher level institutions, e.g. regional service provider (see Section 4.4).

Operation management ensures the professional operation of a sanitation system. Referring to the definition of sustainable sanitation in this strategy (see Section 3.2.3) it includes all technical and managerial actions enabling the collection, transport, treatment and reuse or disposal of wastewater and associated streams. However, the planning and construction of new and rehabilitation of existing facilities as well as certain reuse activities such as irrigation are not considered as operation management actions.

Maintenance management refers to all preventive and reactive work ensuring proper function of the technical infrastructure of the sanitation system such as facilities, equipment and machinery. Preventive maintenance thereby comprises systematic and regular routine checks; it includes minor repairs and replacement of small parts where it is possible in daily operation. Reactive maintenance in turn comprises larger repairs of damaged or failed infrastructure that cannot be carried out during routine checks.

Because O&M includes many management processes it is partly considered also in other key actions of this strategy, in particular Key Action 4: Utility management and development (see Section 4.4) and Key Action 6: Financing (focusing on commercial

and financial management, see Section 4.6). Key to effective O&M are, however, effective processes of O&M, standardised tools and procedures and monitoring of service quality. The basis for effective O&M, however, is appropriateness and excellence of the technology to be operated and maintained, i.e. the technical infrastructure including all facilities of collection, transport, treatment, reuse or dispose, and associated products inside households, commercial, industrial or public buildings. This especially refers to reuse systems which demand for effective reuse management (see Section 4.8).

The choice of the sanitation system and the technical infrastructure set the requirements to O&M management (Brikké and Bredero 2003; IWA 2006). Planning of O&M must be integrated with investment measures, i.e. with planning, design; procurement, construction and financing of the physical infrastructure (see Section 3.3). As decision-making planning and design of the technology fundamentally affects the sustainability of sanitation system, it must be considered at early project stages and according to the project's specific conditions. In particular for decentralised systems, Müllegger *et al.* (2012) considered O&M the most crucial criterion for selecting a sanitation system during the technology selection process.

There are different support tools for decision-support pertaining to sanitation technology; e.g. Mara *et al.* (2007) developed selection procedures and post-selection check-lists for detailed design of sanitation infrastructure comprising requirements to O&M as well as reuse. Also, much research has been carried out on that topic (Tayler *et al.* 2003; Kvarnström and Petersens 2004; Malmqvist *et al.* 2006a; Herbst 2008). This key action is, however, not to answer questions of product development, technology choice and system planning, but to find possible indicators for the professional management of the systems (see Section 3.3).

Finally, management support projects must be closely coordinated with infrastructure projects. This is especially necessary where different donors support different projects in the same service area.

Table 4.10: Indicators and rating criteria for Key Action 7: O&M management

Indicator	Rating criteria			
	0	1	2	3
I-19 Processes of O&M	Processes of O&M not developed	Processes of O&M developed to basic level but responsibilities not defined or organisation not flexible or workflows, documentation, reporting or monitoring not effective	Processes of O&M developed but not fully integrated, responsibilities defined, but organisation not flexible, or workflows, documentation, reporting or monitoring not effective	Processes of O&M developed and fully integrated, responsibilities defined, organisation flexible and workflows, documentation, reporting and monitoring effective
I-20 Standardisation of tools and procedures	O&M tools and procedures not available, staff and others involved in O&M not sensitised	O&M tools and procedures available but not standardised in the utility, staff and others involved in O&M not fully sensitised	O&M tools and procedures available, standardised in the utility but not to national or international regulations and not appropriate for benchmarking, staff and others involved in O&M sensitised	O&M tools and procedures available, standardised in the utility and to national or international regulations and appropriate for benchmarking, staff and others involved in O&M sensitised
I-21 Monitoring of O&M	O&M not monitored	Indicators for O&M introduced but O&M not monitored or not documented	Indicators for O&M introduced, O&M monitored and documented but data not integrated with MIS	Indicators for O&M introduced, O&M monitored and documented, data integrated with MIS

Key to scores as in Table 4.1.

I-19 Processes of O&M. Processes of O&M relate to the collection, transport, treatment and reuse or disposal of wastewater and associated streams (see the definition of sustainable sanitation as in Section 3.2.3; to reuse where the service provider is responsible for that). Usually those processes include the selection and acquisition of equipment and spare parts. The processes need to be integrated with other processes of the service provider, e.g. financial and accounting functions (see Section 4.6).

Operation processes thereby include all activities related to the collection, transport, treatment and reuse or disposal wastewater and associated streams (see Section 4.8). Sohail *et al.* (2001) described operation as all regular activities that are required to run and handle the infrastructure including technical and service activities at provider level but also at user level. While operation processes include mainly management processes (see above) this indicator pays attention to maintenance processes. This is particularly important as maintenance processes and procedures are underdeveloped in many sanitation service providers in developing countries, depending on the appropriateness of technology and other concerns such as financing of operation or HR capacity building.

Maintenance processes generally include (GFA 2009, modified):

- *inspection*—regular measures of control of operating conditions and status of machinery and equipment;
- *repairs*—unpredictable measures of rehabilitation and renovation;
- *preventive maintenance*—continuous measures of maintaining normal working conditions.

Repairs may include leak repairs which often require stronger stakeholder communication, e.g. in case of wilful destruction of sewer pipes (see Section 6.1.1 for an example in Syria). A preventive maintenance strategy helps to avoid major damage and disruption of facilities often caused by improper use or just neglect. Such a strategy is aimed at ensuring optimal functioning and treatment performance as well as longer life cycles of the facilities and assets.

Effectiveness of O&M processes mainly depends on definition of responsibilities, on organisation, workflows and operating plans, on documentation and reporting as well as on monitoring and supervision (GFA 2009). Where O&M of sanitation is not under the responsibility sanitation service providers, e.g. under municipalities, questions of ownership must be answered (see I-6, Section 4.2), and responsibilities must be defined. Where sanitation systems are highly decentralised, e.g. in less developed areas, O&M processes may be more effective if they are carried out by communities, if the technical complexity of the system allows it. Especially in low-income or rural areas, community participation under the guidance and steering from professional organisations can help sustain the system. Small or smallest service providers can take part and take over responsibility within logistic chains or for reuse activities; while effective integration with macro organisations is thereby important (see Section 4.4).

Processes of O&M must be organised in line with general management processes (see I-11, Section 4.4) and operationalised with workflows and operational plans. O&M processes and procedures as well as instructions on using tools need to be documented, e.g. in manuals. Manuals should be standardised and conform to relevant guidelines and regulations (see I-20). Other important processes are the documentation of the O&M activities, reporting routines as well as the monitoring and supervision with the use of professional tools (Cotton 2000; IWA 2006).

Development and optimisation of O&M processes should be integrated with HR capacity building (see Section 4.5) in cooperation with infrastructure projects. While technical training is usually provided through the construction project, e.g. instruction workshops or practice seminars on the use of new facilities and equipment and on maintenance routines, an accompanying management project can cover more areas of O&M. Close cooperation is therefore required between the management consultant and the engineering consultant. And finally, the awareness of all involved in O&M is important which usually requires sensitisation measures (see I-20).

I-20 Standardisation of tools and procedures. Professional tools and procedures of O&M need to be standardised in the utility and be conform to national or international standards. Standardisation is, however, a challenge in many developing countries and especially in service areas with different sanitation systems or services structures or both. Where non-professionals take part in the sanitation service provision, standardised tools and procedures are particularly important to ensure the safe and professional implementation of services. This includes the monitoring and supervision of performance.

Accounting adequately for the human factor is key to the implementation of sanitation projects (Holden *et al.* 2004; Krantz 2005; Krantz and Drangert 2006). The influence of the human factor refers to different aspects including the design of household sanitation equipment and the organisation of O&M pertaining to workflows and the use of tools and facilities. Problems to consider are thereby people's lack of knowledge about pathogens and utilisable substances in wastewater or dealing with illiterates or otherwise untrained staff. Standardisation of tools and procedures according to the local needs, accompanied with technical support services to customers and sensitisation measures, thereby helps avoid problems caused by that phenomenon.

Standardised tools and procedures can be O&M plans or safety plans or other instructions related to O&M. Those standards may include instructions for users especially where systems are highly decentralised or the complexity of household sanitation facilities is high (Sohail *et al.* 2001). Professional standards are documented systematically for all O&M areas. Standards may thereby contain definitions, collections and descriptions of tools and procedures, evaluation of experiences and recommendations on best practices. Often, professional advice is given in a manual of practice, e.g. for operating WWTPs (Water Environment Federation 2008).

Pertaining to the elaboration of sector-wide standards, involvement of a sector organisation can be helpful. This can be an authority or a professional association such as IWA, DWA, European Water Association or the Arab Water Association. The standardisation work in such organisations is usually carried out by professionals in technical committees and work groups, which ensures the required knowledge and experience. Finally, the tools and procedures must be communicated to the utility staff and all others involved in O&M.

Communication should be complemented by sensitisation measures to raise awareness of the importance and adequate use of the tools and procedures. Staff and others involved in O&M activities need to be aware of their role and importance in the system. They should be aware of the importance of O&M including responsible handling of water and other resources or materials. Furthermore, they should be aware of the relations between O&M and costs as well as service quality and customer satisfaction as considered in Key Action 6: Financing (see Section 4.6). In this strategy,

communication and sensitisation actions are also considered in Key Action 9: CRM (see Section 4.9) and Key Action 10: Awareness raising (see Section 4.10).

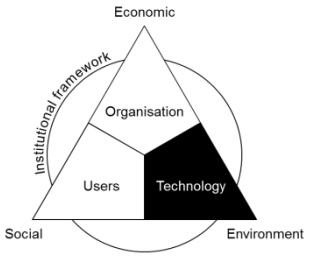
I-21 Monitoring of O&M. Experts of IWA agreed on a framework to assess O&M and rehabilitation of sanitation systems based on 40 PIs (Matos *et al.* 2003). The framework contains 40 indicators in five groups: environmental, operational, quality of service, economic and financial, and physical but mainly focusing on conventional sanitation systems. To assess O&M and rehabilitation in non-conventional systems, it can be important to adapt those indicators or to develop new indicators where necessary and according to the system's needs. Such additional indicators may relate to risks beyond technical functionality, e.g. environmental or health risks, or to the robustness of the system (Svensson 2006). Svensson referred to two studies in which a respective risk model has been applied in two model cities in Sweden, a new city area and a city centre. In both cities both conventional and non-conventional systems such as source separating systems have been monitored. He further concluded that conventional large-scale urban water systems are more reliable pertaining to technical functionality while many small-scale systems leave users more open to health-related risk events and to higher cumulative risks.

In Germany, a performance comparison of municipal WWTPs by the DWA Working Group BIZ-1.1 "Wastewater Treatment Plant Neighbourhoods" (2014) brought representatively high treatment efficiencies with degradation degrees of 82.3% for total N (organic and inorganic N) and about 90.1% for P for all WWTPs in the country. The results were considered representative of Germany; 5,917 WWTPs took part in the comparison with a treatment capacity of 142.6 million PE (in total 9,933 WWTs with a capacity of 151.3 million PE in Germany, i.e. a participation of about 94.2%). Bertzbach *et al.* (2012) described performance improvements through wastewater benchmarking projects in Germany, especially due to changes in operation.

Besides developing appropriate assessment frameworks, it is necessary to permanently improve O&M with internal measures. Therefore, it is essential to integrate the monitoring in a utility's MIS which allows including O&M monitoring results in strategic decisions. Le Gauffre *et al.* (2008) developed a model for sewer asset management helping to integrate PIs in decision criteria where monitoring data is not fully available, which is the case in many developing countries. Another way for improving functions and processes of O&M is performance benchmarking (see Section 4.4). Often systematic PI-based comparisons of O&M and other functions of service providers are implemented formally and informally by donors who are involved in many projects (Yepes and Dianderas 1996).

To integrate O&M monitoring in the assessment of a utility's overall performance this strategy requires coordination with I-12, and I-10, e.g. in the case of using the Balanced Scorecard (see Section 4.4).

4.8 Key Action 8: Reuse management



Strategic area: Technology.

Objective: Reuse effective for large-scale sustainable sanitation.

Indicators: (I-22) Processes of production and reuse, (I-23) Logistics of product delivery, (I-24) Marketing of reuse (see Table 4.11).

Rationale. Professional management practices are required to enable effective reuse of products or by-products in a sanitation system. In this case reuse management means delivering products and services of high quality in the right composition, place and time to fully and effectively meet the needs of users. Those can be farmers or others depending on the products delivered.

Gensch *et al.* (2012) called systems with enhanced reuse "productive sanitation systems". This means basically that sustainable sanitation is not only discharge and treatment to certain standards, i.e. disposal, but also the reuse of valuable resources. Beyond that, the experts considered productive systems an option particularly where for food security is a serious challenge (see Section 1.1.1). Although resources are not being lost in the natural cycle, in sanitation systems without reuse, they would no longer be available in the specific condition and area where needed; e.g. fresh water which is available and needed on land becomes saltwater when the wastewater is discharged into the ocean, or P which is contained in sewage sludge and needed in the soil is removed in treatment facilities.

Productive systems help to avoid such a "local destruction" of resources. Kramer *et al.* (2007) showed that, e.g. reuse of reclaimed wastewater can significantly help using water resources efficiently and reduce pollution of the environment; both key challenges in water scarce countries.

This strategy takes up the above ideas. It is based on a new definition of sustainable sanitation which, amongst others, is aimed to protect human health and environment and add value by the reuse of resources (see Section 3.2.3). In practice, however, productive or sustainable sanitation systems will require professional reuse management as reuse is basically a new business area with similar but also different tasks in comparison with other business areas, e.g. O&M. Sanitation systems with

enlarged reuse will again require appropriate management procedures. This idea also follows the research guiding principle, in particular to “link sanitation to business opportunities” (see Section 2.1.1).

The basis for developing reuse practices, however, is an analysis to assess whether there is a market for the products (see Section 4.9). Focus on reuse management is necessary to overcome obstacles to paradigm shifts within service providers or systems and to link stakeholders of the sanitation system better, e.g. farmers. It will only be possible to market products if professional and satisfactory services are provided which include troubleshooting, quality control, specific services and reliable delivery.

Traditional O&M processes may not be as suitable for the development of reuse management, as specific utilisation processes are often taking place in other places than the common treatment processes takes place. Furthermore, traditional O&M processes are usually not yet developed in sanitation on a professional basis and on large scale. Besides learning from successful pilot projects in the sanitation industry, it helps to take a look in other reuse industries, e.g. waste management where more experience has been available for a longer period of time (GFA-Umwelt *et al.* 1999). Key elements of reuse management are processes of production and reuse including control mechanisms to ensure product quality and safety for both workers at sanitation and production facilities and along logistic chains as well as end-users, e.g. farmers. Further elements are logistics of product delivery whether products are solid or liquid; and marketing of reuse as the products are usually new and in need of explanation.

Table 4.11: Indicators and rating criteria for Key Action 8: Reuse management

Indicator	Rating criteria			
	0	1	2	3
I-22 Processes of production and reuse	Processes of production and reuse not developed, health risks cannot be excluded	Processes of production and reuse limited, not effective, not integrated with O&M or not coordinated with processes of users, health risks can usually be excluded but quality control not effective	Processes of production and reuse developed, but not fully effective, not fully integrated with O&M or not fully coordinated with processes of users, health risks can be excluded but quality control not fully effective	Processes of production and reuse effective, fully integrated with O&M and fully coordinated with processes of users, health risks can be excluded, quality control effective
I-23 Logistics of product delivery	Logistics do not allow for delivery of products	Logistics allow for delivery of products but products not available to users in right composition, place or time	Logistics allow for delivery of products but products not fully available to users in right composition, place or time	Logistics allow for delivery of products, products fully available to users in right composition, place and time
I-24 Marketing of reuse	Products and services not available	Products and services available but poor in quality or quantity, prices and charges not affordable for users or not cost-covering, places of production and use not sufficient, promotion not effective	Products and services available but not excellent or prices and charges not affordable for users or not cost-covering or places of production and use not sufficient or promotion not effective	Products and services available and excellent, prices and charges are affordable for users and cost-covering, places of production and use sufficient, promotion effective

Key to scores as in Table 4.1.

I-22 Processes of production and reuse. The creation of preconditions for the production and delivery of products and related services, i.e. effective processes within the sanitation organisation and coordination with user structures, is essential for a professional reuse management. It means developing effective processes of production and reuse and integrating those processes with the O&M actions in the system (see Section 4.7). Furthermore, processes of production need to be coordinated with the processes of reuse where reuse organisations are external, e.g. farms or other processing firms.

Reuse refers to the products in a sanitation system such as reclaimed wastewater, fertiliser, biogas, sludge, compost, or energy. With regard to the demand for these products it must be considered that concurring reuse scenarios may exist, such as biofuels versus sludge disposal. Processes of reuse in the responsibility of a sanitation utility should thereby also include related services to users such as logistics as

well as support pertaining to troubleshooting and repairs. *One-stop service* from the sanitation utility to users is attractive and may help promoting reuse approaches.

Beyond that, only where all related processes production, delivery and reuse are safe to workers and all other people who may come into contact with related pathogens both directly or indirectly, can productive systems productive systems be promoted. Emphasis must therefore be placed on the prevention of health risks to staff, external workers and users. Related risks may occur from excreta through persistent pathogenic organisms in excreta such as bacteria, viruses, protozoa and helminths (Gensch *et al.* 2012). The sanitation system itself should already provide effective barriers to those pathogens, e.g. through the system's design in a multi barrier approach (WHO 2006b). However, professional reuse management must provide effective processes, responsibilities and work instructions for both use and production respectively of treatment and processing. Guidelines of the WHO (2006b) provide practice-oriented instructions on the use of water, wastewater and excreta, focusing on managing health risks in a system approach and on the use of those products in agriculture. Kramer *et al.* (2007) published, as the outcome of a multinational European Union project, other guidelines focusing on improving wastewater treatment and reuse practices in water-scarce Mediterranean countries.

Furthermore, the products delivered must be excellent, whether being solid or liquid (see I-24). That means that the quality control of the product must be effective, which includes troubleshooting during production. Only where excellent products can be delivered in high quality and in the right composition to fully meet the needs of the users, production and reuse will then contribute to a sustainable sanitation system.

Finally, processes of production have to be integrated with other O&M measures. Processes of reuse in turn must be coordinated with the processes of the user organisation where required. Monitoring of service quality is also considered in the indicators for O&M (see Section 4.7).

I-23 Logistics of product delivery. Products in sanitation systems are usually not available in the place and time in which users need them. Moreover, they often do not arise in the required quantity and composition. In systems where treated wastewater as well as fertiliser produced from yellowwater, are sold to farmers for reuse in agriculture, the need of water and fertiliser varies during the year depending on the crops grown. On the contrary, water and fertiliser arise continuously during that time. Furthermore, the treatment of wastewater, i.e. the production of irrigation water and fertiliser are usually done in places remote from farming fields. So both treated wastewater and fertiliser need to be transported to the fields. Storage and distribution systems and operation of these systems are required to overcome the basic disparity of needs and demands.

A project planner will, for such a system, try to place the treatment facilities close to the farming fields to ease the use of the products. Practice shows, however, that such attempts often fail in urban and peri-urban areas. One obstacle is limited space usually being available for installing WWTPs in densely settled areas, accompanied by problems with regulation of ownership (see Section 4.2). Another obstacle is change in settlement structures after, or even before project implementation. Once a reuse-oriented sanitation system is implemented with good intentions, land prices usually rise fast due to the improvements in living conditions and the original mixture of farming and housing areas changes. Farmers, often poor, will be tempted to sell their land and buyers, usually investors, will develop new housing areas. The basis for the originally planned reuse of wastewater on site will be lost and the sanitation project will fail. However, such problems can be avoided, by good planning of projects, early regulation of ownership (see Section 4.2) and by the introduction of professional logistics for product delivery.

The basic function of operational logistics is (Gudehus 2010, translated):

> "Efficient provision of the required quantities of required objects in the right composition at the right time in the right place."

Objects thereby relate to products. To effectively implement logistics service providers need to develop optimised processes, structures and systems. There are many technical options available for various kinds of sanitation systems (Werner *et al.* 2004b; Tilley *et al.* 2014). Of utmost importance for the planning of productive-oriented sanitation systems is, however, that logistics meet the needs of the users.

Logistics of reuse basically means the distribution (i.e. delivery) of products and the disposal or discharge of possible residues. The technical processes of wastewater treatment, preparation of materials as fertiliser or soil conditioner as well as filling and packing are actually not matters of logistics; these processes belong to production. In other industries, e.g. in the consumer industry, the responsibility of logistics includes the supply of production processes with necessary raw materials and additives (Gudehus 2010). However, there is a difference. The logistics of wastewater treatment and production is part of O&M management (see Section 4.7) while the logistics of delivery is part of reuse management. Logistics of the reuse itself, e.g. applying products to fields, must be part of farming management as the user is responsible for using the product after having been delivered.

I-24 Marketing of reuse. Marketing is a business instrument that can effectively support the development and promotion of reuse targets. Marketing can also help creating supportive framework, e.g. for selling new sanitation products and enhanced reuse of wastewater. However, the implementation of professional reuse management in sanitation needs to be handled as any other market entry or change of new products in other industries. Essentially, market rules apply as the goal is to promote

new products and services. Reuse is thereby also understood as new products and services. Changes require a shift in thinking and acceptance by both operators and users who here become customers.

The role of marketing for utility management and development is described in Section 4.4. Further arguments for marketing are reflected in Key Action 10: Awareness raising (see Section 4.10).

Marketing is considered an excellent instrument for attracting users to connect to a system and promoting behaviour change in the short and medium term (Cosgrove and Talafré 2009). Marketing is thereby more than information about products and services. By offering excellent products and services including the required logistics at cost-covering and affordable prices and promoting both products and services, marketing can help developing demand for reuse of resources in a sanitation system. Especially where conventional systems fail, marketing can effectively support the up-scaling of reuse-oriented systems (Cairncross 2004; Obika 2004; UNICEF 2008).

The basic principle of marketing is reaching and convincing users to buy products or services. It is thereby demand-oriented. Although, in the sanitation industry, marketing is often approached from a user's or a producer's perspective, e.g. as a strategic tool of business development, it is a tool of CRM thus user management. Marketing activities should thereby promote both sanitation products and services to attract users to adequately invest in it, i.e. mainly buying improved and sustainable toilets and paying adequate service charges. So marketing ensures that people receive what they want and that they are willing to pay for it. Customers then benefit from receiving improved sanitation services and producers or providers profit from generating revenues enabling them to finance O&M of the system and to further develop and improve technology and services. The variety of factors influencing marketing of sanitation make clear that marketing is more than advertising.

There are four main factors (GFA-Umwelt *et al.* 1999; Cairncross 2004; modified):

- *products and services*—excellent and available in adequate quality and quantity;
- *prices and charges*—affordable and cost-covering;
- *places of use and production*—requiring appropriate infrastructure and logistics;
- *promotion*—effective in informing and attracting potential users.

Products and services must be excellent and designed to social advantages taking into account local conditions. In South Africa, introducing ecosan on a large scale was much more successful where it was marketed through highlighting social advantages rather than through the benefits of reusing products such as soil conditioner (Holden *et al.* 2004). Although main successes were documented in rural areas the authors found that those factors were also valid for urban areas. Product designs, such as latrines, must thereby meet what users want and not what others believe

what they should want (Cairncross 2004); e.g. Morgan (2007) advised on constructing and using appropriate low-cost toilets that produce compost in Africa. Both development and implementation of the products were very successful with toilets being used worldwide, which was acknowledged in the water industry (Weinberg 2013).

A new approach to the development of products and services is *frugal innovation* which has been increasingly discussed in science, and used in practice (Tiwari and Herstatt 2012a, 2012b; Tiwari *et al.* 2014; Herstatt and Tiwari 2015). Herstatt and Tiwari (2015) described it as new products and services minimising the use of material and financial resources throughout the product life cycle from development and production to use and disposal, and substantially reducing the costs of ownership and use while maintaining acceptable safety and quality standards. The authors thereby draw a conceptual relationship between resources, cost and benefit, and the target group. The joint development of foreign and local organisations is likewise important. Products should thereby not only be developed on site in cooperation with foreign firms but also be produced in the target market if economically feasible. Some of these characteristics can be found in some approaches of international development cooperation, e.g. international public-private or private-private partnerships; but I assume that in particular the sanitation industry can benefit from this new approach and so, at the same time, contribute to reach the international sanitation goals faster.

There is an example for frugal innovation in the water sector in India. Tata Chemicals, a company of Tata Group, developed the Tata Swach as the world's cheapest household water purifier in 2009 for households that are poor, are in rural areas or both or are in semi-urban areas with poor access to electricity or water supply (Tiwari and Herstatt 2012a, 2012b). The product has been an enormous success with over 4 million sales of non-electric storage water purifiers up to 2015 not including other versions of it (TATA Chemicals 2015).

The approach is especially relevant for emerging economies (Tiwari *et al.* 2014), considered to be developing countries in this research. Furthermore, it seems particularly applicable to product development in sanitation with often complex but necessarily low-cost products and services adapted to local conditions. In India, a global *hotspot* of frugal innovation (Tiwari and Herstatt 2012a, 2012b), 44% of the total population have no toilet and practice open defecation, mainly in rural areas (see Section 1.1.1). So there is an enormous need for excellent sanitation products and services that are affordable to all people.

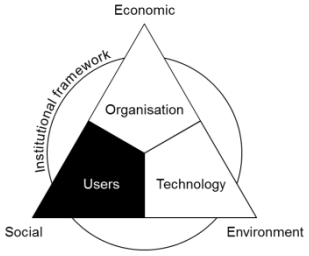
Prices and charges setting for products and services is one of the most difficult in marketing sanitation. Usually it is the poor who need to connect to a sanitation system but can least afford it (Cairncross 2004; Cross and Morel 2005; Holden 2008; Triche and McIntosh 2009). Hence a range of products with various prices needs to be marketed depending on affordability and willingness to pay. When designing and

marketing products and services, not only the investment cost have thereby to be considered but also the cost for O&M (see Section 4.6). Finally, both products and services must be available in adequate quality and quantity.

Places of reuse and production resulting in requirements to infrastructure and logistics are even though important. Product and services must be delivered to the place of customer needs, e.g. a latrine must be installed onsite, meaning that the supply chain must reach household level (see Section 4.8).

Promotion of reuse is communication with customers about the specific sanitation product or service. It is also part of awareness raising (see Section 4.10).

4.9 Key Action 9: Customer relations management



Strategic area: Users.

Objective: Customer relations effective for large-scale sustainable sanitation.

Indicators: (I-25) Management of customer data, (I-26) Service orientation and customer satisfaction, (I-27) Management of complaints and suggestions (see Table 4.12).

Rationale. Customer relations basically refer to the business relation between a provider of a product or service and the people who buy or use it. CRM thereby aims at understanding, expecting, managing and personalising the needs of those people including the potential users. The basis of CRM is comprehensive and up-to-date customer data being regularly collected and maintained in a database. This requires effective processes for the collection, storage and analyses of customer information.

Knowing customers is thereby important to meet their needs and demands. The Water Utility Partnership (2003) highlighted that it is especially important for serving the poor, usually having different demands, interests, abilities, circumstances and opportunities than other customers. The partnership also highlighted that the service options, payment and management systems as well as investment requirements can be developed better according to the needs of the target group. The UN Population Fund (2007) confirmed that, however, authorities and providers lack adequate information about the situation in low-income communities as such settlements are usually unplanned and informal.

Service orientation and customer satisfaction including complaints management are further elements of professional CRM. Especially in developing countries utilities are often not very customer oriented. Problem analyses usually show that staffs do not consider users as customers or even tend to neglect customers in a system focusing on other areas such as technology or administration. Often corruption is a problem (Elshorst and O'Leary 2005; Plummer and Cross 2006); amongst others, due to substantial working hours lost and at the household level it is reflected in deficient service delivery and practices (Stålgren 2015). Furthermore, staffs who tend to be unfamiliar with customers are unskilled when working with communities and individuals (Water Utility Partnership 2003). Raising awareness among staff, introducing incentive structures and assessing customer satisfaction regarding service delivery, supports changes. Moreover, customer satisfaction improves the willingness to pay and so provides the basis for commercial practices contributing to securing the financing of services. Actions of CRM need to be supervised by the utility's management and monitored through an MIS (see Section 4.4). Adequate awareness and skills are required for all staff coming in contact with customers. Annual reviews need to be carried out to adjust customer relations policies to current needs and conditions.

Table 4.12: Indicators and rating criteria for Key Action 9: Customer relations management

Indicator	Rating criteria			
	0	1	2	3
I-25 Management of customer data	Customers not known, customer data not adequately collected	Customers partly known, irregular customer surveillance, no customer database in use	Customers known, regular customer surveillance, customer database in place and regularly updated but customer data not linked up with MIS	Customers known, regular customer surveillance, customer database in place and regularly updated, customer data linked up with MIS
I-26 Service orientation and customer satisfaction	Staff not oriented to service or customer satisfaction not assessed	Staff oriented to service but processes and organisational functions to assess customer satisfaction ineffective, satisfaction rarely assessed	Staff oriented to service and customers, processes and organisational functions to assess customer satisfaction effective, satisfaction irregularly assessed	Staff oriented to service and customers, processes and organisational functions to assess customer satisfaction effective, satisfaction regularly assessed
I-27 Management of complaints and suggestions	Complaints and suggestions not received	Complaints and suggestions received but No. of filings not reasonable, filings not recorded, not processed, not analysed or not reported	Complaints and suggestions received, No. of filings reasonable, filings recorded, processed, analysed and reported but no timely response to filings	Complaints and suggestions received, No. of filings reasonable, filings recorded, processed, analysed and reported, timely response to filings

Key to scores as in Table 4.1.

I-25 Management of customer data. Customer data is the basis for managing customer relations and for generating revenues from sanitation charges. Collection and management of customer data goes hand in hand with commercial and financial management (see Section 4.6). To secure adequate revenues it is necessary to register all customer-relevant data. More important than primary registration of customers is, however, the follow-up of the customer data. Emphasis should therefore be laid on the creation of efficient processes and responsibilities for continuous customer surveillance, which may be in two steps (GFA 2009).

Firstly, all required data needs to be defined. Data should contain contact data like the name of contractual partner, physical address and information concerning the sewerage connection or sanitation facility, such as GPS coordinates and tariff or use-class. Surveillance routes have to be defined according to sewer lines or administrative boundaries and surveillance teams. Every customer receives a unique reference number. Together with the GPS coordinates, every customer can then be identified easily. Especially in low-income areas the collection of customer data should be coordinated with providers of other services, e.g. water when not the same organisation or electricity to avoid duplication of effort and incompatibility of data.

Secondly, all data is entered into the customer database. Such a database is ideally part of the billing software (see Section 4.6). All data relevant to a customer and their connection are held in the database. Through an interface to the geographic information system, it should be possible to get a visual overview of the pilot area. To keep the customer database up-to-date, it is necessary to repeat the customer surveillance regularly. This can be done together with the monthly meter reading, requiring close cooperation with the water supply department. While the meter readers follow their routes, they are obliged to watch out for unauthorised connections as well as for leakages or defective meters. Technicians who repair or change a meter or install a new one to a new customer have to hand over respective data to the personnel responsible for the customer database.

Although meter reading is usually done by the water utility, it may also be part of the sanitation utility, e.g. in productive sanitation systems, where users sell their wastewater as a product, e.g. greywater, organic matter or urine as fertiliser. In sewerage + WWTP systems, wastewater charges usually depend on water use. Close cooperation with the water department or utility is important, to share revenues. Where their own measurement systems need to be established for sanitation, separate reading procedures are required. It is important to make such processes efficient and customer-oriented, since revenues can usually be increased fast due to improvement of processes. Possible measures may be workshops on revenue awareness for staff, from management to meter readers, shortening of invoice cycles including optimisation of reading routines and routes and effective and consistent reminder for late payers.

I-26 Service orientation and customer satisfaction. Low performance in service provision is usually a result of a weak financial status caused by low revenues (see Section 4.6). Low revenues again result mainly from poor collection and payment rates and inadequate wastewater charges.

A problem analysis starts at the basis of service provision, at staffs' orientation to service and customer satisfaction. The basic principle of service provision in industry is that only satisfied customers are willing to pay for a service. The same principle applies to sanitation. Pleased customers usually pay their bill timely, which has a direct influence on collection efficiency and cost coverage. In many public service providers in developing countries users are, however, not considered customers; sometimes they are just neglected. To change this, staff at all levels must acknowledge that users are customers, who are the starting point of the service cycle and not the end of it (Water Utility Partnership 2003), whether they are financially strong or not. This perception is a prerequisite for service orientation and customer satisfaction.

First of all, awareness and competences of staff need to be raised to an adequate level, which is also important for O&M (see Section 4.7). Competence building means HR capacity building (see Section 4.5); awareness raising means improving staff's orientation to services and customers. An effective motto for raising awareness in public service providers is "from authority to service provider" (GFA 2009). Measures need to bring staff to understand sanitation as a service and acknowledge that service again requires putting the needs of customers in the centre of their work. A variety of tools and activities can be used, e.g. workshops, concepts to increase customer focus including training and awareness of employees, the introduction of competitions such as the worker of the month and strategies for user complaints management including reduction of responding time and monitoring of customer satisfaction.

Furthermore, effective processes to service orientation and clear responsibilities for continued customer surveillance are required. Moreover, adequate organisational functions for enhanced customer orientation within the service provider need to be developed, e.g. through the set-up of a customer service centre comprising a department for complaints and suggestions. Effective strategies for communication with customers and stakeholders and respective routines are likewise important. Very important is, however, responding to customer demands in a timely manner and to keep them informed, not only of the general status of service provision and progress with projects, but also of service performance and problems (Water Utility Partnership 2003). This includes professional complaints and suggestions management comprising routines for recording, processing, analysing and reporting of customer complaints and suggestions, e.g. through a call centre.

Finally, customer satisfaction regarding quality of service (and acceptance of sanitation products and services) is crucial to effective CRM.

The Water Utility Partnership (2003) highlighted that customers usually have little access to information on the services being provided, e.g. technology, tariff structures, service level decisions and income from water. Customers from low-income areas also have more difficulty in accessing customer complaint services due to the lack of communication, accessibility and the lack of recognition as customers when they use a community service. The partnership also highlighted that utilities rarely analyse information on low-income communities to assess performance, problems and identify solutions. So the lack of targets for improvement of coverage and service levels for low-income communities makes progress impossible to assess.

Furthermore, assessing satisfaction of customers is especially important to the success of non-conventional sanitation systems and approaches. Experience with introducing urine diversion in housing areas in Sweden shows that only when the needs and attitudes of customers are assessed it is possible to offer and introduce the right technologies and services and to developing them further (Johansson *et al.* 2009).

In addition to the common PIs such as complaints, providers can assess customer needs, opinions and attitude in community surveys. Such surveys allow for identifying customer satisfaction, customer needs and requirements to service improvement. Surveys can also help raising users' awareness of sanitation and supporting the development of effective awareness-raising actions (see Section 4.10).

I-27 Management of complaints and suggestions. Poor maintenance of sanitation infrastructure causes unreliable service delivery to users. The result is poor service quality, leading in most cases to a low level of willingness to pay and thus to low revenues. Wright (1997) assessed that worldwide many sanitation schemes became practically worthless shortly after construction mainly caused by a neglect of maintenance. While service providers can relatively easily maintain central facilities, as staff can act independent from users, maintenance of decentral facilities at the user level is much more difficult in terms of logistical efforts. However, monitoring of failures affecting services in households, such as clogging and breakdowns, is relatively easy where customer complaints and suggestions are managed in a professional way. Moreover, by closely monitoring complaints and suggestions, staff can identify operational inefficiencies in certain functions within the service provider. Management of complaints and suggestions is therefore an indicator for professional CRM.

Customer complaints are commonly used as an indicator of the quality of utility's interaction with customers (Mugabi and Castro 2009). Key processes of professional complaints management are recording, processing, analysing and reporting of complaints. Possible organisational functions of the service provider may comprise a call centre for complaints registration and reporting or analysis. The management of complaints can be organised in close cooperation with the provider of water supply services where possible. All activities have, however, to be developed demand-

oriented and transferred to local service providers, e.g. to small and smallest providers (see Section 4.4). In such cases standard operation procedure for customer complaint management help structuring work flows and reporting standards.

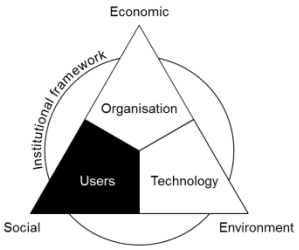
Complaints can be assessed in various ways: (a) by the No. of complaints related to sanitation services, e.g. in % of sanitation connections or in total complaints per defined No. of connections, e.g. 1,000); (b) by the No. of repeated complaints, e.g. % of total complaints; and (c) by the compliance within time, e.g. % of total complaints or average response to complaints within a defined period, e.g. given in hours. In comparison with other PIs, complaints are relatively easy to report and assess. However, the interpretation of complaints requires careful assessment of a utility's overall performance in CRM.

Mugabi and Castro (2009) highlighted crucial aspects in a report on the self-assessment of utilities in African water and sanitation utility performance: (a) customers may become accustomed to poor service and just do not complain; (b) it may be difficult for some customers to report complaints—therefore it is sometimes difficult to derive any meaning from the complaints quantity; (c) a very low No. of complaints can indicate that a provider is just not relating to its customers, e.g. with little interaction between the utility and its customers—such a situation should raise concern regarding other PIs, e.g. hours of service showing performance levels that should be generating complaints; (d) a very high No. of complaints meaning dissatisfaction and customers. So the provider should aim at receiving a reasonable No. of complaints ensuring an acceptable level of interaction with customers where those are normally satisfied.

Furthermore, management of complaints is important for non-conventional, decentral and on-site sanitation systems usually requiring high grade of user participation. Where sanitation systems are under development with new and innovative facilities, users are usually unfamiliar with the new facilities and behaviours in the beginning. So complaints management becomes a factor for success of such systems. Johansson *et al.* (2009) assessed that, going to scale with urine diversion in Sweden faced operational problems in pilot projects during the first years, e.g. as toilet types were less user friendly and thus more difficult to use. In such projects in particular but also in all other projects, complaints management is essential. Professional complaints management guides utility's staff to respond to and solve customer complaints efficiently and effectively; and so it ensures professional customer relations.

Finally, the management of complaints should always include the management of suggestions from customers. The identification and follow-up of the desires and wishes of customers can help improving sanitation services and thus contribute to better customer relations, especially in non-conventional systems.

4.10 Key Action 10: Awareness raising



Strategic area: Users.

Objective: Users' awareness high for large-scale sustainable sanitation.

Indicators: (I-28) Communication with stakeholders, (I-29) Sensitisation of users, (I-30) Promotion to potential users (see Table 4.13).

Rationale. The UN Economic and Social Council (2004) acknowledged that where households and communities are aware of the health and economic benefits of sanitation, there is a greater willingness to pay adequate prices for improved facilities and services and to change behaviour if necessary. The council also acknowledged that where communities understand the benefits of sanitation and hygiene and accept relevant technologies or products as appropriate to their culture, sanitation projects are more likely to be successful. Awareness raising thereby starts at the provider level of sanitation products and services.

Adequate awareness of staff and orientation to service are musts for effective CRM (see Section 4.9). Awareness raising outside the provider targets three basic groups: (a) stakeholders, i.e. all public or private organisations or individuals that are involved in or affected by the particular sanitation project, or the day-to-day service delivery in the service area (e.g. authorities, NGOs); (b) users of the sanitation products and services (customers); and (c) potential users (*non-users*) who are not yet connected including those users who are not yet sustainably connected (see Figure 4.10).

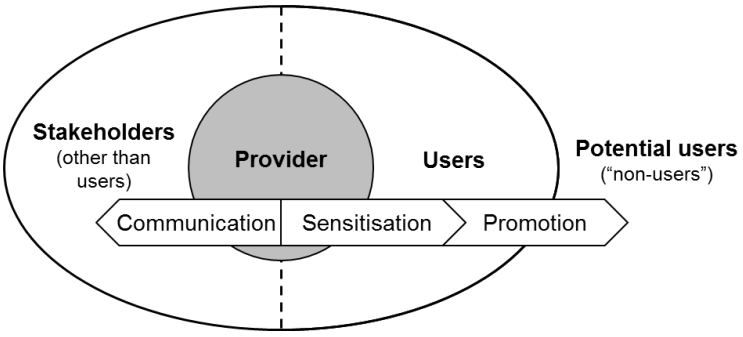


Figure 4.10: Conceptual framework of awareness raising

In this strategy, awareness raising is basically seen as the information about the needs and benefits of sustainable sanitation. But depending on the targets of particular campaigns and the target group, awareness raising is more than information; it is communication with stakeholders, sensitisation of users, and promotion to potential users. Figure 4.10 illustrates that perspective. It shows the service provider, the three groups and the main activity for each group. All three activities sensitisation, communication and promotion comprise information as the basic element of awareness raising. All measures are designed to be of different in character to reach the specific goals of awareness raising. Promotion is thereby part of marketing which has proved to be effective in attracting users to change behaviour and connect to a sanitation system especially in low-income areas of developing countries (see Section 4.8).

All activities of awareness raising need to be designed in close coordination with stakeholders and the target groups. Understanding both sanitation and hygiene of all groups users, stakeholders and potential users can help designing cost-effective facilities, services and campaigns, and avoiding failures in operating and maintaining those facilities. Often health aspects are included in sanitation campaigns, e.g. call for hand-washing to help improve health conditions within communities (Evans 2005a). The poor thereby require special attention within the concepts and plans for awareness raising. Uncoordinated campaigns of different stakeholders, however, e.g. sanitation utilities, water utilities not responsible for sanitation, health departments, electricity authorities or road authorities may result in duplication of effort. Duplication of activities again causes overloading of people’s capacity thus lowers their interest. Effective communication helps avoiding such problems and improving the impact of related activities.

Table 4.13: Indicators and rating criteria for Key Action 10: Awareness raising

Indicator	Rating criteria			
	0	1	2	3
I-28 Communication with stakeholders	Stakeholders not regularly informed about sanitation activities, almost no communication	Stakeholders regularly informed about sanitation activities but communication ineffective	Stakeholders regularly informed about sanitation activities, communication effective but stakeholders not involved in decision-making	Stakeholders regularly informed about sanitation activities, communication effective, stakeholders involved in decision-making
I-29 Sensitisation of users	People not willing to use improved sanitation facilities and not willing to change behaviour	People willing to use improved conventional sanitation facilities, e.g. water toilets, people not willing to change behaviour	People willing to use improved modern conventional sanitation facilities, e.g. water-saving toilets and improved latrines, people willing to change behaviour but not pay more for sustainable services	People willing to use improved innovative sanitation facilities, e.g. water saving toilets, water free toilets, urine diverting toilets, people willing to change behaviour and pay more for sustainable services
I-30 Promotion to potential users	Potential users not informed about sanitation activities	Potential users not adequately informed about sanitation activities, no promotion activities carried out or activities not demand-oriented	Potential users adequately informed about sanitation activities, promotion activities carried out demand-oriented but not for sustainable sanitation	Potential users adequately informed about sanitation activities, promotion activities carried out demand-oriented and for sustainable sanitation

Key to scores as in Table 4.1.

I-28 Communication with stakeholders. Experts of NETSSAF (2008) and DWA (2008) as well as others promoting large-scale sustainable sanitation considered that stakeholders in sanitation projects often take strong positions against changes towards non-conventional sanitation, usually caused by a lack of information, misinformation or just by generalisation of experience with failures of certain projects. Usually there is a large variety of stakeholders in sanitation projects including farmers, water and waste utilities, authorities and municipalities and NGOs. Communication strategies for large-scale programmes need to consider all but focus on public and government organisations as these stakeholders are the natural link to the institutional framework thus to the key to upscaling sustainable sanitation.

Knowledge of stakeholders and effective communication with stakeholders help sanitation service providers to identify, understand and solve obstacles for raising awareness and willingness to cooperate in sanitation. Therefore, responsibilities for communication within the service provider need to be defined, contact persons in stakeholder organisations must be identified and adequate communication routines have

to be developed. Activities may comprise campaigns, the spread of newsletters, direct contact, the participation in meetings, seminars and conferences and invitations for visits to pilot projects. Furthermore, stakeholders should be involved in decision-making for sanitation strategies where ever reasonable.

Communication with stakeholders is, however, often a difficult task in sanitation projects. The Water Utility Partnership (2003) highlighted that especially in many low-income areas, people or local organisations have no point of contact to external service providers that would enable a substantial discussion of the service needs. Furthermore, necessary pro-poor strategies are often not existent in authorities or they are not enforced. The partnership also highlighted that the illegal status of people again reduces their confidence to demand services from the authorities; and lack of knowledge about hygiene and sanitation affects their willingness to pay for services and to maintain the infrastructure. Communication between service providers and relevant organisations in those areas are thus important. Effective communication instead, improves and accelerates awareness raising.

I-29 Sensitisation of users. Users usually have less idea and interest in the specific processes and functions of a sanitation system behind the house connection or latrine. What is most important for users is a functioning discharge of their wastewater and low charges. Sensitisation activities, when designed and carried out in a professional way, can help sanitation providers to raise users' awareness and acceptance of sanitation; thus user's willingness to pay adequate charges. It can further help to introduce a shift in thinking towards sustainable sanitation approaches and technologies and changes in personal behaviour. While marketing is also a part of reuse management (see Section 4.8), sensitisation of users means measures that have a broader and more basic effect to pave to way for advanced instruments of user management. In practice, however, sensitisation of users usually goes hand in hand with measures of CRM (see Section 4.9).

Here, users are considered as both users of the sanitation system and users of products evolving from the system. Sensitisation of users must therefore focus on both groups. Users of the first group, e.g. people in households, are the "traditional receivers" of sensitisation campaigns. Users of the second group, e.g. farmers, need to be sensitised and attracted to use the products, which requires the introduction of professional reuse management (see Section 4.8) at the same time. Successful sensitisation in both cases, however, requires "demand side management" (Otterpohl 2008). Marketing is an effective instrument to inform about and develop demand for sanitation and should therefore be applied where necessary.

The major objectives of sanitation, human health and environmental protection are important for the whole sanitation system. However, other factors turn out to be people's real drive for sanitation in practice. Holden *et al.* (2004) found that in South Afri-

ca security and status were more important to users than health and environmental aspects when thinking about investing in a new toilet. Platzer *et al.* (2008) found that in Peru, poor people in marginal urban settlements did not have interest, time or patience to look after their toilets or even to use products from treatment processes. Often, people had no interest in ecology and were just trying solving their poor sanitary situation.

Bracken *et al.* (2004) found that such drive for sanitation is transferrable to other countries. Also in developed countries, where sanitation's main objective turned out to be environmental protection rather than human health, people care more on economic incentives and further aspects than on environmental goals. Health is secured within households due to a high technical standard in most developed countries. Krantz (2005) showed for two areas in Sweden that only the adaptation of physical or technical arrangements helps changing personal routines towards environmentally protecting behaviour. Hegger (2007) showed in an empirical study of non-conventional sanitation systems in the Netherlands, Germany and Sweden that the demands and wishes of users should be considered in the beginning when developing and implementing innovations in sanitation solutions. Factors such as convenience, hygiene, aesthetic and status turned to be user's real drive for successful innovation in sanitation.

Willingness to change behaviour and adapt to new, often more complex technology is not easy but can bring opportunities. Johansson *et al.* (2009) found pros and cons when analysing the introduction of urine diversion and the necessary new separating toilets in Sweden over two decades. Visibility of the wastewater system made users more aware of an otherwise invisible part of daily life, while visibility also lead to more engagement, being good for understanding one's actions and its effects on the environment, but it also demanded more from users, e.g. adaptation to a new toilet type. The authors further assessed that there were toilets on the market that are less user friendly thus more difficult to use. So highlighting demands in sensitisation campaigns is necessary and learning from such experiences is likewise important.

Sensitisation campaigns may be designed as combined water supply and sanitation campaigns as it is usually easier to raise awareness of users for water than for sanitation. In the end, however, feedback of users and monitoring of campaigns' success is important to adapt and improve the measures.

I-30 Promotion to potential users. Promotion has become a core tool for raising awareness of sanitation, thus for upscaling it worldwide (UN General Assembly 2009). It is therefore considered an indicator for awareness raising. Jenkins (1999) assessed the principles and key factors of successful promotion in developing countries using the example of Benin. Tayler *et al.* (2003), Evans (2005a) and others have elaborated comprehensive strategies and guidelines to promotion campaigns.

Promotion basically aims at raising awareness and acceptance of sanitation, especially the personal benefits but also the necessary financial contributions. The major goal is therefore to inform about and develop demand for sanitation (Tayler *et al.* 2003). Goals of promotion can be, however, just improving the utility's image in the public perception. Mobilisation and information of the public is thereby an important element in the public relations processes of sanitation service providers, but also within implementation of new projects.

In the day-to-day business of service providers, promotion activities should, above all, generally inform about sanitation, the needs for it and about related activities in the public areas. For example, larger construction works in the streets or housing areas should be announced to the public. Comprehensive and regular information prevents general dissatisfaction of the public pertaining to sanitation works and encourages the public to care about sanitation and to cooperate during implementation of infrastructure projects on a large scale.

However, promotion for upscaling sanitation is more than information. In developing countries where sanitation coverage is low, promotion is also communication with the public and there especially with unserved people; the "potential customers", to raise people's general awareness about sanitation and the personal benefits of it. Where health conditions are poor, joint promotion of hygiene and sanitation is therefore important (Evans 2005a). In developed countries, where sanitation coverage is high and health concerns are not a priority, promotion should inform about and develop demand for more innovative products and services towards more sustainable sanitation. Promoting a paradigm shift to sustainable thus reuse-oriented sanitation is, however, not just relevant for developed countries, it's also key factor for marketing sustainable sanitation in the developing countries.

Successful promotion is demand-orientated. Experiences with selling sanitation in Vietnam showed that where promotion activities are designed based on demand-influencing factors, the impact of promotion is much higher and the upscaling sanitation is accelerated (World Bank 2002). Planning respective activities in a joint approach for awareness raising and CRM helps to meet people's demands. This includes marketing and professional user management.

Promotion activities may include mass media campaigns, e.g. via newspapers and radio advertisements, printed leaflets and conventions. Activities may also include participatory promotion activities, e.g. community activities such as social mapping and group events. Further activities may be the provision of institutional incentives such as financial rewards for better behaviour and hygiene activities, e.g. hand-washing campaigns. Promotion activities should be closely linked to administrative representatives, traditional leaders and other important people.

Targeting children, e.g. at schools, can be very effective in comparison with usual promotion activities. Children who are more open to new, free things from prejudice and easier to inspire in comparison with adults, usually spread information faster and inspire their elders (Snel 2003). Large and long-lasting education campaigns in schools are usually not core activities within sanitation projects due to time and budgetary limits. They have to be initiated by the public authorities. Within projects, however, there is usually at least some space for smaller but effective activities when carefully planned and implemented with clear objectives.

5 Assessment tool

This section provides, *Result 3*, an analytical assessment tool and the discussion of it. The tool supports the assessment of management needs in a sanitation system or project, the identification of improvement measures and the monitoring of their implementation. It facilitates the application of *Result 1* and *Result 2*. The tool is based on a scorecard and is implemented using the standard software Excel. It can be used electronically or in a printed version.

5.1 Scorecard

Scorecard scheme. The basis of the tool is a scorecard that contains the 10 key strategic actions, 30 key strategic indicators and 120 rating criteria from *Result 2*. Figure 5.1 illustrates the scheme of the scorecard. It follows the visualisation of a Balanced Scorecard as described in Section 4.4 but contains as perspectives, the strategic areas 1 to 4 identified in Section 3.4.

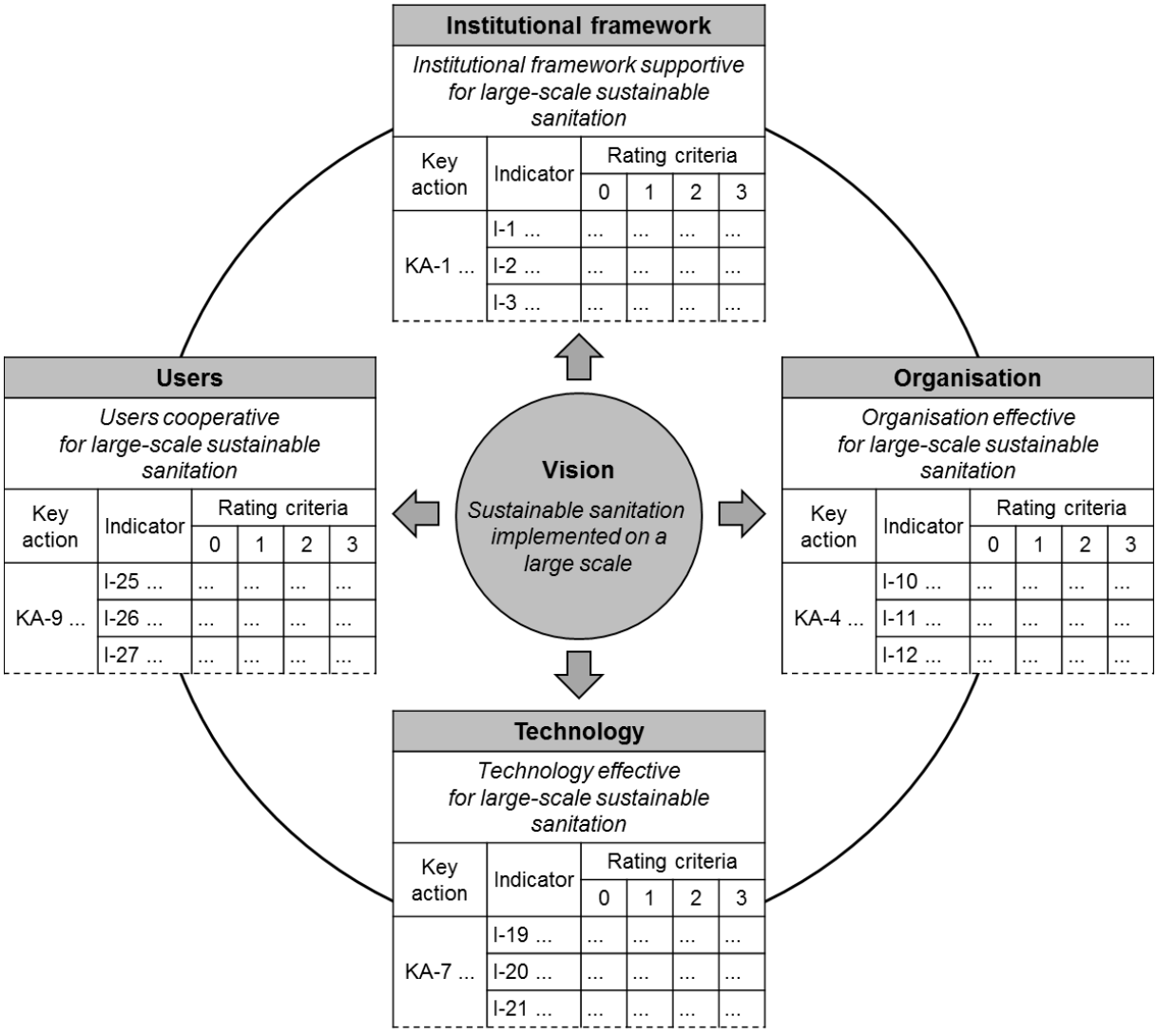


Figure 5.1: Scorecard scheme of the management strategy

In the centre of the scheme is the vision of the strategy: *Sustainable sanitation implemented on a large scale* (see Section 3.1). Based on this vision, there are four perspectives corresponding to the four strategic areas of this strategy (see Section 3.4). Each perspective contains the strategic objective, key actions, indicators and rating criteria that relate to the strategic area. The analysis of these elements was carried out in Section 4.

Score values and indicators. Overall, there are 30 indicators, i.e. 3 indicators per key action, each to be scored with 0, 1, 2 or 3.

Key to scores:

> *0—Undesirable:* Dramatic scope for improvement; i.e. interventions to improve management capacity are necessary on a very large scale.
>
> *1—Poor:* Significant scope for improvement; i.e. interventions to improve management capacity are necessary on a large scale.
>
> *2—Satisfactory:* Some scope for improvement; i.e. interventions to improve management capacity are necessary for the less developed aspects; innovations should be promoted.
>
> *3—Desirable:* Limited scope for improvement; i.e. interventions to improve management capacity should be planned for the less developed aspects; innovations should be promoted; best practice should be stated and disseminated, e.g. by publications, presentations and site visits.

The individual meaning of the specific scores is described based on individual rating criteria; i.e., there are total 120 rating criteria. The description of the indicators in the scorecard is the same as in the corresponding tables in Section 4.

5.2 Model and output data

The tool is implemented as a single file in the format Excel. The file consists of two data sheets, a questionnaire as input sheet and an evaluation sheet as output sheet. The questionnaire is interactive. Data can be entered for table heading information, e.g. project title, No., date and name. The assessment data to be entered by the user represents the scores of the indicators. The table shows rating criteria from 0 to 3 as well as the No. and name of each indicator as well as the key actions and strategic areas to which it belongs. The evaluation is in three sheets that comprise a radar chart, a bar chart and corresponding tables with the total scores for the key actions and the scores for the indicators. Basic information from the table heading cells is automatically transferred from the questionnaire. Furthermore, there is a large cell on the top which shows the *Total Management Score* of the system for a quick overview in case there are several assessments.

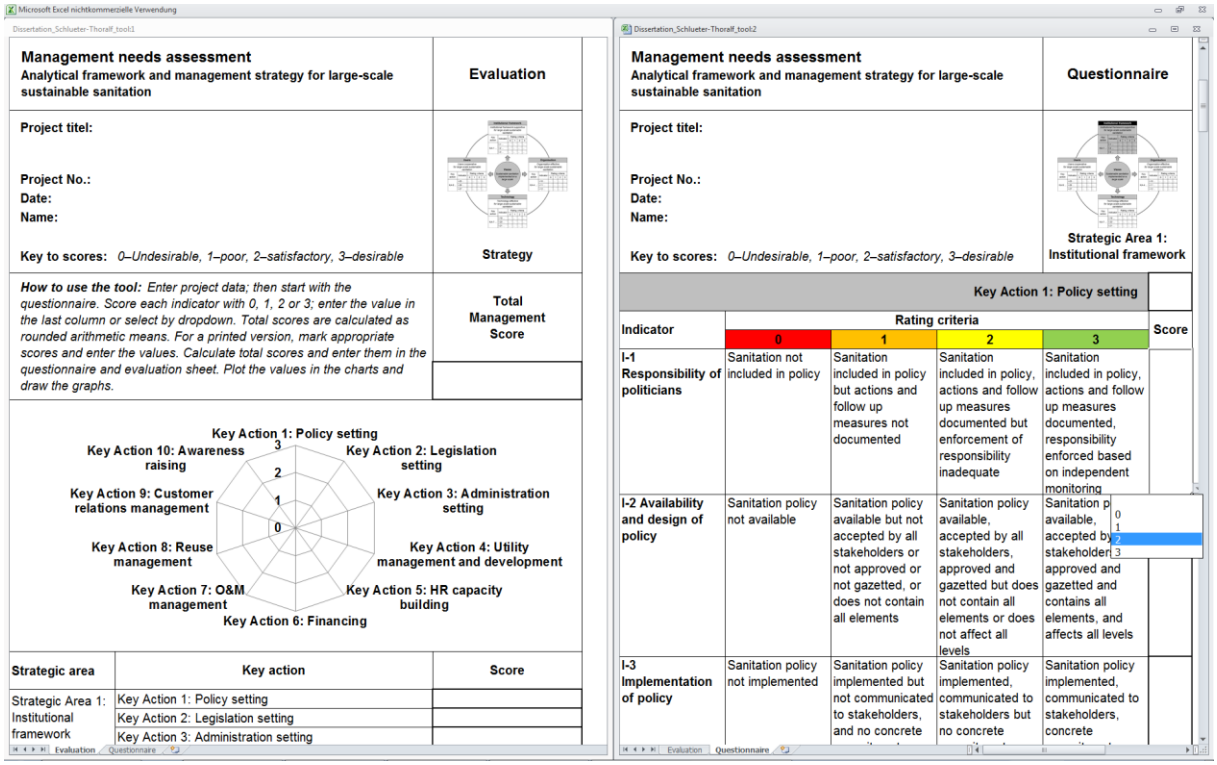


Figure 5.2: Screenshot of the tool with evaluation sheet (left) and questionnaire (right)

Figure 5.2 is a screenshot of the tool that illustrates parts of the questionnaire and evaluation sheet. The tool can be operated with the keyboard and by the mouse. The setting of values can be made by drop-down menus or by entering numbers directly in the cells. Cells without input options are disabled and thus protected against accidental changes. The input cells for scoring the indicators and the cells of the rating criteria are formatted conditionally to indicate which entries have been made or which are still required. That includes an intuitive colour scheme consisting of red, orange, yellow and green, respectively for the scores 0, 1, 2 and 3. The tool automatically controls the input data regarding logic and completeness, giving warning when contrary. Both data sheets have explanatory help texts.

The user gets the results immediately after data has been entered. The selected scores of the indicators are automatically transferred from the questionnaire to the evaluation sheet. A bar chart gives a one-page overview of the scores of all indicators so as to better identify needs and areas of improvement.

The total scores are automatically calculated after all required values have been entered. The scores of the key actions are the arithmetic means of the scores of the three related indicators, rounded to one decimal point. The score values are automatically plotted in the radar chart to give a graphic overview of the identified management needs pertaining to each key action. The *Total Management Score* is the arithmetic mean of the scores of all key actions, rounded to one decimal point. It gives an overall indication of the management status of the system.

There are no total values for the strategic areas as those could not be weighted equally. The strategic areas 1 and 2 each comprise three key actions while the strategic areas 3 and 4 each comprise two key actions. In addition, I assumed that further score values for the strategic areas would lead to too general perspectives on the one hand and to too many values on the other. The strategic areas are designed to give a rough orientation of the area of intervention, e.g. key actions can be grouped according to strategic areas in related project plans.

All results depend on the assessment of data and on the objectivity of the user (see Section 5.3). Results are not weighted (see Section 2.4.3).

5.3 Application

Opportunities. The assessment tool enables both researchers and practitioners to apply this strategy to scientific and real-world projects. It is user friendly and can be applied to various project situations such as research projects or feasibility studies, project preparation studies or management support projects. It can thereby be used as a strategic instrument to support decision-making and planning.

In detail the tool supports assessment of the management and institutional framework in a planned or existing sanitation system or project according to the key actions and indicators of this strategy. It helps the user to identify deficient areas of management and institutional development and to find corrective measures that tackle the identified deficiencies. Furthermore, it helps to define milestone indicators for the planning and implementation of suitable management interventions. In addition, the user of the tool becomes aware of management requirements for sustainable sanitation in general and in the investigated system.

Stepwise assessment. The management needs assessment is in two steps:

> *Step 1: Questionnaire*—Score each indicator with 0, 1, 2 or 3; enter the value in the last column or select by dropdown. Total scores are calculated as rounded arithmetic means. For a printed version, mark appropriate scores and enter the values. Calculate total scores and enter them in the corresponding cells.
>
> *Step 2: Evaluation*—In the electronic version all data is automatically transferred from the questionnaire and plotted in the chart. For a printed version, transfer the scores of key actions from the questionnaire into the corresponding cells. Plot the values in the charts; connect the dots with a line and draw bars. Calculate the *Total Management Score* (as described in Section 5.2) and enter the value.

The assessment should be a multi-stage and recurrent process in practice. It should be integrated with other management processes and communicated within the utility.

Kaplan and Norton (2008) found that to make a strategy work through strategy maps and scorecards, employees must understand it and support it; while meshing strategy and operations requires strong leadership. The management needs assessment, as an early step of strategy implementation, help follow these principles. The illustration of the results is easy to understand for informed experts and good to communicate to stakeholders.

However, the basis of the assessment must be a comprehensive analysis of management and institutions in the sanitation system. The results of the assessment depend on the care taken in the use of data.

Use and customising options. The tool can be used electronically or in a printed version without a computer. It works under various local conditions, even in regions with poor IT infrastructure and without regional restrictions. Excel is standard software, used by many people in the wastewater industry worldwide. Furthermore, the file format allows easy adaptation to specific needs as well as transfer and development on other platforms, e.g. web applications. The base of the application is the developed scorecard.

Availability of the tool. See Appendix A for templates of the assessment tool in a printed version including the questionnaire and evaluation sheet. This dissertation helps as an accompanying document with background information on the strategy and the assessment framework as well as further details on the application of the tool. Furthermore, the digital file of the tool will be available. However, I do not take responsibility for decisions that are made using the tool.

6 Case study for a semi-arid Middle Eastern region

This section provides, *Result 4*, a case study for a semi-arid Middle Eastern region and the discussion of it. The study is to test and refine the strategy and tool, in particular the plausibility and functionality of the identified indicators and rating criteria, as well as to illustrate their application. I used a model case; but the data is based on realistic assumptions. The case study includes the initial situation, objectives and strategy formulation as well as a management needs assessment using the tool and a concept for implementation based on the outcome of the assessment.

6.1 Introduction

The case is:

> Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region.

The study is to assess needs and develop solutions for improving institutional and management framework, as necessary to implement large-scale sustainable sanitation using constructed wetlands. *Large scale* in this case means that support measures are part of an overarching management strategy, as an integrated approach at different administrative levels. This is different from common practice in initial small-scale pilot projects which often bring only individual O&M concepts. Furthermore, the sanitation system is based on the technology of constructed wetlands that has been implemented successfully on pilot scale in a similar area although on a much smaller scale. The choice of the technology is not intended to show the best sanitation option. Professional technology choice requires a comprehensive feasibility study including cost-benefit and other analyses. The decision for a final design has to found on a sound decision-making process supported by professional tools.

6.1.1 Initial situation

The case study area is a model region of a district area in Middle East in semi-arid climate. The area is of intermediate density (towns and suburbs, classified after Dijkstra and Poelman 2014).

Area	1,000 km^2
p (total area)	200,000
p density (total area)	200/km^2

The settlement structure of the study area comprises urban clusters with 7 towns representing 70% of the total area p. Two of the 7 towns are significantly larger representing 40% of the total area p. Furthermore, there are rural grid cells with 40 settlements of different sizes outside the urban clusters. The rural grid cells represent 30% of the total area p (see Table 6.1).

Table 6.1: Settlement structure of the case study area

Type	Size	No.	p (total)	Share of p (total area) (%)
Urban clusters[a]	p > 15,000	2	80,000	40
	5,000 < p ≤ 15,000	5	60,000	30
Rural grid cells[b]	1,000 < p ≤ 5,000	20	50,000	25
	p ≤ 1,000	20	10,000	5

[a] Clusters of contiguous grid cells of 1 km^2 with a density of at least 300 inhabitants per km^2 and a minimum population of 5,000 (Dijkstra and Poelman 2014)

[b] Grid cells outside urban clusters (Dijkstra and Poelman 2014).

The study area is near a large city which is expanding rapidly. The development of the city still only affects the study area to a limited extent, but is expected to significantly affect it in future. Urbanisation, however, is taking place in the urban clusters of the area. The area is further characterised by housing and commercial buildings including craft and trade as well as industry to a limited extent, e.g. building material production. There is a lot of agriculture with mainly crop production based on inefficient irrigation techniques often with untreated wastewater.

The water and sanitation sector is characterised by relatively high coverage ratios but low efficiency in water management and an even worse situation in sanitation. The status of the physical infrastructure is widely weak. Crucial factors are cost and complexity of systems resulting in inefficient O&M, lack of capacity and skilled HR, lack of autonomy of local service providers, inflexible management rules, inadequate institutional framework and low awareness. Furthermore, strategic planning and implementation of new infrastructure faces problems with urbanisation in the urban clusters.

Coverage with sanitation and water supply is relatively high in the area in comparison with other developing countries. Water supply and sanitation coverage are 90% and 96% respectively. National and foreign donors have been helping to improve coverage in both fields through funded studies, projects and programmes.

> *Example:* Although the situation in Syria is largely different in 2015, the country was generally on track reaching the MDG target on sanitation in 2008 (UNICEF and WHO 2008). According the report, until then, 48% of the Syrian population had gained access to *improved sanitation* by 1990 which was almost the MDG target of halving the p without access by 2015. Hence Syria had made the second most rapid progress worldwide after Myanmar with 68% of the population gained access by 1990 and before Vietnam with 47%. The progress was based on large-scale sanitation infrastructure programmes in Syrian cities, mainly the

two largest Damascus and Aleppo. UNICEF and WHO (2008) estimated that, in 2006, out of the total population of the country of about 19.4 million, 51% lived in urban areas. The successes in sanitation included the urban poor: between 1990 and 2004, the No. of urban dwellers without *improved sanitation* decreased, while the total urban population increased by about 48%; the absolute decrease in urban population without sanitation was 96,000 (WHO and UNICEF 2006).

Water supply is ensured by different freshwater production facilities and a distribution system including pumping stations. There is a spring system, a surface reservoir and well fields. During the rainy season which usually lasts 1 to 2 months per year water is available in sufficient quality and quantity. During the rest of the year water scarcity is a daily occurrence. Overall water demand is increasing in the region due to a high birth rate, migration from other parts of the country and economic development. But also by growing irrigated agriculture which consumes over 80% of the available freshwater resources. The high water demand results amongst others in extended extraction and depletion of the groundwater. Furthermore, untreated wastewater and many pesticides are used for irrigation in agriculture in many areas. This practice leads to additional health risks for people as well as environmental pollution including the contamination of groundwater resources, e.g. spring system and well fields.

The sector is characterised by inadequate cost recovery thus low performance of both water and sanitation services; in particular, besides other problems, low revenues and high unaccounted for water (UFW).

Example (Schlüter 2006b, modified; see Table 6.2): In the district area of Damascus Rif Governorate, UFW and water tariff regulations were a major concern in the rehabilitation of water supply systems in 2006. While service coverage in the district area was relatively high, there was a substantial need for improving services particularly water quality and service reliability, e.g. UFW was about 40%. Water tariffs ranged from €0.05 to €0.28/m³ for domestic use in an increasing block tariff. The status could be compared to public water utilities in Vietnam where UFW reached 38% with an average water price of €0.12/m^3. The situation in Jerusalem was better. In addition to technical and administrative improvements, the local water works set the water price at €1.00/m^3. They adjusted or renewed old water meters and cut the connection when unauthorised consumption occurred. In this way UFW has decreased to 28%, with the best quartile from developing countries being at 23%.

Sanitation is thereby not ensured according to international standards in rural and peri-urban areas. There are no functioning sanitation systems in those areas except pilot projects, as common in other regions of the country. So sanitation significantly

contributes to a dramatic health situation in the region with a large portion of the population being infected in particular with typhus, hepatitis and diarrhoea. In the neighbouring large city, as in other larger cities of the country, conventional systems with combined sewers and central WWTPs ensure sanitation more or less effectively according to international standards. This case study does not include those urban areas but takes into account the effects of urbanisation in the suburbs related to it. In some areas of the case study old, but unmaintained sewers, collect and discharge wastewater without treatment.

Table 6.2: Operational and financial PIs in different developing countries and best practice targets (GFA 2009, modified)

Indicator	Damascus (2004)[a]	Jerusalem (2002)[b]	Vietnam (2001)[c]	Best practice target (2001/´05)[d]
Service coverage water supply (%)[e]	90	n/a	45	95
Average water use (l/p/d)[f]	102	92	82	n/a
Average service water supply (h/d)	n/a	n/a	19.6	24
UFW (%)[g]	40	28	38	23
Staff per 1,000 connections	5.8	6	12	5
Staff cost per m^3 water billed (€)[h]	0.04	0.43	0.05	n/a
Staff cost of total O&M cost (%)	35	34	33	39
Energy cost of total O&M cost (%)	43	10	31	n/a
Working ratio[i]	2.4	1.2	0.64	0.7
Collection period (months)[j]	6	6.2	1.1	3
Collection efficiency (%)[k]	50	86.5	90	n/a

[a] GFA (2009).

[b] Jerusalem Water Undertaking: water tariffs high, on average €1/m^3, cited in GFA (2009).

[c] Figures from 67 public water utilities in Vietnam, water tariff on average €0.12/m^3 (Sharifian 2002).

[d] Developing countries, assessment of 246 water utilities from 51 countries (Tynan and Kingdom 2002).

[e] Coverage level of population served.

[f] Average water consumption = (total billed water in m^3 / total p x 0.9 (service coverage)) x 1,000 / 365.

[g] UFW = difference between water supplied and water sold as percentage of water supplied capturing physical and commercial losses (Tynan and Kingdom 2002).

[h] Exchange rate: US$1.00 = €1.20.

[i] Working ratio = operational cost without depreciation / operational revenues.

[j] Collection period = accounts receivable at year-end / annual revenues (billed amount) x 12.

[k] Collection efficiency = collected revenues / net total billings.

Conventional sanitation is applied in the neighbouring large city as in other large-scale systems in the country. Treatment technologies include aerated lagoons, stabilisation ponds and activated sludge. The systems in the case region, however, are

neither properly implemented nor professionally managed, e.g. only parts of systems are installed with wastewater being collected and discharged into combined sewers without treatment. The requirements for complex and cost-intensive conventional sanitation do not meet the framework and capacities in the region.

> *Example:* Mohamed (2004) showed obstacles to implementing conventional, centralised WWTPs in many places of Syria; mainly technological and economical. In Damascus wastewater was collected from western city districts and discharged to the central WWTP in the eastern part of the city. The treated wastewater was supposed to be used as irrigation water by farmers in that area. However, farmers in the western city wanted the self-produced and treated wastewater to be pumped back to use it on own fields. That would have been technologically possible, but extremely costly, and so has been rejected. As a result, sewers in the west were regularly being destroyed and the out-flowing untreated wastewater was used for irrigation (see Section 2.1).

Non-conventional sanitation with decentral treatment of wastewater has become an option to conventional sanitation through pilot projects. Consultants and decision-makers started thinking about sanitation concepts with smaller WWTPs, e.g. ponds and constructed wetlands. Avoiding long-distance transport of wastewater and reuse of treated wastewater on site would be assets especially in decentralised rural or sub-urban areas. Local materials can be used for construction and local craft and people can take part in basic activities of construction and O&M. Therewith, awareness of sanitation can be raised and promoted with effects in the wider region or even the whole country.

> *Example:* The possible wider use of non-conventional wastewater treatment systems especially in rural areas, informal housing estates and in isolated smaller localities was subject to debate in Syria (Münch *et al.* 2009). Stakeholders discussed the use of constructed wetlands, especially in rural areas, informal settlements and remote areas. Moreover, feasibility studies of donor agencies indicated for urban and peri-urban areas in Syria that conventional treatment technologies get extremely costly. Hence the cost problem not only referred to infrastructure investments but also to O&M. The construction costs for reed bed systems in pilot projects were comparable to the costs of conventional treatment systems with aerated lagoons or activated sludge, while costs for O&M can be significantly lower.

Pilot projects of non-conventional sanitation in different settings showed that these systems are an alternative to conventional systems.

Example: Constructed wetlands have been successfully applied in pilot projects in Syria. The first project was implemented for 7,000 inhabitants in Haran Al-Awamied near Damascus in 2000 (Mohamed 2004; Mohamed *et al.* 2005; Münch *et al.* 2009). The system comprised combined gravity sewers, wastewater treatment and sludge conservation in reed beds as well as reuse of treated wastewater and harvested reed. Another project was implemented with the same technology for 1,700 inhabitants in Homs province; a further project was implemented with the same technology for 3,500 inhabitants in a public-private partnership in Jedaidet Yabous; and a project to build 23 constructed wetlands in 6 governorates with German-Syrian financing started with 5 wetlands being implemented before the outbreak of war (A. Mohamed, personal communication, 19 March 2016).

Other projects show the commercial use of constructed wetlands even on a larger scale:

Example: Greenbank *et al.* (2014) reported that one of the largest constructed wetlands has been implemented in Moldova at the scale of small and medium-sized towns with a PE of 20,000. As a replacement for an old treatment plant it significantly reduced operational costs in comparison with conventional treatment.

The planned sanitation system consists of several individual systems which are jointly to be planned, constructed, operated and maintained. Each system is based on a reference system that is categorised as 1-stream sewerage + WWTP system according to the categorisation in Section 1.1.2 (see Figure 6.1).

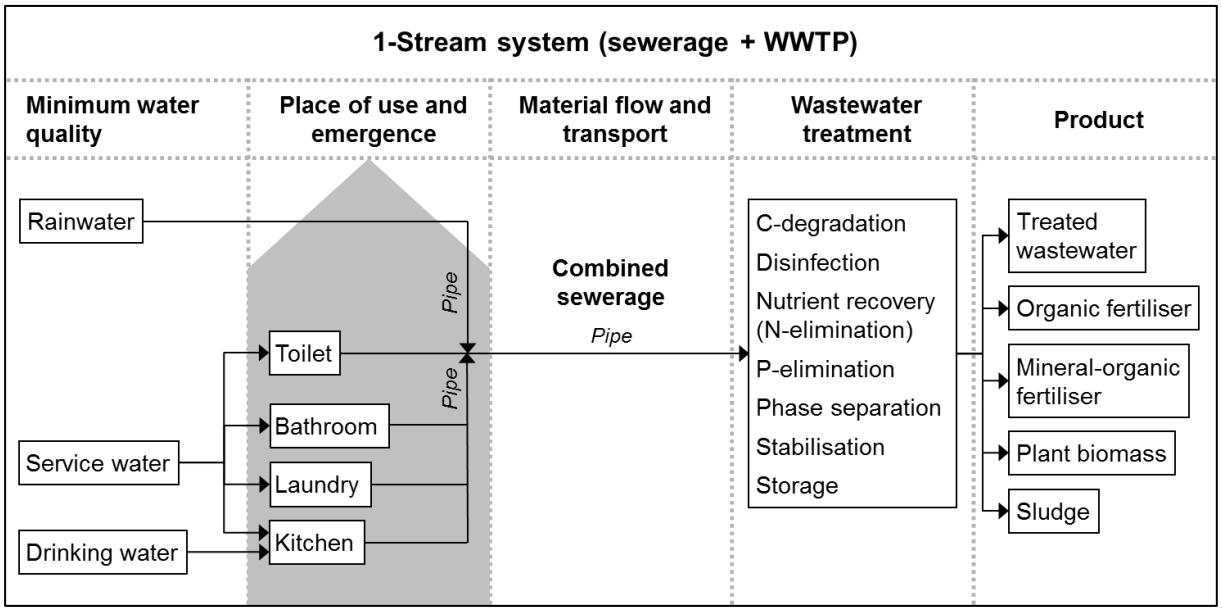


Figure 6.1: Basic scheme of sanitation system in the case (DWA 2008, adapted to the case)

People use drinking water and service water of lower quality. Combined sewers collect household wastewater, rainwater and wastewater from other sources such as craft and commercial buildings. Sewers transport it by gravity to decentral WWTPs. Treatment steps include pre-treatment with bar screens and sedimentation, treatment with reed beds and sludge treatment also with reed beds. Collecting tanks store the treated wastewater for demand-oriented use in the region, while by-products such as fertiliser or plant biomass (reed) are used occasionally.

The reference system is based on experience of constructed wetlands in Syria described above. However, planners should also consider experiences from other projects as the technology is being developed. There are several recommendations to consider (Gauss 2005; Kramer *et al.* 2007; Masi *et al.* 2008; Hoffmann *et al.* 2011) particularly the German standard for the design, construction and operation of constructed wetlands by DWA (2006, corrected version 2014). The International Organization for Standardization (2015) published guidelines for treated wastewater use for irrigation projects with a focus on project development and execution.

Technology adaptation needs to be considered in the early project stages. Despite successes with using constructed wetlands, the technology is being developed in both science and practice. While its function has been shown in semi-arid climate (Masi *et al.* 2008; Münch *et al.* 2009; and the Syrian examples above), there is room for improvement.

> *Example:* Researchers found that using earthworms can significantly improve the effectiveness of the treatment process in constructed wetlands, also in a semi-arid climate (Chiarawatchai and Otterpohl 2006; Chiarawatchai 2010). The potential for resource recovery from cultivating plants can be enhanced, if stakeholders provide significant efforts, e.g. concerning the organisation of the use of harvested plants. However, the study also showed the need for further research. Pabsch (2004) in turn investigated sludge drying and treatment methods which could also be considered in the planned projects.

Those examples show that up-dating existing technology can be a step to easier and more efficient O&M, and hence to the reduction of related costs. Applicability in practice, however, is essential for the implementation of systems on a large scale, and need to be demonstrated. And, although this case is about upscaling a specific approach, in real projects technology choice has to be based on professional approaches (see Section 6.1) which means that other appropriate technologies can be applied. The major basis of the decision for the system in this case is that extremely low water fees and widely generally no wastewater charges require significantly low operation cost. Costs for the rehabilitation and new construction of sewers will be the largest amount of investment, to be financed by external sources.

Large-scale implementation of this case study refers to the regional impact of the overall project and a large No. of people served. The project aims at the implementation of several decentral systems in a unified approach but single systems in this case can be considered small-scale. Other aspects of large-scale refer to the joint implementation of the management strategy at local, regional and even national level, which include joint structures and framework, e.g. joint O&M concepts, local and regional service providers and institutional framework. It also refers to joint financing, planning and design, procurement and construction as well as technical development; although those fields are not studied in this research (see Section 3.3).

In conclusion, non-conventional sanitation using constructed wetlands is an option for large projects in the region. Large in this case refers to the impact and scale of the project, its joint organisation and management and the institutional framework. The implementation of technology can be jointly coordinated in smaller projects. Pilot projects confirmed for the region that appropriate sanitation technologies are available (according to the consensus of experts of the IWA 2006, see Section 1.1.3). Arguments for the application of the technology are low costs, easy construction and simple O&M in comparison with conventional systems. The treated wastewater can be made available for reuse on-site to cover a part of the irrigation demand which is currently covered with raw wastewater (see example Syria above). Although system design and technology should be adapted and improved as development continues in science and practice, pilot projects provide convincing arguments for its upscaling.

The status of institutions and management, however, does not support the upscaling. Also pilot projects, although answering essential technical questions of planning, implementing and operating under local conditions, do not answer all questions of management and institutional development that arise from large-scale implementation. It is assumed that a professional management strategy would help identifying needs and areas of interventions to improve both the institutional framework and the management capacity in the sector as in the project area. In reality that would also require a management consulting project that accompanies the investment project which again comprises infrastructure planning, construction and its supervision as well as technical training (see Section 1.1.3).

6.1.2 Objectives

The case study has two main objectives:

- to test and improve the prior results of this research, i.e. the strategy (*Result 1*), the key actions, indicators and rating criteria (*Result 2*) and the tool (*Result 3*);
- to illustrate the application of the prior results to a real-world problem and how the outcome of a management needs assessment can be translated into a concept for implementation.

To carry out the case study I planned to formulate the strategy for the case, to assess management needs using the software tool and to develop a concept of implementation based on the outcome of the needs assessment. The implementation concept should be a realistic project definition including milestones, time schedule and budgets.

6.2 Strategy formulation

The basis of the management strategy in this case are the statements on mission, vision and values that I have adapted from those in Section 3.1.

Mission: Management strategy for upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region.

Vision: Sustainable sanitation using constructed wetlands implemented on a large scale in a semi-arid Middle Eastern region.

Values: Scientific foundation, transdisciplinarity, business orientation and applicability.

Figure 6.2 is the strategy map of the case study that gives a summary picture of the management strategy applied to the case. It is the guiding instrument for the implementation of both the management needs assessment in Section 6.2 and the elaboration of the implementation concept in Section 6.4. It is also the guide for strategy implementation.

The map is adapted from the basic strategy map developed in Section 3.6. It illustrates the main elements of the strategy, i.e. the mission, vision and values as defined above and the 10 key actions in four strategic areas. Furthermore, it gives a reference to the analytical assessment framework consisting of 30 indicators and 120 rating criteria and relates to the strategic action plan (see Figure 6.5) which is an outcome of the management needs assessment according to Section 6.2.

The map needs to be refined and detailed during project preparation. Steps of strategy implementation include planning the strategic actions, monitoring and learning as well as testing and adapting (see Section 2.4.1). This implementation concept is considered to be the initial operation plan of the strategy. Learning, testing and adapting needs to be carried out regularly after completing the initial project. The basis should be professional performance monitoring of both system and institutional framework, e.g. according to the IWA standard (see Section 4.4).

Vision

Sustainable sanitation[a] using constructed wetlands implemented on a large scale in a semi-arid Middle Eastern region

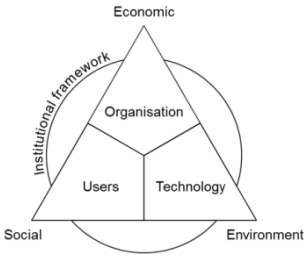
Mission

Management strategy for upscaling sustainable sanitation[a] using constructed wetlands in a semi-arid Middle Eastern region

Values

Scientific foundation, transdisciplinarity, business orientation and applicability

Strategic areas and key actions



Strategic Area 1: Institutional framework	Strategic Area 2: Organisation	Strategic Area 3: Technology	Strategic Area 4: User
Key Action 1: Policy setting	Key Action 4: Utility management and development	Key Action 7: O&M management	Key Action 9: Customer relations management
Key Action 2: Legislation setting	Key Action 5: HR capacity building	Key Action 8: Reuse management	Key Action 10: Awareness raising
Key Action 3: Administration setting	Key Action 6: Financing		

Assessment framework

To assess management needs in a system or project and the impact of management actions implemented; evaluation of 3 indicators per key action (total 10 key actions and 30 indicators) each scored from 0 to 3 on the basis of individual rating criteria (total 120 rating criteria).

Strategic action plan

Required actions based on the outcome of the management needs assessment (see Figure 6.5).

Infrastructure and financing strategies (not studied in this research)

[a] Sustainable sanitation protects human health and the environment and adds value by the reuse of resources (see Section 3.2.3).

Figure 6.2: Strategy map of the case study

6.3 Management needs assessment

See Appendix B for the questionnaire and evaluation sheet completed with the data of the case as well as for comments on the assessment of the indicators.

Generally, the results of the assessment indicate a significant demand for improvement in both the management of the system and the institutional framework to implement large-scale sustainable sanitation in the study area. Although the key actions in Strategic Area 1: Institutional framework are assessed to be slightly better than the others on average, all strategic areas comprise at least one indicator with an undesirable score and dramatic scope for improvement (see Figure 6.4). However, there are some areas where prior measures build a basis for improvement.

The Total Management Score is 1.0, i.e. *poor with significant scope for improvement* according to the key to scores in Section 5.1. Significant large-scale interventions are required to improve management and institutional framework for a successful upscaling of sustainable sanitation in the case area.

The scores of the key actions range from 0 to 1.7 which again is considered *undesirable with dramatic score for improvement* to *poor with significant scope for improvement* (see Figure 6.3). All scores of the key actions are provided in the completed questionnaire and evaluation sheet in Appendix B.

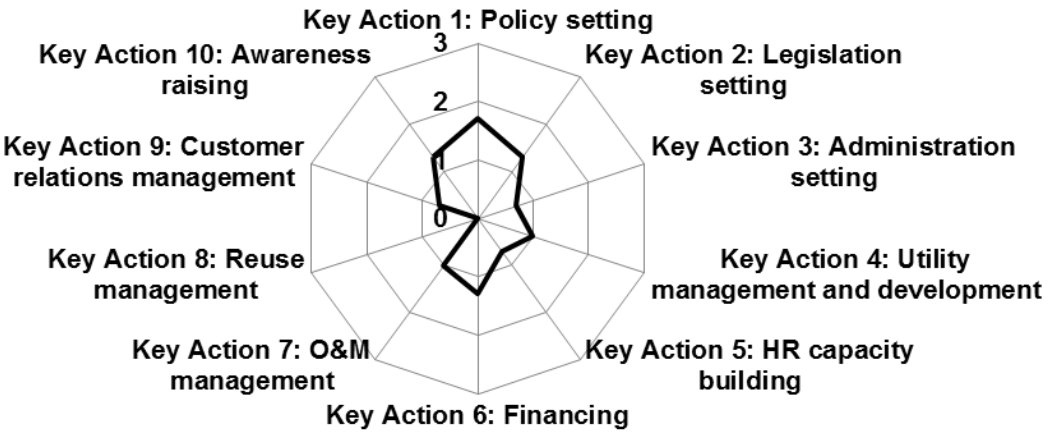


Figure 6.3: Scores of the 10 key actions in the case study (extract from Appendix B)

There are four key actions with a score below 1.0, i.e. *undesirable with dramatic scope for improvement* (Key Action 3: Administration setting; Key Action 5: HR capacity building; Key Action 8: Reuse management; Key Action 9: CRM). Key Action 4: Utility management and development and Key Action 9: O&M management reached a score of 1.0, i.e. *poor with significant scope for improvement*. The four other key actions reached scores of 1.3 or 1.7 all considered *poor with significant scope for improvement* (Key Action 1: Policy setting; Key Action 2: Legislation setting; Key Action 6: Financing; Key Action 10 Awareness raising).

The scores of the indicators range from 0 to 2, i.e. *undesirable* to *satisfactory* (see Figure 6.4). Six indicators were assessed with a score of 0, nineteen reached a score of 1, and five a score of 2. No indicator reached a score of 3 which would have meant *desirable* and best practice. All scores of the indicators are given in the questionnaire and evaluation sheet in Appendix B.

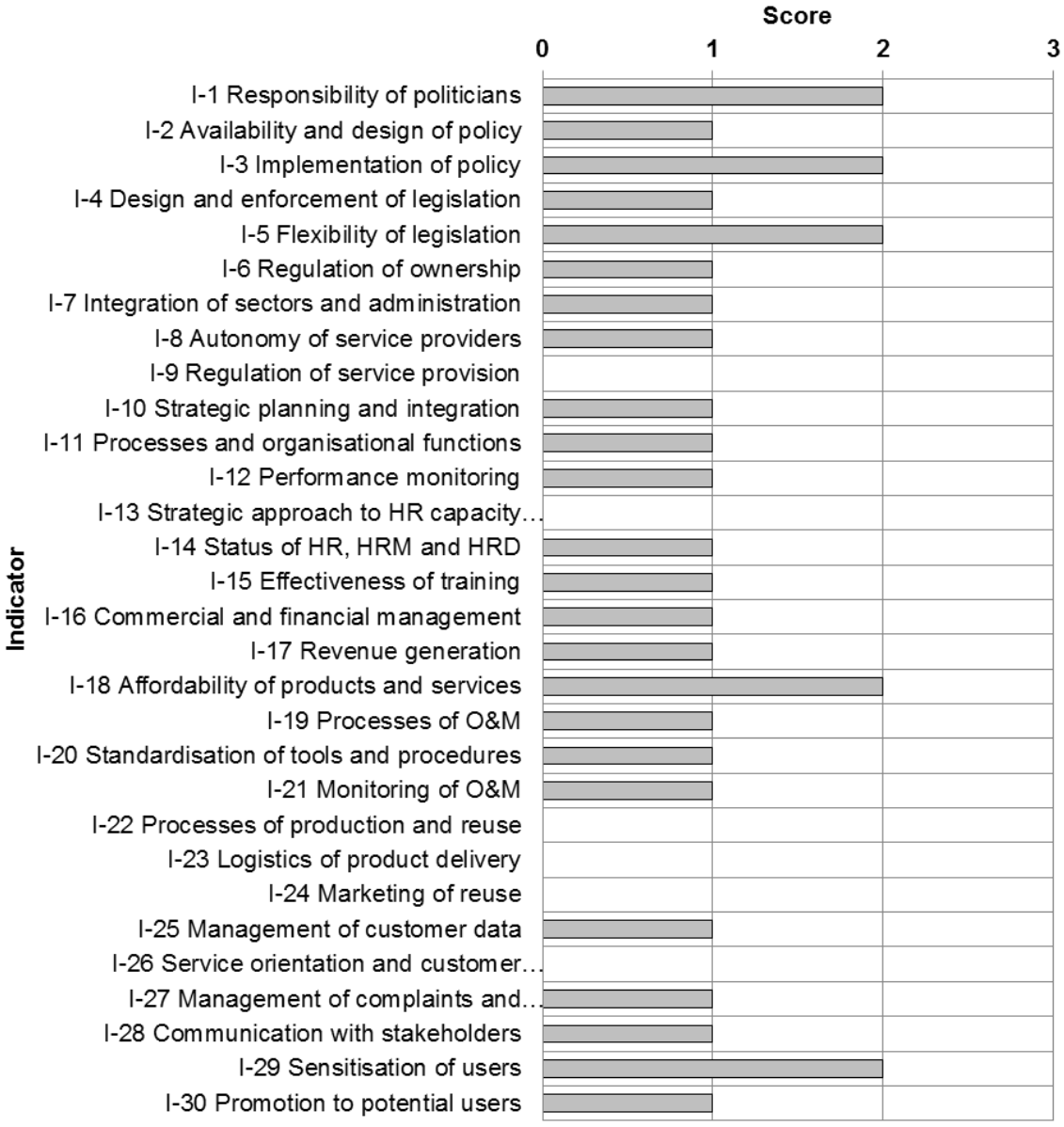


Figure 6.4: Scores of the 30 indicators in the case study (extract from Appendix B)

The underlying data of the assessment were realistic assumptions comparable to the data of real projects in science and practice, based on my own professional field experience as well as desk studies (see Section 2.4.4). I used the assessment tool to identify, assess and illustrate management needs in the case. The assessment brought implications for the need of improvement in the strategic areas and key actions related to management and institutional development. As the strategy is designed to accompany *hard-engineering* measures of project implementation, i.e. the

development and construction of the physical infrastructure, to ensure a holistic approach to the project (see Section 3.3); the strategy can only be one part of an overall project for upscaling sustainable sanitation in the project area.

The underlying analyses of the case study assessment were limited in this research. Real-world implementation of the case will require profounder analyses and assessments. To examine all key aspects on site and to analyse the findings, a comprehensive feasibility study is a suitable instrument. The management needs assessment should be a part of it.

6.3.1 Strategic Area 1: Institutional framework

The institutional framework does not support large-scale sustainable sanitation. While the strategic area performs generally slightly better than the other areas, the scores of the related key actions range only from 0.7 to 1.7 which leaves significant scope for improvement. Policy setting (score 1.7) and legislation setting (score 1.3) are more enabling than the administration setting (score 0.7) which is very ineffective. Measures should support policy and legislation setting by concretising its implementation and enforcement and improve the effectiveness and autonomy of the water and sanitation administration which amongst others requires the regulation of ownership pertaining to sanitation assets. Measures need to include the review of existent laws and regulations, adapting it to the policy goals of sanitation and requirements for the planned new sanitation systems approaches and strengthen the capacity of administration authorities to improve enforcement. Measures must be carried out at local and national level and integrated with other sectors such as waste, water supply, water resources management and irrigation.

Key Action 1: Policy setting (score 1.7); actions required:

- Review and support adaptation of sanitation policy;
- Review and support adaptation of sanitation policy implementation processes;
- Coordinate sanitation policy with stakeholders including agreements;
- Establish independent sanitation policy monitoring.

Key Action 2: Legislation setting (score 1.3); actions required:

- Review and support adaptation of sanitation legislation (including mandates for regulation of service provision; relate to Key Action 3);
- Assess sanitation assets;
- Prepare and introduce asset register;
- Prepare and introduce asset management plans;
- Support transfer of sewer network and other sanitation assets.

Key Action 3: Administration setting (score 0.7); actions required:

- Analyse sanitation administration setting at all levels (including responsibilities, processes, capacities and coordination mechanisms; relate to Key Action 1 and Key Action 2);
- Develop IWRM approach and coordinate with water basins committee;
- Elaborate institutional development plan of authority for more autonomy for local service providers;
- Define and coordinate future role of municipalities in sanitation;
- Support implementation of plans, structures and enlarged tasks of local service providers;
- Develop outsourcing options for sanitation service provision;
- Develop procedures for the regulation of sanitation service provision (relate to Key Action 2).

6.3.2 Strategic Area 2: Organisation

Organisation management is not effective for large-scale sustainable sanitation. Scores of related key actions range from 0.7 to 1.3 which means dramatic and significant scope for improvement. The overall status of the strategic area is the status of institutional framework but better than technology management. Large-scale interventions are required to improve utility management and development (score 1.0), HR capacity building (score 0.7), and financing of O&M (score 1.3). Priority areas of intervention are the introduction of strategic approaches within sanitation utilities especially for HR capacity building including adaptation to the local level, the improvement of processes and organisation functions as well as commercial and financial management to generate revenue better. Finally, approaches of performance monitoring need to be strengthened and related to the strategic management.

Key Action 4: Utility management and development (score 1.0); actions required:

- Develop and introduce sanitation utility development plan (relate to Key Action 3);
- Develop and introduce annual work and financial plans (relate to Key Action 6 and Key Action 7);
- Develop and introduce documentation and reporting system including databases (relate to Key Action 7);
- Develop and establish MIS;
- Develop and coordinate PIs and monitoring framework that is appropriate for benchmarking;
- Support data collection for performance monitoring;
- Develop and implement training and follow-up advice in databases, MIS and performance monitoring.

Key Action 5: HR capacity building (score 0.7); actions required:

- Assist in recruiting processes for restructuring organisations;
- Develop and implement performance-based HRD/HRM plans for authority and sanitation utility (relate to Key Action 4);
- Develop and implement training needs assessment;
- Develop and implement training programmes for authority and local service providers (relate to Key Action 4);
- Introduce tools and procedures to document, monitor and evaluate training.

Key Action 6: Financing (score 1.3); actions required:

- Improve commercial and financial management in authority, water units, sanitation utility;
- Introduce integrated billing-accounting system in authority, water units, sanitation utility;
- Develop and integrate new sources of revenues particularly from wastewater reuse (relate to Key Action 8);
- Develop criteria of affordability of sanitation products and services for the project area;
- Develop and implement revenue awareness campaigns.

6.3.3 Strategic Area 3: Technology

Technology management is not effective in implementing sustainable sanitation on a large scale. There is significant scope for improvement in some areas and dramatic scope for improvement in others where new approaches and tools need to be introduced. O&M management is generally poor (score 1.0) and requires an equal improvement of processes, standardisation and monitoring. On the contrary, reuse management (score 0) needs to be developed from scratch where sanitation systems should enable a professional reuse of resources. Effective processes of production and reuse are required including logistics of product delivery especially for treated wastewater but also professional marketing of reuse.

Key Action 7: O&M management (score 1.0); actions required:

- Review and improve or introduce integrated O&M processes (to clarify responsibilities, flexible organisation, and effective workflows, documentation, reporting and monitoring);
- Introduce O&M tools and procedures with documentation and reporting system (standardised and appropriate for benchmarking);
- Develop and implement training and follow-up advice in the application of tools and procedures (relate to Key Action 5 and Key Action 9);
- Establish inventory and monitoring system for indirect polluters;

- Implement sewer mapping and measuring (coordinate with investment project);
- Implement sewer leak detection and immediate repairs (coordinate with investment project).

Key Action 8: Reuse management (score 0); actions required:

- Design and implement wastewater user surveys (relate to Key Action 9);
- Develop and introduce processes of production and reuse (coordinate with investment project and users);
- Establish logistics of reuse (coordinate with investment project and users);
- Draft and conclude agreements with wastewater user groups (farmers; formal or informal arrangements; relate to Key Action 3);
- Develop and implement training programmes for wastewater users (farmers);
- Design and implement marketing campaigns for wastewater reuse.

6.3.4 Strategic Area 4: Users

Users are not assessed to be sufficiently cooperative to implement sustainable sanitation on a large scale. In particular user management must be more effective. Improving CRM (score 0.7) generally requires better management of customer data but also more service orientation of staff in many departments and procedures for assessing customer satisfaction. Furthermore, the management of complaints and suggestions needs to be improved. Awareness raising (score 1.3) is slightly better than CRM but it needs also to be significantly improved. Measures should focus on improving the effectiveness of communication with stakeholders and a demand-oriented promotion of sustainable sanitation to potential users who, in many areas, are not adequately informed about sanitation activities. This is also related to the planned new options of reusing treated wastewater.

Key Action 9: Customer relations management (score 0.7); actions required:

- Design and implement customer surveys and small-scale baseline studies in unserved areas;
- Develop and introduce customer database;
- Develop and introduce customer surveillance procedures and house connection management;
- Support the legalisation of house connections (relate to Key Action 2);
- Improve CRM and communication procedures and assessment of customer satisfaction;
- Develop and implement awareness campaigns to service orientation of staff.

Key Action 10: Awareness raising (score 1.3); actions required:

- Review and improve stakeholder communication procedures (with stakeholder involvement in decision-making);
- Develop and implement sensitisation campaigns for users (relate to Key Action 9);
- Develop and implement promotion activities for unserved people;
- Develop and implement promotion activities for potential users of treated wastewater and by-products (relate to Key Action 6 and Key Action 8).

6.4 Implementation concept

The implementation concept is based on the outcome of the management needs assessment (see Section 6.3). It provides a strategic action plan and translates the assessment results in a defined TA-project as a basis for further project planning. The concept starts with an outline and the strategic action plan including the definition of areas of importance. The project definition includes a description of the project objectives and expected results, project context including the key stakeholders as well as project risks, organisation, communication and coordination. Furthermore, project phases and milestones are defined as well as their timing and duration together with an estimation of cost development over the project duration. Finally, the concept comprises considerations of a project budget.

6.4.1 Outline

The management strategy will be planned and implemented as a TA-project focusing on management and institutional development. The estimated duration of the project is 7 years depending on the development of the sanitation infrastructure. Considering the complexity and comprehensiveness of the required improvement measures and the planned broad impact of it at local but also national level, the implementation concept could also be defined as a programme instead of a project. In the end the definition of it should depend on the responsible authority and financing institution (Aid Delivery Methods Helpdesk 2004). However, it will be essential that respective TA accompanies investment projects which relate to the planning, design and construction of the sanitation infrastructure in the project region.

Overall responsibility of the project will be with the ministry responsible for sanitation which will delegate parts of it. There will be the need for substantial support through TA by international and local consultants experienced in implementing similar projects, possibly financed by a development bank or donor agency. The main beneficiaries will be the people in the region including other users of water, mainly farmers, as well as all organisations involved in sanitation service provision such as ministries, water and sanitation authority and underlying business units in the project region.

6.4.2 Strategic action plan

See Figure 6.5 for the strategic action plan of the case study. The plan is linked up with the strategy map in Section 6.2 and builds the basis for further project definition in Section 6.4.3. The action plan refines the key actions with 55 actions required to achieve the necessary management improvements in the case study as identified in the management needs assessment (see Section 6.3). The actions need to be specified as work packages in further project planning which has not been done in this research. The action plan is illustrated as an objective tree; it includes the overall and specific project objective of the strategy-related TA-project as defined in Section 6.4.3. The actions are aligned to the key actions and numbered alphanumerically.

Areas of importance. The management strategy, including the key strategic actions, developed in this research is valid for implementing sustainable sanitation on a large scale. Real projects, however, usually require compromises considering the specific needs, budget and available timeframe for implementation. This is also assumed for the implementation of the case study. Identifying areas of importance allows orientating on key problems and setting priorities in planning and implementation. Identifying the right areas in a real project requires comprehensive fact-finding and intensive discussions with project stakeholders and the financing institutions.

Here the management needs assessment indicates that the status of management and institutional development in the case is generally poor and needs to be significantly improved in all strategic areas (*Total Management Score* of 1.0; scores of the key actions varying between 0 and 1.7, see Section 6.2). In addition to this wide demand there are specific needs considered as the areas of importance in defining the project. Some of those areas are of particular interest for some stakeholders. Related measures can make those stakeholders supporters of the project, which would help to achieve the planned impact of the project more easily.

Areas of importance relate to improving water availability, e.g. through the introduction of effective wastewater reuse schemes (Key Action 8: Reuse management). Related activities must go hand in hand with substantial awareness-raising of potential users, e.g. farmers (Key Action 10: Awareness raising). Furthermore, the unclear role of the municipalities in the future provision of sanitation services and other water related services needs to be clarified which mainly means administration setting (Key Action 3: Administration setting). Other areas of importance are the introduction of strategic management and development of the service providers including the set-up of a sanitation utility besides the existent water units (Key Action 4: Utility management and development); and in addition, the introduction of effective CRM (Key Action 9: CRM), staff capacity building (Key Action 5: HR capacity building), and the improvement of both cost efficiency and revenue generation for a better financing of O&M (Key Action 6: Financing).

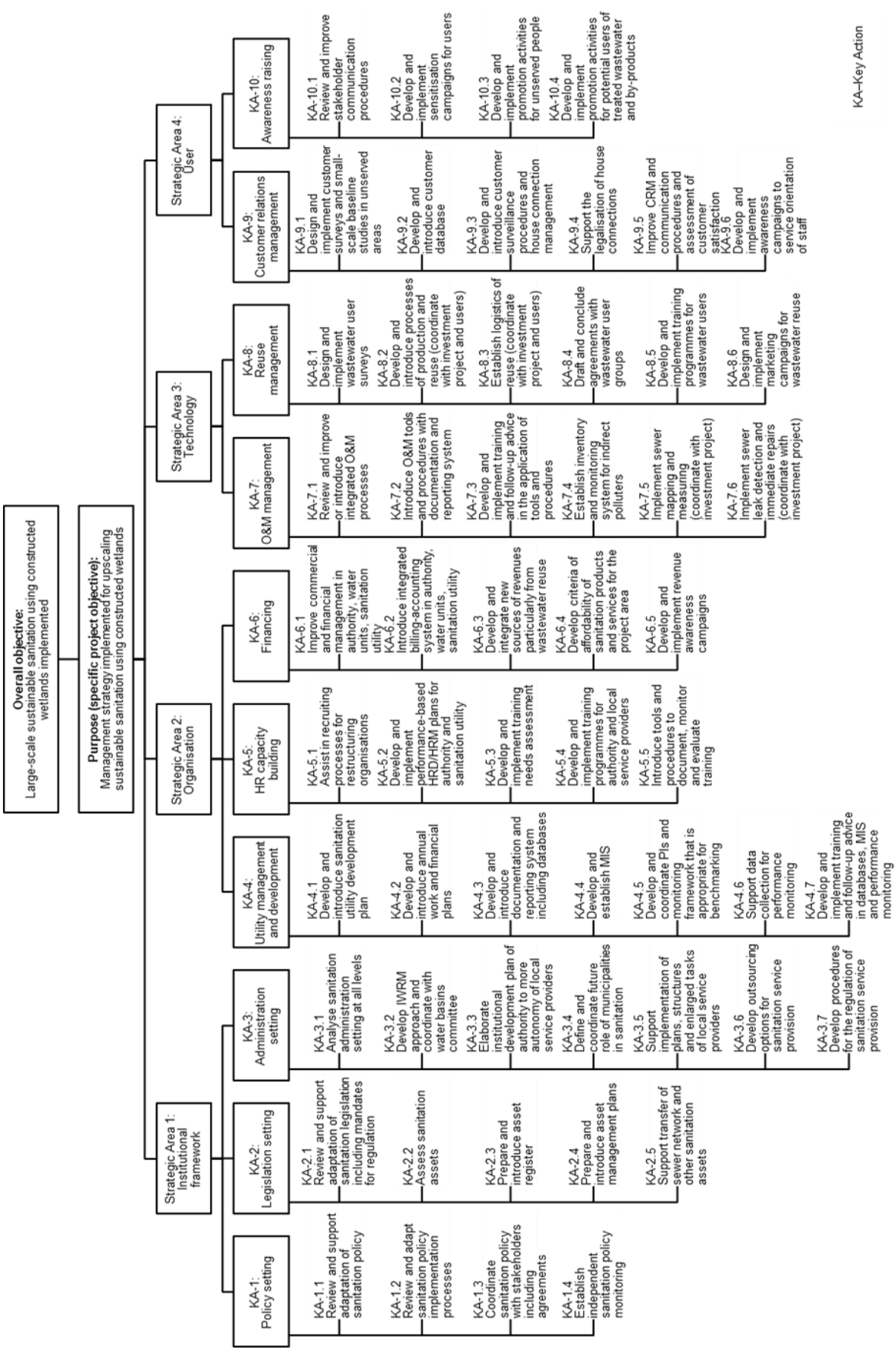


Figure 6.5: Strategic action plan

6.4.3 Project definition

See Appendix B.4 for a **project profile** as a one-page data sheet summarising the project definition and estimated project costs.

Project data:

Project title: TA in implementing a management strategy for upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region.

Project No.: Case-1

Project objectives and expected results are derived from the general strategic objectives in Section 3.3 as well as the adapted strategy map and the outcome of the management needs assessment in Section 6.2. During the project preparation phase those objectives and expected results need to be refined and specified, possibly with further sub-objectives.

Overall objective: Sustainable sanitation using constructed wetlands implemented on a large scale in a semi-arid Middle Eastern region.

Purpose (specific project objective): Management strategy implemented for upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region.

Result 1: Institutional framework supportive (Strategic Area 1 implemented).

Result 2: Organisation effective (Strategic Area 2 implemented).

Result 3: Technology effective (Strategic Area 3 implemented).

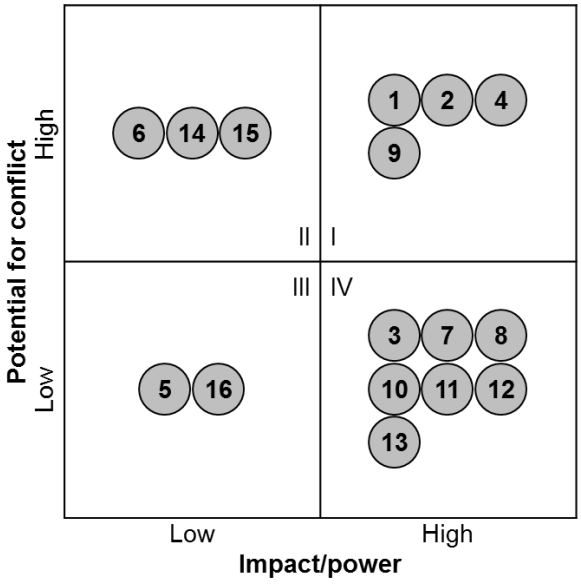
Result 4: Users cooperative (Strategic Area 4 implemented).

Project context is challenging considering the complexity and comprehensiveness of the planned strategic changes and the low development status of the country. The success of the project significantly depends on the successful management of the project influencing factors. Those can be technical and social and bear threats and opportunities. Analysing and assessing those factors during project preparation and managing it effectively during project implementation helps to take them into consideration in the sense of the project.

Technical factors relate to budget, logistics, technical equipment, staff availability, utility culture, local media and others. A detailed analysis of those factors is left to the project preparation phase.

Stakeholders are the social factors of the project, i.e. those people or groups that will be participating, or interested in the project, or influenced by the project results. There are 16 key stakeholders including the minister responsible for sanitation, the general director and the department heads of the water and sanitation authority, the chiefs of the local water units, the heads of the municipalities, the director of the future sanitation utility (to be established), staff of the project management unit, the sanitation infrastructure projects, the strategic management unit, and the management committee, the project manager of this project, responsible staff of the financing institution and of other donors, user groups such as farmers, associations, other NGOs and users including the poor. The list can be extended and needs to be refined during project preparation.

Figure 6.6 illustrates an estimation of the individual relations of impact or power and potential for conflict for each of the 16 stakeholders in a stakeholder portfolio. Suitable measures are required during the project preparation and implementation to move stakeholders from the quadrants I and II into III and IV. Identifying and winning promotors of the project can be very helpful reaching those targets.



Project stakeholders:

1. Ministry responsible for sanitation (minister),
2. Water and sanitation authority (general director),
3. Water and sanitation authority (head of responsible department),
4. Water and sanitation authority (heads of other departments),
5. Water units (chiefs),
6. Municipalities (heads),
7. Sanitation utility (to be established, director),
8. Project management unit (head),
9. Sanitation infrastructure projects (project manager),
10. Strategic management unit (head)
11. Management committee (head),
12. Technical assistance project (project manager, this project),
13. Financing institution (project officer),
14. Other donors,
15. Farmers/associations,
16. Other NGOs and users

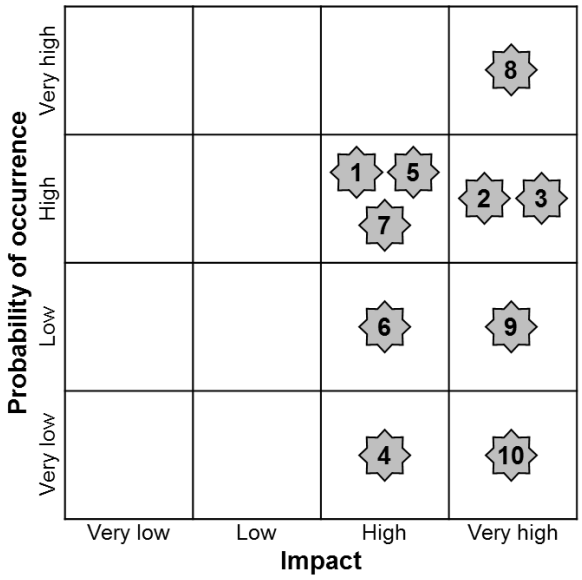
Figure 6.6: Stakeholder portfolio

Project risks that influence the implementation of the project and the achievement of the project objectives need to be identified and managed to ensure an overall sustainable impact. Risks need to be identified during the project preparation phase and regularly updated and monitored during the implementation phase. Possible actions are the preparation of a risk management plan which includes appropriate risk mitigation measures. In this project risks mainly relate to the general delay of development in the country that occur likewise in the sector, the hierarchical and time-consuming

decision-making processes in daily operation and an inefficient organisation structure and the general lack of sufficiently qualified staff in the sector. The identified risks are divided in general risks that relate to the overall objective and specific risks that relate to the specific project objective.

Figure 6.7 illustrates an estimation of the impact and probability of occurrence of the identified risks in a risk portfolio. All risks are estimated to have a high or very high impact on the project. The probability of occurrence varies along the entire scale from very low to very high.

Risks identified for the overall objective (numbered 1 to 5) relate mainly to a delay in the reform process including necessary legal changes, administration setting, development of utilities as well as the allocation of funds due to bureaucratic and time-consuming procedures and the proper and timely implementation of the parallel sanitation infrastructure projects. Risks identified for the specific project objective (numbered 6 to 10) mainly relate to set-up and efficient support of the project management structures, the availability of staff, the acceptance of key staff for the change processes and their participation in it, the coordination with other projects and programmes in the sector as well as an early termination of the project due to lack of progress and insufficient achievements.



Risks to the overall objective:

1. Overall reform process delayed;
2. Legal changes for more cost efficiency, revenue generation (tariff settings) and wastewater reuse delayed
3. Administration setting and utility development at local level delayed;
4. Funds not timely and regularly allocated;
5. Investment projects for the construction of sanitation infrastructure delayed or not completed;

Risks to the specific project objective:

6. Management committee or project management unit not established or maintained or not actively supporting the project;
7. Key staff of local service providers lacks acceptance for change processes and participation in it;
8. Staff not sufficiently available at necessary qualification especially at local level;
9. Project implemented concurrently with other projects or coordination of complementary projects not effective;
10. Early close of project due to lacking progress and insufficient achievements.

Figure 6.7: Risk portfolio

Project organisation is illustrated in Figure 6.8. The chart comprises the main project stakeholders, their main responsibilities as well as most the important links between them that are necessary to implement the project in a professional way and so sustain project achievements.

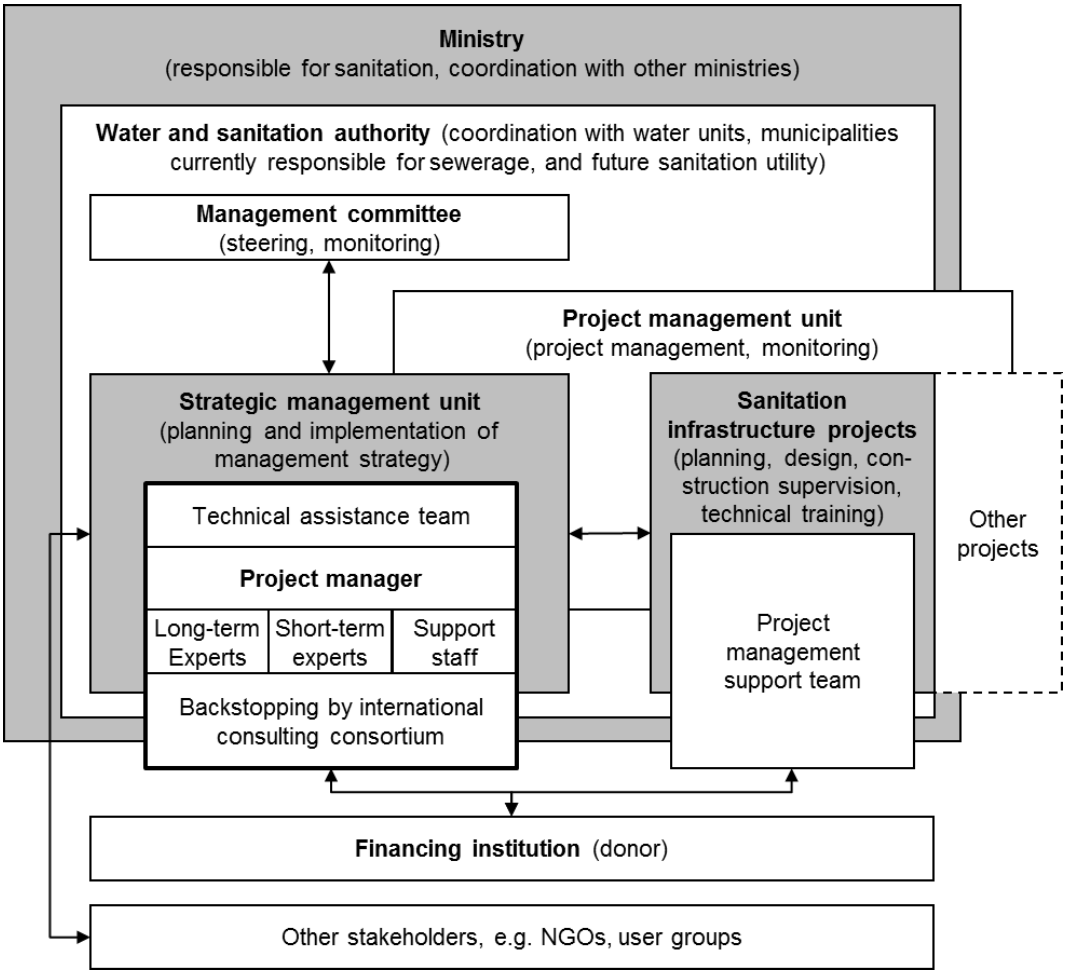


Figure 6.8: Organisation of the project

The ministry responsible for sanitation will need assume the overall responsibility for the project. It will transfer the task of project implementation to the water and sanitation authority which will mainly manage the contracts. The authority has established a project management unit that manages the implementation of the project as well as the parallel implementation of the sanitation infrastructure projects and other large projects that are optional under the authority's responsibility. The unit is supported by an international consulting consortium to help and build capacity. For embedding strategy and management project in the authority and to prepare for independent follow up of strategy implementation, the authority will set up a strategic management unit, or an "Office of Strategy Management" (Kaplan and Norton 2005, 2008) with responsibility for the planning, communication and implementation of strategy. The unit or office will receive support from a TA-team, e.g. assigned by an international consulting consortium.

The financing institution will be responsible for contract management and administration. The water units responsible for water supply, the municipalities still responsible for sewerage and the future sanitation utility are stakeholders and beneficiaries of the project with tasks assigned as required and reasonable. A management committee that is shortly to be established will steer and monitor the implementation of the project and hence the initial steps of strategy implementation.

Further details of project organisation, e.g. required resources, job descriptions or management procedures need to be specified during project preparation. The TA-team thereby needs to assist project stakeholders and the strategic management unit early on in the development of the organisational set-up and assessment of HR to manage the project in a professional way. After the organisation and management structure of the project and responsibilities have been defined, coordination and communication procedures will have to be determined and documented during the project preparation phase.

Project communication is basically necessary to inform the stakeholders about the project and to sensitise and raise awareness of the planned changes and the need for them. That refers also to the staff of the beneficiary organisations, e.g. authorities and operational units. Communication rules and requirements should be planned and documented in a communication matrix during project preparation.

Project coordination with related programmes and projects in the region is necessary as there are several active donors and organisations. The coordination will be to identify identical objectives, ensure complementary or neutral objectives and avoid concurring or conflicting objectives (see also Section 3.5). Coordination will thereby not only be important for the successful implementation of this project, but also for sector objectives. It will be necessary to find a joint approach to monitor sector milestones among the different stakeholders and interventions, to divide responsibilities. Where applicable, the project or parts of it should be integrated into other measures in the region.

Project phases structure the strategy implementation and support measures. Each phase starts and ends with a milestone. There are general project phases pertaining to the logical context of project management and specific phases pertaining to the technically substantial activities of strategy implementation. No. and type of phases depend on the project but can also depend on regulations of the financing institution. This phase planning is sequential. It must be refined during project preparation so that phases may partially overlap.

There are five main phases:

- *Phase P-1: Project inception phase*—comprises the formal project start, organisation, mobilisation of the team as well as analyses, elaboration of a detailed project plan and project handbooks and a kick-off meeting (3 months);

- *Phase P-2: Strategy preparation phase*—comprises the preparation of the strategy including initial analyses and discussion and agreements with stakeholders, especially the responsible ministries, the water and sanitation authority, water units, municipalities and potential users of treated wastewater; furthermore, the clarification of the organisational set-up and responsibilities for sanitation as well as the definition of main business processes in the new sanitation utility and preparation of workflows (18 months);

- *Phase P-3: Strategy implementation phase*—comprises the core activities of strategy implementation; all activities relate to Key Action 1 to Key Action 10; activities and key actions are clustered in the four strategic areas, i.e. the institutional framework, organisation, technology and users; there will be sub-phases for work packages comprising analyses, assessments, development, coordination and implementation of measures; those need to be specified during project preparation (48 months);

- *Phase P-4: Strategy follow-up phase*—comprises intermittent support by the project team to follow up changes and measures and to assess their impact (12 months);

- *Phase P-5: Project completion phase*—comprises the formal completion of the project according to contracts, analysis of results and costs, preparation of lessons learned, dissolving of the project organisation, reallocation of resources as well as final reporting; running measures and further strategy implementation need to be handed over to the responsible organisation (3 months).

The overall project is defined to last 7 years. In practice, however, the duration will also depend on the parallel development of the sanitation infrastructure.

Project milestones will structure the phases and help monitor the implementation of the project. They are possible points of break, refinement of objectives, and go or no go decisions pertaining to the future project measures or even the entire project. In the management strategy, the target for each key action is generally score No. 3 of the related indicator. However, in some projects those targets will not be reachable. More appropriate and reachable targets could then be score No. 2 or even score No. 1 as a first step in the development. In such a case, however, sufficient overall impact of a project needs to be ensured.

There are six major milestones:

- *Milestone M-1: Project approved*—project formally started, e.g. assigned (at the beginning of the project inception phase);
- *Milestone M-2: Project started (kick-off)*—project planned with activities and verifiable indicators; kick-off meeting held (at the end of the project inception phase);
- *Milestone M-3: Strategy prepared*—strategy implementation prepared; initial analyses concluded; key strategic issues discussed and agreed with stakeholders; organisation of sanitation clarified; main business processes and workflows of sanitation defined, customer surveys completed and accounting and billing system introduced (at the end of the strategy preparation phase; *intended results of the parallel investment project: final design and tender are available and approved and procurement process initiated*);
- *Milestone M-4: Strategy implemented*—key strategic actions implemented, i.e. institutional framework and management of the sanitation system improved according to agreed quality standards (at the end of the project implementation phase; further specific milestones are required for each key action; *intended results of the parallel investment project: planned sanitation infrastructure constructed and handed over*);
- *Milestone M-5: Strategy follow-up completed*—follow-up of strategy implementation completed and strategic process handed over to the responsible local organisation (at the end of the follow-up phase);
- *Milestone M-6: Project completed*—project implemented (at the end of the project completion phase).

Figure 6.9 illustrates the defined project phases as bars over the project duration in a project implementation plan and the milestones as diamonds at the beginning and end of each phase. Within 3 months after project inception, the strategy preparation will take 18 months. The main strategy implementation phase will last 48 months and the follow-up measures another 12 months. The completion of the project will again take 3 months. After the TA-project, the strategy implementation needs to be continued by the water and sanitation authority in cooperation with the sanitation utility.

Figure 6.10 illustrates the estimated development of the project costs per phase over the project duration. The costs correspond basically to staff deployment as staffing will be the main cost proportion. The main input of 55% will be required during the strategy implementation phase. Strategy preparation will require 25%, strategy follow-up 15% while the start and completion phase will each require 5%.

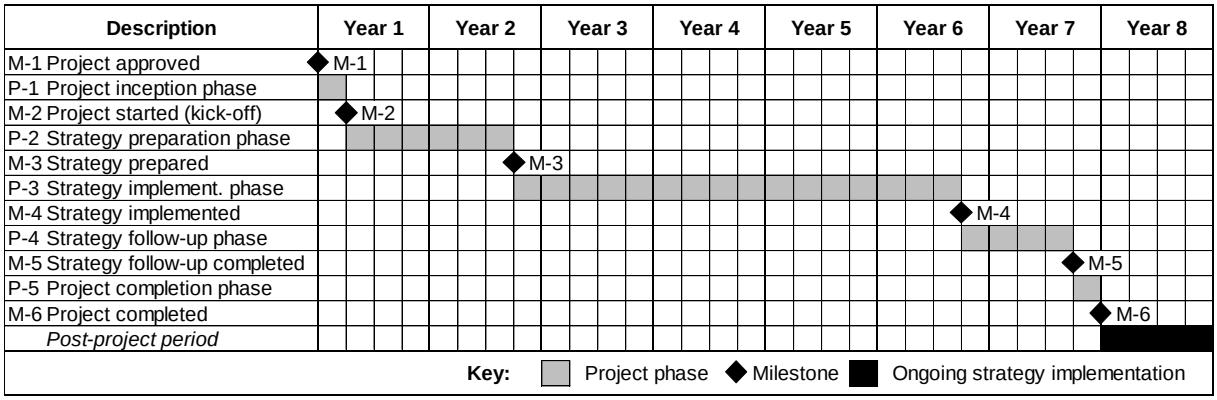


Figure 6.9: Project implementation plan

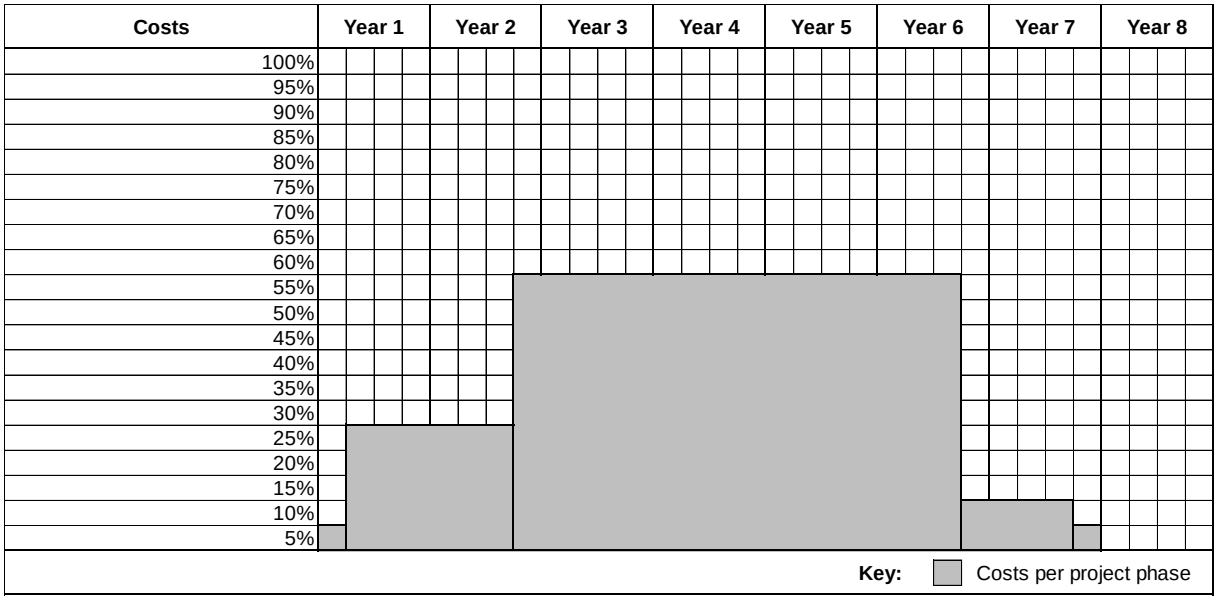


Figure 6.10: Estimated development of the project costs over the project duration—related to the project implementation plan in Figure 6.9

Further milestones need to be brought about by the government and the water and sanitation authority prior to project start. Those milestones basically relate to the institutional framework as well as performance measurement and improvement, and should ensure sufficient preparation of the project and strategy prior to the major investments. Milestones particularly are to relate to the provision of data and information, clarification of the future legal form of the planned sanitation utility, preparation and adoption of land-use plans, opening markets for procurement of essential tools and equipment, introduction of sanitation charges and adaptation of water tariffs, supervision and performance monitoring of sanitation service provision and strengthening capacities for enlarged enforcement of policy. Those milestones need to be planned and agreed upon by all parties including the financing institution in early phases of project preparation, e.g. during a feasibility study.

Further project planning is to be carried out in the later stages of project preparation, e.g. the tendering of related consulting services. Such planning will be need to

comprise a detailed description of the planned activities, the planned staffing as well as working, staffing and time schedules and cost calculations. There is also the need to prepare a financial plan for the project by the financing institution. Further planning will be based on the strategy formulation, strategic action plan and project definition.

Activities are to be planned as work packages that describe objectives, required staffing and responsibilities, timing and duration, relations with other activities, actions and appointments, resources, results and sources of verification, costs, budget, indicators for measuring achievements and risks. The activity planning (work break-down structure) will build the basis of all further project plans including working and staffing schedules and cost calculations. Activities comprise all the necessary technical and management actions to prepare, implement and follow-up the management strategy.

Strategy-related project activities are based on the strategic action plan which is illustrated as an objective tree in Figure 6.5. The plan defines required actions for each key action according to the outcome of the management needs assessment (see Section 6.2). Activities comprise the development of supportive institutional framework, effective organisation and technology and cooperative users. Those technical project activities will be implemented in the strategy preparation phase (P-3), strategy implementation phase (P-4) and strategy follow-up phase (P-5).

Project management activities comprise all the required activities to initialise, define or refine, plan, manage and complete the project according to internationally recognised project management standards (Resultance 2014). They comprise specific coordinating project activities such as support to the establishment and coordination of the management committee or coordination with other donors. In total there are 28 project management activities in the 5 project phases.

During the project inception phase (P-1):

- Initialise project according to contract;
- Refine implementation concept and coordinate strategy with stakeholders;
- Plan project with detailed working, staffing and cost schedules;
- Prepare project organisation and communication structure;
- Mobilise team;
- Support the establishment of management committee;
- Elaborate initial analyses including review of management needs assessment;
- Elaborate and implement stakeholder management measures;
- Elaborate and implement risk management plans.
- Operationalise monitoring and documentation system;
- Organise kick-off meeting.

During the strategy preparation phase (P-3), strategy implementation phase (P-4) and strategy follow-up phase (P-5):

- Review project planning including organisation and methodology and adapt it according to needs;
- Support the coordination of the management committee;
- Organise meetings and workshops with stakeholders, e.g. information meetings, feed-back seminars or joint planning and project review workshops;
- Prepare and submit reports according to contract;
- Prepare and submit internal status reports and technical notes;
- Review and implement risk management plans;
- Review and implement stakeholder management measures;
- Maintain monitoring and documentation systems;
- Monitor and document strategy implementation process, progress and performance.

During the project completion phase (P-4):

- Complete project according to contract;
- Hand over strategy implementation process;
- Analyse results and costs;
- Prepare lessons learned;
- Dissolve project organisation;
- Reallocate resources;
- Elaborate final reports according to contract;
- Organise final debriefing meeting.

Timetable of activities gives a graphical overview of the project planning. It is to illustrate the timing, sequence and duration of the project phases, milestones and activities as well as the planned reports indicating the achievement of the milestones and all planned coordination meetings and workshops. There should be sufficient time for mobilisation and completion of the project.

Staffing needs to be planned according to the planned activities and illustrated in a staffing schedule. All activities in this project need to be implemented by a TA-team of an international consulting consortium with participation of staff of the beneficiary organisations including ministries, the water and sanitation authority and the local service providers. The TA-team will comprise international and local long-term and short-term experts, local support staff and international backstopping support staff, including: international wastewater specialist, reuse expert, CRM specialist and financial expert, other international short-term experts, national organisational specialist, other national short-term experts, and support staff. The beneficiary organisations need to assign sufficiently qualified counterpart staff to implement the project activi-

ties and ensure the integration of all measures in the local organisations right from the beginning of the project.

Costs of the project need to be calculated according to the planning of resources and staffing. Section 6.4.4, however, provides an estimation of the necessary budget based on experience in similar projects.

6.4.4 Budget

The estimated total budget of the defined **TA-project is €6,886,800.** Table 6.3 provides a detailed cost estimation including a description of the individual cost positions. The budget covers eight major cost positions including expatriate and local staff, international travel, local transport, project office, procurements, reports and miscellaneous as well as physical contingencies of 20%. Miscellaneous costs will cover investments in software and hardware, customer surveys, awareness campaigns, training including excursions, workshops and seminars as well as public relations and media. Financial contingencies are not included in the cost estimations and need to be considered in the financial plan of the overall project.

Figure 6.11 illustrates the allocation of estimated costs for the major cost positions, with expatriate staff costs being the largest portion followed by costs for miscellaneous, physical contingencies and local staff.

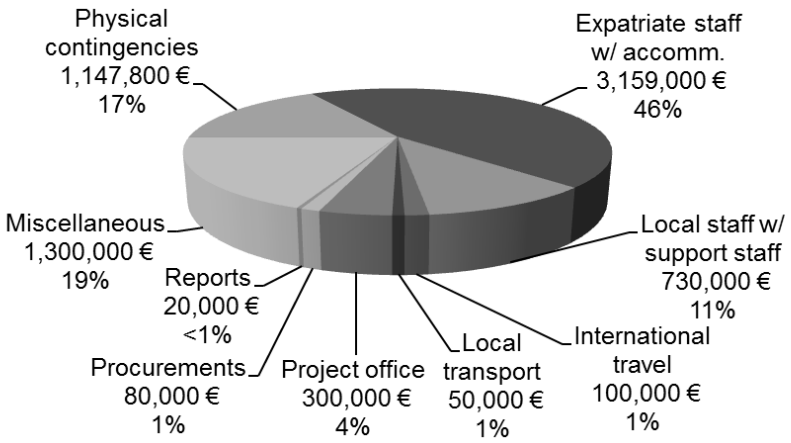


Figure 6.11: Allocation of the estimated TA-project costs

The overall costs of a real project, however, will need to cover both the implementation of the TA-project and the construction or rehabilitation of the technical infrastructure. Besides investments in plants, machines, construction works and other parts of the sanitation system, this also includes the costs for engineering support, often called project management (see Section 1.1.3) including consulting services in planning and design, construction supervision and technical training pertaining to the O&M of machines and plants.

If the costs of the TA-project seem high, it must be borne in mind that it will actually be a relatively small part (e.g. 10-15%) of the overall project cost including costs for engineering support and construction of physical infrastructure, especially for conventional sanitation systems (see Section 1.1.3). The amount of reform and institutional and organisation change, however, is enormous considering the low *Total Management Score* of 1.0 for the system (see Section 6.2) and ambitious objectives of sustainable sanitation at the same time. To reach those objectives substantial professional support will be necessary and justifies those investments depending on cost-benefit-analyses and related political decisions.

Non-conventional sanitation projects leave more degrees of freedom for participation of stakeholders. NGOs, other initiatives and even users can be included in project planning, implementation and O&M to reduce investment, reinvestment and running costs. In a previous study, I developed a corresponding wastewater concept for a smaller model region of 2,500 inhabitants, in a developing country with an arid climate including constructed wetlands (Schlüter 2004). In that concept, I estimated the proportion of user contribution as about 30%.

Participation of stakeholders can thereby also enforce impact, e.g. in sensitisation, awareness raising and agreement building among stakeholders. However, when thinking of alternative approaches to project implementation, it is important to ensure professionalism and effective support as well as learning from other projects and best practice.

Table 6.3: Cost estimation of the TA-project

No.	Position	Description			Sub-total (€)	Total (€)
		Unit (months)	Unit price (€)	Sub-total (€)		
1	Staff					3,889,000
1.1	Expatriate staff				3,159,000	
1.1.1	Team Leader	70	15,000	1,050,000		
1.1.2	Wastewater specialist	60	8,000	480,000		
1.1.3	Reuse expert	36	8,000	288,000		
1.1.4	CRM specialist	24	8,000	192,000		
1.1.5	Financial expert	12	15,000	180,000		
1.1.6	Other short-term international	40	15,000	600,000		
1.1.6	Accommodation	246	1,500	369,000		
1.2	Local staff				730,000	
1.2.1	Organisational specialist	70	4,000	280,000		
1.2.3	Short-term national	40	5,000	200,000		
1.2.4	Support staff	250	1,000	250,000		
2	International travel	Air fares, freight, complementary costs				100,000
3	Local transport	Lease, rent and running costs of vehicles, driver				50,000
4	Project office	Rent, operation, translation				300,000
5	Procurements	Vehicle, equipment, office furniture				80,000
6	Reports	Inception, final and progress reports				20,000
7	Miscellaneous					1,300,000
7.1	Accounting soft- and hardware	Software, hardware, licenses, customising, training			470,000	
7.2	MIS software	Software, licenses, customising, training			20,000	
7.3	Project monitoring software	Software, licenses			10,000	
7.4	Customer surveys				100,000	
7.5	Awareness campaigns				50,000	
7.6	Training	Formal training, excursions			550,000	
7.7	Workshops and seminars	Technical workshops and seminars, kick-off and debriefing meeting			90,000	
7.8	Public relations and media				10,000	
	Total					5,739,000
8	Physical contingencies	20% on total				1,147,800
	Grand total	Financial contingencies to be considered in the financial plan				6,886,800

7 Conclusions

The results of this research suggest that management strategy supports large-scale sustainable sanitation. The management needs assessment, implemented with the new tool, can be integrated into early stages of project planning. The strategy, when introduced within a project and used in daily operation, helps create a supportive institutional framework as well as professional management of the sanitation system related to the organisation, technology and users.

Management strategies in sanitation are needed worldwide especially in developing countries, taking into account the persisting global challenges in sanitation which are highly diverse and inter-sectoral. The particular challenges are low coverage, population growth, urbanisation and informal settling, pressure on water supply, energy and food security, environmental pollution and a high incidence of illnesses and diseases. Frameworks for sanitation thereby develop under fast-changing conditions in many countries which make it particularly difficult to sustain investments. The need for improved research on sanitation and sustainable management is one outcome of the UN Water Decade 2005-2015 and an explicit target of the new SDG. While technologies are available, acknowledged by scientists and practitioners, many countries lack the necessary management capacity and supportive institutional framework for large-scale sustainable sanitation systems. Moreover, there is limited “soft” support to infrastructure investments in many sanitation projects and programmes, although it is widely acknowledged that proper management conditions are needed to successfully implement and sustainably operate sanitation systems.

In line with these shortcomings, the aim of this research was to provide a professional management strategy for large-scale sustainable sanitation and so contribute to the scientific basis for sustainable sanitation and its large-scale implementation. The idea was to approach this work in a transdisciplinary way integrating arguments from both science and practice as well as from different disciplines including engineering and economics.

Result 1 of this research is a management strategy for large-scale sustainable sanitation. It is founded on general statements on mission, vision and values. The analysis of the key strategic issues, including a new view of sustainable sanitation and the strategic objectives, builds the specific strategic framework and underlying theoretical structure of this research. The developed strategy consists of 4 strategic areas and 10 key strategic actions; *Strategic Area 1: Institutional framework* including policy setting, legislation setting and administration setting; *Strategic Area 2: Organisation* including utility management and development, HR capacity building and financing; *Strategic Area 3: Technology* including O&M and reuse management; and *Strategic Area 4: Users* including CRM and awareness raising. The strategy is aimed at both systems and services. It allows for broad management support that goes be-

yond technical training; it includes institutional development. It thus enables a more balanced approach to sanitation projects which, in practice, too often focus on the implementation of technical infrastructure. For project implementation the developed management strategy should accompany infrastructure and financing strategies which were not studied in this research. The strategy thereby supports the implementation of new as well as the improvement of existing systems. A strategy map illustrating all core components gives orientation for the planning and implementation of the strategy. Its use follows recommendations for developing, planning and implementing professional strategies in business.

Result 2 comprises a specification of the key strategic actions from *Result 1* as well as a newly developed set of 30 key strategic indicators and 120 rating criteria. These build an analytical assessment framework that operationalises the strategy. Moreover, this analytical framework allows for assessing management needs in a sanitation system or project according to this strategy as well as evaluating the impact of strategic actions implemented. The identified needs thereby represent *hotspots* of management in a system or project. The strategic indicators are measurable by using a scoring system with total scores for each key action and a *Total Management Score* for the entire system. The rating criteria are distinguishing criteria for evaluating the indicators and thus the management status and strategy impact. The indicators and rating criteria are valid for developing and developed countries without regional restrictions but particularly taking the specific conditions of sanitation in developing countries into account. They aim to provide sustainable sanitation that protects human health and the environment and adds value by the reuse of resources.

Result 3 is an analytical assessment tool that enables informed experts to quickly assess, implement, and monitor management needs and interventions. The basis of the tool is a scorecard that includes the prior identified strategic indicators and rating criteria. The tool is implemented as an interactive Excel file. Thus, it is handy, applicable worldwide and easily adaptable. This dissertation provides templates as a printed version and introduces the use of the tool. The assessment tool can be used for decision-making and planning new and existing systems or projects. An appropriate assessment, however, is based on comprehensive analyses of the specific system or project context. The tool then enables a strategic assessment, helping to understand and develop management framework as well as plan and monitor improvement measures.

Result 4 is a case study of a semi-arid Middle Eastern region. I used it to test and refine the prior results strategy, key actions, indicators, rating criteria and tool, and to illustrate their application. Although implemented as a desk study, the case study shows how the developed strategy can be applied in projects. I used a model case of a typical application scenario of the strategy and shows that the application is possible using the present dissertation for explanation as a side document. The case

study includes a management needs assessment of the case using the tool and an action plan based on the outcome of the assessment. Furthermore, an implementation concept provides a project definition according to project management standards with milestones, time schedule and budget.

The approach with guiding principles, transdisciplinarity and logical framework, as well as process-orientation and the methods used were suitable to carry out this research. The active cooperation between the AWW and GFA under the IPSWaT programme of the BMBF was helpful as well as my own working experience in water and sanitation projects in developing countries. Particularly the transdisciplinary approach brought valuable data and arguments from both science and practice. While the AWW provided the basis of my research, working with GFA provided valuable hints to the problem definition and development of the strategy particularly the identification of realistic indicators and rating criteria. Involvement in the IPSWaT programme enabled international scientific exchange with other PhD students in the research field. Cooperation between science and industry in an international setting provided an enabling research framework which I can recommend to others.

The focus of this research is on developing countries without regional restrictions. Coordination with other research at the AWW and working with GFA in development cooperation in particular brought valuable arguments from both science and practice to approach this research. The idea of transdisciplinarity, i.e. transforming a real-world problem in a scientific problem, solving it with scientifically and developing applicable solutions can be recommended for other comparable research on complex human-environment systems and sustainable development. It seems to be better, however, to approach transdisciplinarity as a group of researchers and practitioners. Also the complexity of the topic calls for group work and different research projects, e.g. as in the Swedish Urban Water programme (Malmqvist *et al.* 2006a). Another suitable approach to develop practice-oriented results is action research (Mattila 2005; Nyborg *et al.* 2008).

Limitations of this work include mainly a lack of time and resources for comprehensive field studies, although I benefited from my own professional field work including data use. A long-term field project can provide more and better data and hence a better framework to develop the management strategy and optimise it. While I used a model case in a developing country with realistic assumptions to test and improve the previously achieved results and to show how it can be applied, the implementation of the case study in a real project was not possible. Also, developing further case studies could validate the developed strategy better.

Furthermore, the development of an integrated strategy for sanitation and water supply seems to be more appropriate instead of exclusively focusing on sanitation. Often differentiation is difficult, e.g. wastewater charges and water prices are usually inte-

grated, thus related management activities and improvement measures at local level need to be jointly planned, e.g. introduction of wastewater charges based on a review and adaptation of water tariffs. Other examples are leak detection programmes that are usually necessary for both sewer and water supply network which need to be co-ordinated to ensure an efficient project implementation. Further integration aspects relate in particular to policy, legislation and administration, regulation, performance monitoring, organisation of integrated service providers. A holistic sector strategy includes all other aspects related to sustainable sanitation including health, waste, energy, water supply, food security as well as urban and rural development.

Key recommendations for further research include:

1. applying this strategy to further case studies for better validation;
2. developing further indicators and rating criteria that support the management needs assessment;
3. conducting studies on strategy implementation and monitoring including their organisation in development projects, e.g. using project management or other strategic units, or an “Office of Strategy Management” with responsibility for the communication and execution of strategy (Kaplan and Norton 2005, 2008);
4. integrating this strategy with other strategies such as financing and infrastructure strategies, water supply and hygiene strategies, or inter-sectoral “nexus” strategies integrating water, energy, food and other related fields.

This research offers multiple benefits. Researchers and students in engineering and non-engineering sciences can use the strategy to improve the development of technical, managerial or other solutions to sustainable sanitation, or initiate new ideas. Operators, consultants and other practitioners can use it to improve the assessment and development of sanitation systems through an improved identification of management needs and related fields of action. Decision-makers and financiers, who plan and coordinate sanitation projects and programmes, can use the strategy to improve the planning and implementation of projects and programmes including sector reform.

Using the strategy and assessment framework in both research and practice will thus provide a basis for a more holistic and professional approach to sanitation particularly in large-scale projects. It helps building the awareness of stakeholders, particularly for non-conventional sanitation solutions and stimulating a realistic discussion on the sustainability of sanitation. Furthermore, it guides practitioners, especially technical planners, who can use the strategy at early stages of project or programme planning and later for monitoring the system. The results of this research thereby help create professional management of large-scale sustainable sanitation and a supportive institutional framework.

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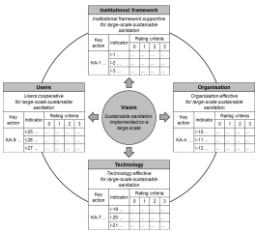
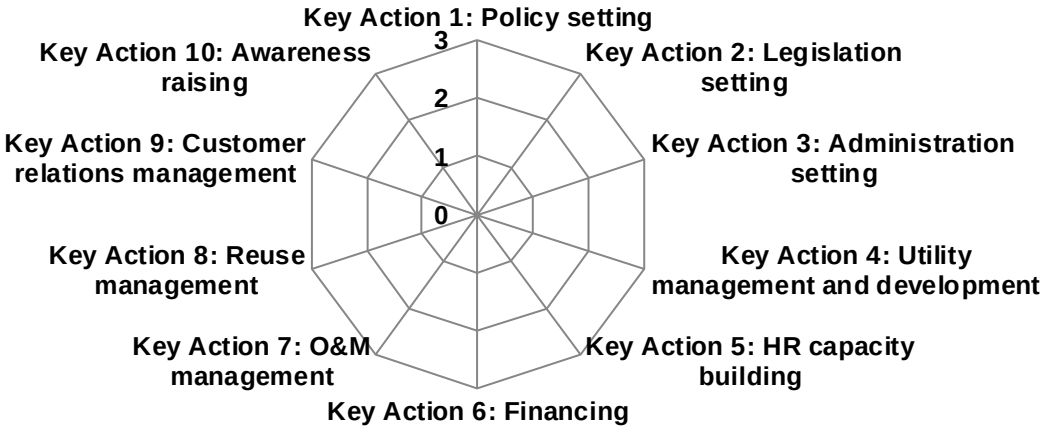
Appendix A—Assessment tool in printed version

The assessment tool comprises of an evaluation sheet and a questionnaire. The evaluation sheet provides instructions on how to use the tool. An electronic version of the tool is available.

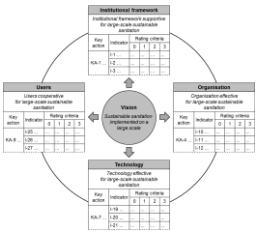
A.1 Evaluation sheet

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Evaluation**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategy**
How to use the tool: *Enter project data; then start with the questionnaire. Score each indicator with 0, 1, 2 or 3; enter the value in the last column or select by dropdown. Total scores are calculated as rounded arithmetic means. For a printed version, mark appropriate scores and enter the values. Calculate total scores and enter them in the questionnaire and evaluation sheet. Plot the values in the charts and draw the graphs.*	**Total Management Score**

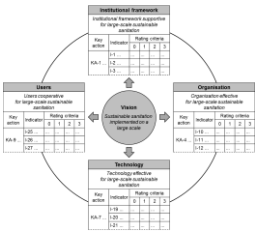


Strategic area	**Key action**	**Score**
Strategic Area 1: Institutional framework	Key Action 1: Policy setting	
	Key Action 2: Legislation setting	
	Key Action 3: Administration setting	
Strategic Area 2: Organisation	Key Action 4: Utility management and development	
	Key Action 5: HR capacity building	
	Key Action 6: Financing	
Straregic Area 3: Technology	Key Action 7: O&M management	
	Key Action 8: Reuse management	
Strategic Area 4: Users	Key Action 9: Customer relations management	
	Key Action 10: Awareness raising	

A.1 Evaluation sheet *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**		**Evaluation**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*		 **Strategy**
Key action	**Indicator**	**Score**
Key Action 1: Policy setting	I-1 Responsibility of politicians	
	I-2 Availability and design of policy	
	I-3 Implementation of policy	
Key Action 2: Legislation setting	I-4 Design and enforcement of legislation	
	I-5 Flexibility of legislation	
	I-6 Regulation of ownership	
Key Action 3: Administration setting	I-7 Integration of sectors and administration	
	I-8 Autonomy of service providers	
	I-9 Regulation of service provision	
Key Action 4: Utility management and development	I-10 Strategic planning and integration	
	I-11 Processes and organisational functions	
	I-12 Performance monitoring	
Key Action 5: HR capacity building	I-13 Strategic approach to HR capacity building	
	I-14 Status of HR, HRM and HRD	
	I-15 Effectiveness of training	
Key Action 6: Financing	I-16 Commercial and financial management	
	I-17 Revenue generation	
	I-18 Affordability of products and services	
Key Action 7: O&M management	I-19 Processes of O&M	
	I-20 Standardisation of tools and procedures	
	I-21 Monitoring of O&M	
Key Action 8: Reuse management	I-22 Processes of production and reuse	
	I-23 Logistics of product delivery	
	I-24 Marketing of reuse	
Key Action 9: Customer relations management	I-25 Management of customer data	
	I-26 Service orientation and customer satisfaction	
	I-27 Management of complaints and suggestions	
Key Action 10: Awareness raising	I-28 Communication with stakeholders	
	I-29 Sensitisation of users	
	I-30 Promotion to potential users	

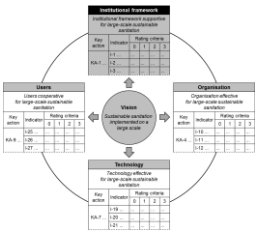
A.1 Evaluation sheet *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Evaluation**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategy**

Score

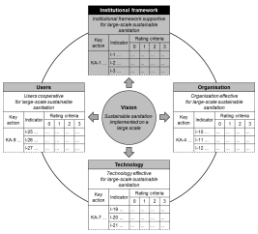
Indicator	0	1	2	3
I-1 Responsibility of politicians				
I-2 Availability and design of policy				
I-3 Implementation of policy				
I-4 Design and enforcement of legislation				
I-5 Flexibility of legislation				
I-6 Regulation of ownership				
I-7 Integration of sectors and administration				
I-8 Autonomy of service providers				
I-9 Regulation of service provision				
I-10 Strategic planning and integration				
I-11 Processes and organisational functions				
I-12 Performance monitoring				
I-13 Strategic approach to HR capacity…				
I-14 Status of HR, HRM and HRD				
I-15 Effectiveness of training				
I-16 Commercial and financial management				
I-17 Revenue generation				
I-18 Affordability of products and services				
I-19 Processes of O&M				
I-20 Standardisation of tools and procedures				
I-21 Monitoring of O&M				
I-22 Processes of production and reuse				
I-23 Logistics of product delivery				
I-24 Marketing of reuse				
I-25 Management of customer data				
I-26 Service orientation and customer…				
I-27 Management of complaints and…				
I-28 Communication with stakeholders				
I-29 Sensitisation of users				
I-30 Promotion to potential users				

A.2 Questionnaire

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 1: Institutional framework**

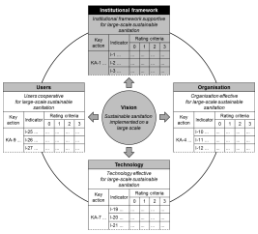
Key Action 1: Policy setting					
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-1 Responsibility of politicians	Sanitation not included in policy	Sanitation included in policy but actions and follow up measures not documented	Sanitation included in policy, actions and follow up measures documented but enforcement of responsibility inadequate	Sanitation included in policy, actions and follow up measures documented, responsibility enforced based on independent monitoring	
I-2 Availability and design of policy	Sanitation policy not available	Sanitation policy available but not accepted by all stakeholders or not approved or not gazetted, or does not contain all elements	Sanitation policy available, accepted by all stakeholders, approved and gazetted but does not contain all elements or does not affect all levels	Sanitation policy available, accepted by all stakeholders, approved and gazetted and contains all elements, and affects all levels	
I-3 Implementation of policy	Sanitation policy not implemented	Sanitation policy implemented but not communicated to stakeholders, and no concrete commitments documented or responsibilities not defined and not monitored	Sanitation policy implemented, communicated to stakeholders but no concrete commitments documented or responsibilities not defined or not monitored	Sanitation policy implemented, communicated to stakeholders, concrete commitments documented, responsibilities defined and monitored	

A.2 Questionnaire *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 1: Institutional framework**

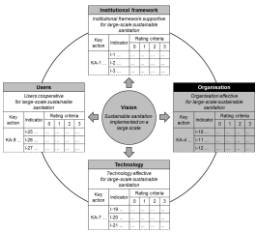
Key Action 2: Legislation setting					
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-4 Design and enforcement of legislation	Sanitation legislation not available	Sanitation legislation available but not adapted to local conditions, outdated or not enforced	Sanitation legislation available, adapted to local conditions, up-to-date and enforced but reuse of wastewater and associated streams limited	Sanitation legislation available, adapted to local conditions, up-to-date and enforced, reuse of wastewater and associated streams possible	
I-5 Flexibility of legislation	Sanitation legislation not available	Sanitation legislation not flexible, adaptation and non-conventional projects almost not possible	Sanitation legislation flexible, adaptation possible but very time-consuming, non-conventional projects limited to small scale	Sanitation legislation flexible, adaptation possible within common project time frame, non-conventional projects possible on a large scale	
I-6 Regulation of ownership	Ownership of assets not regulated	Ownership of assets not passed to service providers or responsible authority	Ownership of assets passed to service providers or responsible authority, status of ownership registered but status not regularly updated	Ownership of assets passed to service providers or responsible authority, status of ownership registered and regularly updated in asset register	

A.2 Questionnaire *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 1: Institutional framework**

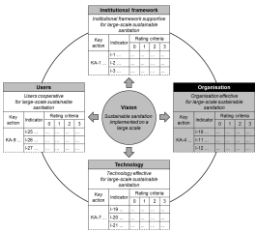
Key Action 3: Administration setting					
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-7 Integration of sectors and administration	Sanitation not reflected in administration	Sanitation reflected in administration, but responsibilities unclear and coordination mechanisms ineffective	Sanitation reflected in administration, responsibilities clear, coordination mechanisms effective, but IWRM not fully implemented	Sanitation reflected in administration, responsibilities clear, coordination mechanisms effective, IWRM fully implemented	
I-8 Autonomy of service providers	Sanitation service provision not delegated to local service provider	Sanitation service provision delegated to local service provider, but provider has almost no autonomy	Sanitation service provision delegated to local service provider but provider has limited autonomy	Sanitation service provision delegated to local service provider, provider has full autonomy	
I-9 Regulation of service provision	Sanitation service provision not regulated	Sanitation service provision regulated on the basis of a legal mandate but not for systems of all scales or regulatory institution has no autonomy or no enforcing power	Sanitation service provision regulated on the basis of a legal mandate but not for systems of all scales or regulatory institution has limited autonomy or limited enforcing power	Sanitation service provision regulated on the basis of a legal mandate for systems of all scales, regulatory institution has full autonomy and enforcing power	

A.2 Questionnaire *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 2: Organisation**

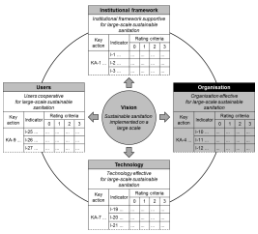
Key Action 4: Utility management and development					
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-10 Strategic planning and integration	Strategic planning tools not available, sanitation services not monitored, integration of projects limited	Strategic planning tools available, sanitation services monitored, but not improved for sustainability, coordination and monitoring mechanisms not effective, integration of projects limited	Strategic planning tools available, sanitation services monitored and improved for sustainability, but coordination and monitoring mechanisms not effective or integration of projects limited	Strategic planning tools available, sanitation services monitored and improved for sustainability, coordination and monitoring mechanisms effective and integration of projects effective	
I-11 Processes and organisational functions	Processes and functions not developed, minor or no sanitation services delivered	Processes and functions extremely bureaucratic and control-oriented, not monitored or not regularly improved, or decision-making centralised	Processes and functions bureaucratic, or not monitored or not regularly improved, decision-making decentralised	Processes and functions unbureaucratic, monitored and regularly improved, decision-making decentralised	
I-12 Performance monitoring	Performance of sanitation system not monitored	Performance indicators introduced, but performance of sanitation system not monitored or not documented	Performance indicators introduced, performance of sanitation system monitored and documented but data not integrated with MIS	Performance indicators introduced, performance of sanitation system monitored and documented, data integrated with MIS	

A.2 Questionnaire *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 2: Organisation**

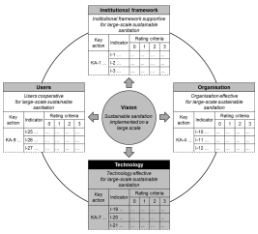
Key Action 5: HR capacity building					
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-13 Strategic approach to HR capacity building	HR capacity building not carried out at local level	HR capacity building carried out at local level but activities not linked up with utility development strategy	HR capacity building carried out at local level, activities linked up with utility development strategy but not with sector strategy	HR capacity building carried out at local level, activities linked up with utility development strategy and sector strategy	
I-14 Status of HR, HRM and HRD	HR extremely limited at necessary qualification, training rarely provided	HR limited at necessary qualification, training provided but not according to needs, HR not developed as overall concept	HR available at necessary qualification, training provided according to needs, but HR not developed as overall concept, or staff and career planning not performance-based or data not integrated with MIS	HR available at necessary qualification, training provided according to needs, HR developed as overall concept, staff and career planning performance-based, data integrated with MIS	
I-15 Effectiveness of training	Training not provided	Formal or on-the-job training provided but training needs not assessed	Formal or on-the-job training provided, training needs assessed but training not monitored or not evaluated	Formal or on-the-job training provided, training needs assessed, training monitored and evaluated	

A.2 Questionnaire *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 2: Organisation**

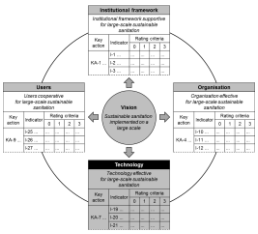
Key Action 6: Financing					
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-16 Commercial and financial management	Processes of commercial and financial management not developed	Processes of commercial management developed to basic level with billing and collection but processes of financial management not developed or not effective	Processes of commercial and financial management developed with billing, collection and accounting functions but software support not effective, or data not integrated with MIS	Processes of commercial and financial management developed with billing, collection, financial and accounting functions, software support effective, data integrated with MIS	
I-17 Revenue generation	Revenues not generated	Revenues generated but not to recover full costs of O&M, financing and major repairs, or many customers not able or not willing to pay	Revenues generated to recover nearly full costs of O&M, financing and major repairs, customers able and willing to pay but new sources of revenues not developed	Revenues generated to recover full costs of O&M, financing and major repairs, customers able and willing to pay and new sources of revenues developed	
I-18 Affordability of products and services	Sanitation products or services not available	Sanitation products and services available but not affordable for all users and potential users	Sanitation products and services available and affordable for all users and potential users but criteria of affordability not assessed locally	Sanitation products and services available and affordable for all users and potential users, criteria of affordability assessed locally	

A.2 Questionnaire *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 3: Technology**

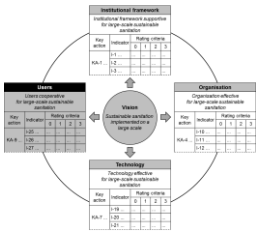
Key Action 7: O&M management					
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-19 Processes of O&M	Processes of O&M not developed	Processes of O&M developed to basic level but responsibilities not defined or organisation not flexible or workflows, documentation, reporting or monitoring not effective	Processes of O&M developed but not fully integrated, responsibilities defined, but organisation not flexible, or workflows, documentation, reporting or monitoring not effective	Processes of O&M developed and fully integrated, responsibilities defined, organisation flexible and workflows, documentation, reporting and monitoring effective	
I-20 Standardisation of tools and procedures	O&M tools and procedures not available, staff and others involved in O&M not sensitised	O&M tools and procedures available but not standardised in the utility, staff and others involved in O&M not fully sensitised	O&M tools and procedures available, standardised in the utility but not to national or international regulations and not appropriate for benchmarking, staff and others involved in O&M sensitised	O&M tools and procedures available, standardised in the utility and to national or international regulations and appropriate for benchmarking, staff and others involved in O&M sensitised	
I-21 Monitoring of O&M	O&M not monitored	Indicators for O&M introduced but O&M not monitored or not documented	Indicators for O&M introduced, O&M monitored and documented but data not integrated with internal systems	Indicators for O&M introduced, O&M monitored and documented, data integrated with internal systems	

A.2 Questionnaire *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 3: Technology**

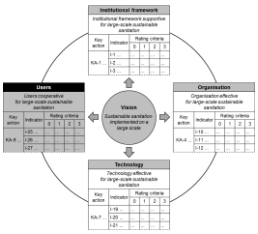
Key Action 8: Reuse management					
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-22 Processes of production and reuse	Processes of production and reuse not developed, health risks cannot be excluded	Processes of production and reuse limited, not effective, not integrated with O&M or not coordinated with processes of users, health risks can usually be excluded but quality control not effective	Processes of production and reuse developed, but not fully effective, not fully integrated with O&M or not fully coordinated with processes of users, health risks can be excluded but quality control not fully effective	Processes of production and reuse effective, fully integrated with O&M and fully coordinated with processes of users, health risks can be excluded, quality control effective	
I-23 Logistics of product delivery	Logistics do not allow for delivery of products	Logistics allow for delivery of products but products not available to users in right composition, place or time	Logistics allow for delivery of products but products not fully available to users in right composition, place or time	Logistics allow for delivery of products, products fully available to users in right composition, place and time	
I-24 Marketing of reuse	Products and services not available	Products and services available but poor in quality or quantity, prices and charges not affordable for users or not cost-covering, places of production and use not sufficient, promotion not effective	Products and services available but not excellent or prices and charges not affordable for users or not cost-covering or places of production and use not sufficient or promotion not effective	Products and services available and excellent, prices and charges are affordable users and cost-covering, places of production and use sufficient, promotion effective	

A.2 Questionnaire *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 4: Users**

Key Action 9: Customer relations management					
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-25 Management of customer data	Customers not known, customer data not adequately collected	Customers partly known, irregular customer surveillance, no customer database in use	Customers known, regular customer surveillance, customer database in place and regularly updated but customer data not linked up with MIS	Customers known, regular customer surveillance, customer database in place and regularly updated, customer data linked up with MIS	
I-26 Service orientation and customer satisfaction	Staff not oriented to service or customer satisfaction not assessed	Staff oriented to service but processes and organisational functions to assess customer satisfaction ineffective, satisfaction rarely assessed	Staff oriented to service and customers, processes and organisational functions to assess customer satisfaction effective, satisfaction irregularly assessed	Staff oriented to service and customers, processes and organisational functions to assess customer satisfaction effective, satisfaction regularly assessed	
I-27 Management of complaints and suggestions	Complaints and suggestions not received	Complaints and suggestions received but No. of filings not reasonable, filings not recorded, not processed, not analysed or not reported	Complaints and suggestions received, No. of filings reasonable, filings recorded, processed, analysed and reported but no timely response to filings	Complaints and suggestions received, No. of filings reasonable, filings recorded, processed, analysed and reported, timely response to filings	

A.2 Questionnaire *(continued)*

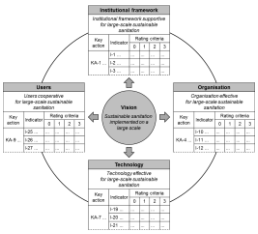
Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: **Project No.:** **Date:** **Name:** **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 4: Users**

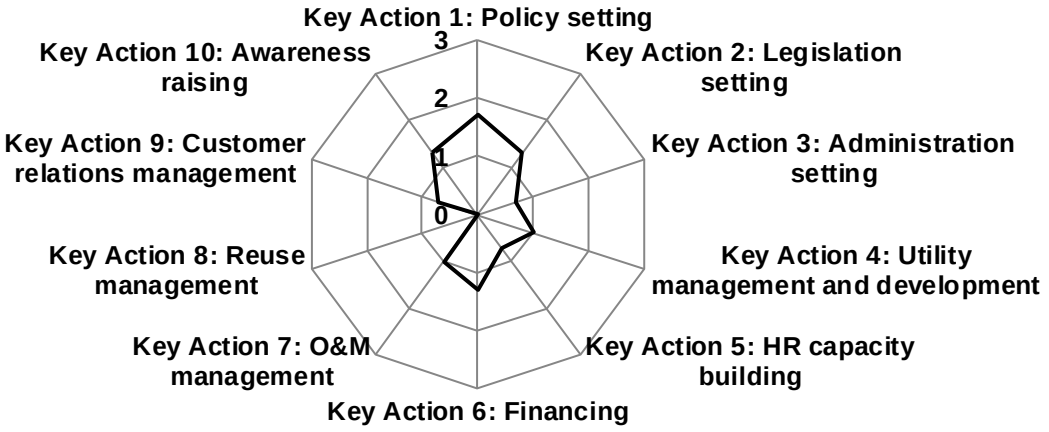
Key Action 10: Awareness raising					
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-28 Communication with stakeholders	Stakeholders not regularly informed about sanitation activities, almost no communication	Stakeholders regularly informed about sanitation activities but communication ineffective	Stakeholders regularly informed about sanitation activities, communication effective but stakeholders not involved in decision-making	Stakeholders regularly informed about sanitation activities, communication effective, stakeholders involved in decision-making	
I-29 Sensitisation of users	People not willing to use improved sanitation facilities and not willing to change behaviour	People willing to use improved conventional sanitation facilities, e.g. water toilets, people not willing to change behaviour	People willing to use improved modern conventional sanitation facilities, e.g. water-saving toilets and improved latrines, people willing to change behaviour but not pay more for sustainable services	People willing to use improved innovative sanitation facilities, e.g. water saving toilets, water free toilets, urine diverting toilets, people willing to change behaviour and pay more for sustainable services	
I-30 Promotion to potential users	Potential users not informed about sanitation activities	Potential users not adequately informed about sanitation activities, no promotion activities carried out or activities not demand-oriented	Potential users adequately informed about sanitation activities, promotion activities carried out demand-oriented but not for sustainable sanitation	Potential users adequately informed about sanitation activities, promotion activities carried out demand-oriented and for sustainable sanitation	

Appendix B—Output tables of the case study

The output tables comprise the completed evaluation sheet and questionnaire, comments on the assessment of indicators as well as a one-page project profile of the implementation concept.

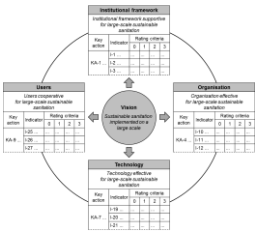
B.1 Evaluation sheet completed

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Evaluation**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategy**
How to use the tool: *Enter project data; then start with the questionnaire. Score each indicator with 0, 1, 2 or 3; enter the value in the last column or select by dropdown. Total scores are calculated as rounded arithmetic means. For a printed version, mark appropriate scores and enter the values. Calculate total scores and enter them in the questionnaire and evaluation sheet. Plot the values in the charts and draw the graphs.*	**Total Management Score** **1.0**



Strategic area	Key action	Score
Strategic Area 1: Institutional framework	Key Action 1: Policy setting	1.7
	Key Action 2: Legislation setting	1.3
	Key Action 3: Administration setting	0.7
Strategic Area 2: Organisation	Key Action 4: Utility management and development	1.0
	Key Action 5: HR capacity building	0.7
	Key Action 6: Financing	1.3
Straregic Area 3: Technology	Key Action 7: O&M management	1.0
	Key Action 8: Reuse management	0.0
Strategic Area 4: Users	Key Action 9: Customer relations management	0.7
	Key Action 10: Awareness raising	1.3

B.1 Evaluation sheet completed *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**		**Evaluation**
Project titel:	Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region	
Project No.:	Case study	
Date:	2015-10-07	
Name:	Thoralf Schlüter	
Key to scores:	*0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	**Strategy**

Key action	**Indicator**	**Score**
Key Action 1: Policy setting	I-1 Responsibility of politicians	**2**
	I-2 Availability and design of policy	**1**
	I-3 Implementation of policy	**2**
Key Action 2: Legislation setting	I-4 Design and enforcement of legislation	**1**
	I-5 Flexibility of legislation	**2**
	I-6 Regulation of ownership	**1**
Key Action 3: Administration setting	I-7 Integration of sectors and administration	**1**
	I-8 Autonomy of service providers	**1**
	I-9 Regulation of service provision	**0**
Key Action 4: Utility management and development	I-10 Strategic planning and integration	**1**
	I-11 Processes and organisational functions	**1**
	I-12 Performance monitoring	**1**
Key Action 5: HR capacity building	I-13 Strategic approach to HR capacity building	**0**
	I-14 Status of HR, HRM and HRD	**1**
	I-15 Effectiveness of training	**1**
Key Action 6: Financing	I-16 Commercial and financial management	**1**
	I-17 Revenue generation	**1**
	I-18 Affordability of products and services	**2**
Key Action 7: O&M management	I-19 Processes of O&M	**1**
	I-20 Standardisation of tools and procedures	**1**
	I-21 Monitoring of O&M	**1**
Key Action 8: Reuse management	I-22 Processes of production and reuse	**0**
	I-23 Logistics of product delivery	**0**
	I-24 Marketing of reuse	**0**
Key Action 9: Customer relations management	I-25 Management of customer data	**1**
	I-26 Service orientation and customer satisfaction	**0**
	I-27 Management of complaints and suggestions	**1**
Key Action 10: Awareness raising	I-28 Communication with stakeholders	**1**
	I-29 Sensitisation of users	**2**
	I-30 Promotion to potential users	**1**

B.1 Evaluation sheet completed *(continued)*

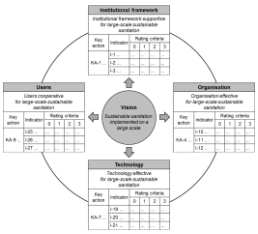
Management needs assessment
Analytical framework and management strategy for large-scale sustainable sanitation

Evaluation

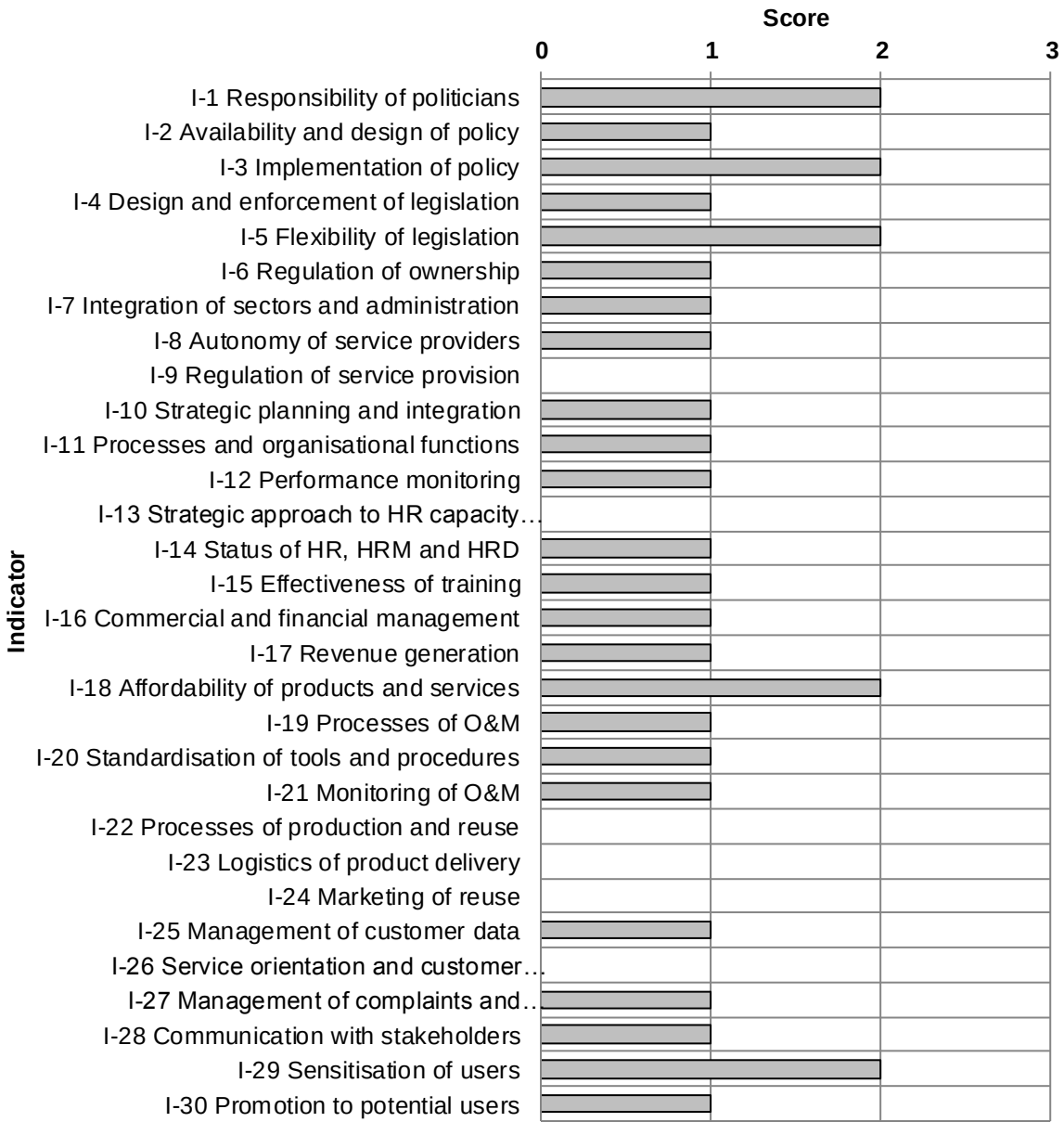
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region

Project No.: Case study
Date: 2015-10-07
Name: Thoralf Schlüter

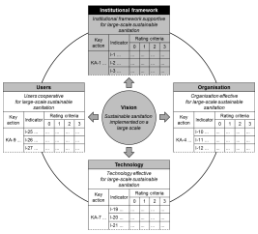
Key to scores: *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*



Strategy

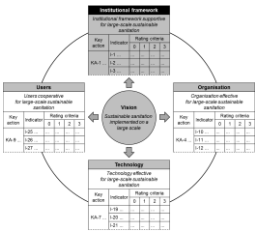


B.2 Questionnaire completed

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 1: Institutional framework**

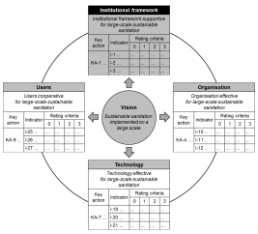
Key Action 1: Policy setting					**1.7**
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-1 Responsibility of politicians	Sanitation not included in policy	Sanitation included in policy but actions and follow up measures not documented	Sanitation included in policy, actions and follow up measures documented but enforcement of responsibility inadequate	Sanitation included in policy, actions and follow up measures documented, responsibility enforced based on independent monitoring	**2**
I-2 Availability and design of policy	Sanitation policy not available	Sanitation policy available but not accepted by all stakeholders or not approved or not gazetted, or does not contain all elements	Sanitation policy available, accepted by all stakeholders, approved and gazetted but does not contain all elements or does not affect all levels	Sanitation policy available, accepted by all stakeholders, approved and gazetted and contains all elements, and affects all levels	**1**
I-3 Implementation of policy	Sanitation policy not implemented	Sanitation policy implemented but not communicated to stakeholders, and no concrete commitments documented or responsibilities not defined and not monitored	Sanitation policy implemented, communicated to stakeholders but no concrete commitments documented or responsibilities not defined or not monitored	Sanitation policy implemented, communicated to stakeholders, concrete commitments documented, responsibilities defined and monitored	**2**

B.2 Questionnaire completed *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 1: Institutional framework**

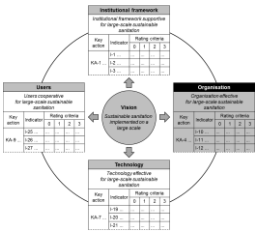
Key Action 2: Legislation setting					**1.3**
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-4 Design and enforcement of legislation	Sanitation legislation not available	Sanitation legislation available but not adapted to local conditions, outdated or not enforced	Sanitation legislation available, adapted to local conditions, up-to-date and enforced but reuse of wastewater and associated streams limited	Sanitation legislation available, adapted to local conditions, up-to-date and enforced, reuse of wastewater and associated streams possible	**1**
I-5 Flexibility of legislation	Sanitation legislation not available	Sanitation legislation not flexible, adaptation and non-conventional projects almost not possible	Sanitation legislation flexible, adaptation possible but very time-consuming, non-conventional projects limited to small scale	Sanitation legislation flexible, adaptation possible within common project time frame, non-conventional projects possible on a large scale	**2**
I-6 Regulation of ownership	Ownership of assets not regulated	Ownership of assets not passed to service providers or responsible authority	Ownership of assets passed to service providers or responsible authority, status of ownership registered but status not regularly updated	Ownership of assets passed to service providers or responsible authority, status of ownership registered and regularly updated in asset register	**1**

B.2 Questionnaire completed *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 1: Institutional framework**

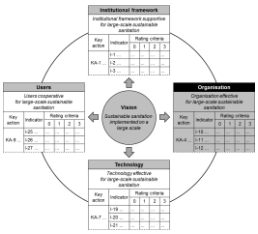
Key Action 3: Administration setting					**0.7**
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-7 Integration of sectors and administration	Sanitation not reflected in administration	Sanitation reflected in administration, but responsibilities unclear and coordination mechanisms ineffective	Sanitation reflected in administration, responsibilities clear, coordination mechanisms effective, but IWRM not fully implemented	Sanitation reflected in administration, responsibilities clear, coordination mechanisms effective, IWRM fully implemented	**1**
I-8 Autonomy of service providers	Sanitation service provision not delegated to local service provider	Sanitation service provision delegated to local service provider, but provider has almost no autonomy	Sanitation service provision delegated to local service provider but provider has limited autonomy	Sanitation service provision delegated to local service provider, provider has full autonomy	**1**
I-9 Regulation of service provision	Sanitation service provision not regulated	Sanitation service provision regulated on the basis of a legal mandate but not for systems of all scales or regulatory institution has no autonomy or no enforcing power	Sanitation service provision regulated on the basis of a legal mandate but not for systems of all scales or regulatory institution has limited autonomy or limited enforcing power	Sanitation service provision regulated on the basis of a legal mandate for systems of all scales, regulatory institution has full autonomy and enforcing power	**0**

B.2 Questionnaire completed *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 2: Organisation**

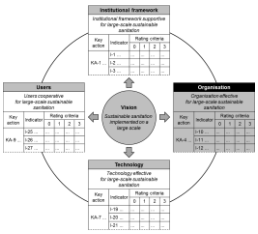
Key Action 4: Utility management and development					**1.0**
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-10 Strategic planning and integration	Strategic planning tools not available, sanitation services not monitored, integration of projects limited	Strategic planning tools available, sanitation services monitored, but not improved for sustainability, coordination and monitoring mechanisms not effective, integration of projects limited	Strategic planning tools available, sanitation services monitored and improved for sustainability, but coordination and monitoring mechanisms not effective or integration of projects limited	Strategic planning tools available, sanitation services monitored and improved for sustainability, coordination and monitoring mechanisms effective and integration of projects effective	**1**
I-11 Processes and organisational functions	Processes and functions not developed, minor or no sanitation services delivered	Processes and functions extremely bureaucratic and control-oriented, not monitored or not regularly improved, or decision-making centralised	Processes and functions bureaucratic, or not monitored or not regularly improved, decision-making decentralised	Processes and functions unbureaucratic, monitored and regularly improved, decision-making decentralised	**1**
I-12 Performance monitoring	Performance of sanitation system not monitored	Performance indicators introduced, but performance of sanitation system not monitored or not documented	Performance indicators introduced, performance of sanitation system monitored and documented but data not integrated with MIS	Performance indicators introduced, performance of sanitation system monitored and documented, data integrated with MIS	**1**

B.2 Questionnaire completed *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 2: Organisation**

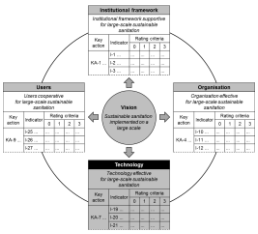
Key Action 5: HR capacity building					**0.7**
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-13 Strategic approach to HR capacity building	HR capacity building not carried out at local level	HR capacity building carried out at local level but activities not linked up with utility development strategy	HR capacity building carried out at local level, activities linked up with utility development strategy but not with sector strategy	HR capacity building carried out at local level, activities linked up with utility development strategy and sector strategy	**0**
I-14 Status of HR, HRM and HRD	HR extremely limited at necessary qualification, training rarely provided	HR limited at necessary qualification, training provided but not according to needs, HR not developed as overall concept	HR available at necessary qualification, training provided according to needs, but HR not developed as overall concept, or staff and career planning not performance-based or data not integrated with MIS	HR available at necessary qualification, training provided according to needs, HR developed as overall concept, staff and career planning performance-based, data integrated with MIS	**1**
I-15 Effectiveness of training	Training not provided	Formal or on-the-job training provided but training needs not assessed	Formal or on-the-job training provided, training needs assessed but training not monitored or not evaluated	Formal or on-the-job training provided, training needs assessed, training monitored and evaluated	**1**

B.2 Questionnaire completed *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 2: Organisation**

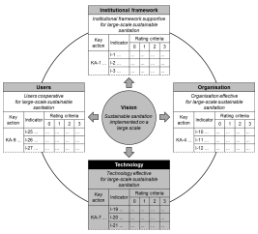
Key Action 6: Financing					**1.3**
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-16 Commercial and financial management	Processes of commercial and financial management not developed	Processes of commercial management developed to basic level with billing and collection but processes of financial management not developed or not effective	Processes of commercial and financial management developed with billing, collection and accounting functions but software support not effective, or data not integrated with MIS	Processes of commercial and financial management developed with billing, collection, financial and accounting functions, software support effective, data integrated with MIS	**1**
I-17 Revenue generation	Revenues not generated	Revenues generated but not to recover full costs of O&M, financing and major repairs, or many customers not able or not willing to pay	Revenues generated to recover nearly full costs of O&M, financing and major repairs, customers able and willing to pay but new sources of revenues not developed	Revenues generated to recover full costs of O&M, financing and major repairs, customers able and willing to pay and new sources of revenues developed	**1**
I-18 Affordability of products and services	Sanitation products or services not available	Sanitation products and services available but not affordable for all users and potential users	Sanitation products and services available and affordable for all users and potential users but criteria of affordability not assessed locally	Sanitation products and services available and affordable for all users and potential users, criteria of affordability assessed locally	**2**

B.2 Questionnaire completed *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 3: Technology**

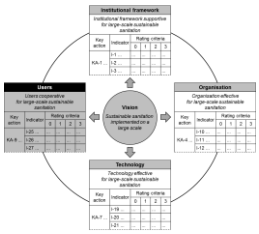
Key Action 7: O&M management					**1.0**
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-19 Processes of O&M	Processes of O&M not developed	Processes of O&M developed to basic level but responsibilities not defined or organisation not flexible or workflows, documentation, reporting or monitoring not effective	Processes of O&M developed but not fully integrated, responsibilities defined, but organisation not flexible, or workflows, documentation, reporting or monitoring not effective	Processes of O&M developed and fully integrated, responsibilities defined, organisation flexible and workflows, documentation, reporting and monitoring effective	**1**
I-20 Standardisation of tools and procedures	O&M tools and procedures not available, staff and others involved in O&M not sensitised	O&M tools and procedures available but not standardised in the utility, staff and others involved in O&M not fully sensitised	O&M tools and procedures available, standardised in the utility but not to national or international regulations and not appropriate for benchmarking, staff and others involved in O&M sensitised	O&M tools and procedures available, standardised in the utility and to national or international regulations and appropriate for benchmarking, staff and others involved in O&M sensitised	**1**
I-21 Monitoring of O&M	O&M not monitored	Indicators for O&M introduced but O&M not monitored or not documented	Indicators for O&M introduced, O&M monitored and documented but data not integrated with internal systems	Indicators for O&M introduced, O&M monitored and documented, data integrated with internal systems	**1**

B.2 Questionnaire completed *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 3: Technology**

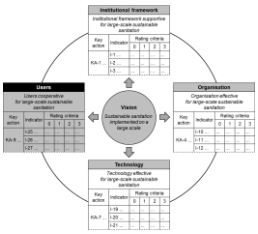
Key Action 8: Reuse management					**0.0**
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-22 Processes of production and reuse	Processes of production and reuse not developed, health risks cannot be excluded	Processes of production and reuse limited, not effective, not integrated with O&M or not coordinated with processes of users, health risks can usually be excluded but quality control not effective	Processes of production and reuse developed, but not fully effective, not fully integrated with O&M or not fully coordinated with processes of users, health risks can be excluded but quality control not fully effective	Processes of production and reuse effective, fully integrated with O&M and fully coordinated with processes of users, health risks can be excluded, quality control effective	**0**
I-23 Logistics of product delivery	Logistics do not allow for delivery of products	Logistics allow for delivery of products but products not available to users in right composition, place or time	Logistics allow for delivery of products but products not fully available to users in right composition, place or time	Logistics allow for delivery of products, products fully available to users in right composition, place and time	**0**
I-24 Marketing of reuse	Products and services not available	Products and services available but poor in quality or quantity, prices and charges not affordable for users or not cost-covering, places of production and use not sufficient, promotion not effective	Products and services available but not excellent or prices and charges not affordable for users or not cost-covering or places of production and use not sufficient or promotion not effective	Products and services available and excellent, prices and charges are affordable for users and cost-covering, places of production and use sufficient, promotion effective	**0**

B.2 Questionnaire completed *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 4: Users**

Key Action 9: Customer relations management					**0.7**
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-25 Management of customer data	Customers not known, customer data not adequately collected	Customers partly known, irregular customer surveillance, no customer database in use	Customers known, regular customer surveillance, customer database in place and regularly updated but customer data not linked up with MIS	Customers known, regular customer surveillance, customer database in place and regularly updated, customer data linked up with MIS	**1**
I-26 Service orientation and customer satisfaction	Staff not oriented to service or customer satisfaction not assessed	Staff oriented to service but processes and organisational functions to assess customer satisfaction ineffective, satisfaction rarely assessed	Staff oriented to service and customers, processes and organisational functions to assess customer satisfaction effective, satisfaction irregularly assessed	Staff oriented to service and customers, processes and organisational functions to assess customer satisfaction effective, satisfaction regularly assessed	**0**
I-27 Management of complaints and suggestions	Complaints and suggestions not received	Complaints and suggestions received but No. of filings not reasonable, filings not recorded, not processed, not analysed or not reported	Complaints and suggestions received, No. of filings reasonable, filings recorded, processed, analysed and reported but no timely response to filings	Complaints and suggestions received, No. of filings reasonable, filings recorded, processed, analysed and reported, timely response to filings	**1**

B.2 Questionnaire completed *(continued)*

Management needs assessment **Analytical framework and management strategy for large-scale sustainable sanitation**	**Questionnaire**
Project titel: Upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region **Project No.:** Case study **Date:** 2015-10-07 **Name:** Thoralf Schlüter **Key to scores:** *0–Undesirable, 1–poor, 2–satisfactory, 3–desirable*	 **Strategic Area 4: Users**

Key Action 10: Awareness raising					**1.3**
Indicator	**Rating criteria**				**Score**
	0	**1**	**2**	**3**	
I-28 Communication with stakeholders	Stakeholders not regularly informed about sanitation activities, almost no communication	Stakeholders regularly informed about sanitation activities but communication ineffective	Stakeholders regularly informed about sanitation activities, communication effective but stakeholders not involved in decision-making	Stakeholders regularly informed about sanitation activities, communication effective, stakeholders involved in decision-making	**1**
I-29 Sensitisation of users	People not willing to use improved sanitation facilities and not willing to change behaviour	People willing to use improved conventional sanitation facilities, e.g. water toilets, people not willing to change behaviour	People willing to use improved modern conventional sanitation facilities, e.g. water-saving toilets and improved latrines, people willing to change behaviour but not pay more for sustainable services	People willing to use improved innovative sanitation facilities, e.g. water saving toilets, water free toilets, urine diverting toilets, people willing to change behaviour and pay more for sustainable services	**2**
I-30 Promotion to potential users	Potential users not informed about sanitation activities	Potential users not adequately informed about sanitation activities, no promotion activities carried out or activities not demand-oriented	Potential users adequately informed about sanitation activities, promotion activities carried out demand-oriented but not for sustainable sanitation	Potential users adequately informed about sanitation activities, promotion activities carried out demand-oriented and for sustainable sanitation	**1**

B.3 Comments on the assessment of indicators

I-1 Responsibility of politicians (score 2). Sanitation is included in policy. There is a regularly updated 5 year plan with actions and follow up measures documented. However, the enforcement of responsibility is not possible because there is no independent monitoring and adequate legal settings are missing.

I-2 Availability and design of policy (score 1). There is a national water policy which includes sanitation. So sanitation policy is available, approved and gazetted, and accepted by many, but not by all, stakeholders. The policy contains many important elements of sanitation, such as political will, stakeholder participation, legal setting, administrative settings, performance targets as well as goals for sanitation coverage, health and environment. However, it lacks other elements, e.g. the concept of ability and willingness to pay for water and sanitation services, economic instruments and the promotion of innovations in sanitation. Especially the promotion of non-conventional approaches and technology options should be included to enable the large-scale implementation of respective projects.

I-3 Implementation of policy (score 2). Sanitation policy is widely communicated to stakeholders with commitments documented and responsibilities defined. However, the implementation of the policy is not professionally monitored. Moreover, staff members in the responsible ministries are much too involved in the implementation of the policy and the daily business of downstream authorities and service providers. This binds resources unnecessarily for tasks that can be delegated and hinders autonomy in sanitation pertaining to the local level.

I-4 Design and enforcement of legislation (score 1). There is a national water law which includes sanitation. So sanitation legislation is available—also adapted to local conditions but not comprehensive and not fully oriented to sustainability goals. Many water related topics are dealt with but others are ignored, e.g. the trend of groundwater depletion in the country. Furthermore, the legislation does not enable the reuse of wastewater and associated streams on a regular legal basis. Part of the existing law is a regulation of conflicting demands giving water supply priority, which is good on the one hand, but limits sanitation projects on the other. The enforcement of existing sanitation laws and regulations is missing to a large extent. There are overlapping functions and time-consuming procedures. The enforcement of laws to avoid the pollution of the water resources and the illegal use of raw wastewater for irrigation and to reduce unauthorised or uncontrolled use of groundwater is hardly possible.

I-5 Flexibility of legislation (score 2). The existing legislation is fairly flexible and adaptable for policy changes, although adaptation is also very time-consuming and bureaucratic ones. As a consequence, non-conventional sanitation projects are limited to small scale, e.g. pilot projects and large-scale implementation of new approaches lacks an enabling legal framework.

I-6 Regulation of ownership (score 1). Ownership needs to be more reflected in the legislative setting. For example, strategic planning faces problems from urbanisation where during feasibility studies areas reserved for WWTPs cannot be secured for project implementation. When implementing the planned sanitation infrastructure, the planned areas are often no longer available, have been taken over by stakeholders in the building sector that have started to construct new buildings. This can also be a problem of law enforcement. However, insufficient legal setting related to ownership will also affect the financial status and therefore autonomy of local service providers. The sewers and other assets of the sanitation system need to be transferred to the responsible service providers. The status of ownership needs to be registered and regularly updated in an asset register and all assets need to be managed by asset management plans.

I-7 Integration of sectors and administration (score 1). Sanitation is reflected in administration but the main responsibilities are unclear and coordination mechanisms are ineffective. The administration is fragmented and responsible for both sanitation and water supply. Institutions have overlapping functions and responsibilities. The lack of coordination among those administration bodies hinders an effective setting of an appropriate framework for sanitation. Accordingly, an integrated approach such as IWRM including the required administrative and legal set-up to manage sanitation, water supply and related services efficiently has not been implemented in the case study area. However, there are IWRM approaches and water efficiency plans in place and partially implemented in other parts of the country and it would be advisable to coordinate with them. Furthermore, there is a committee for water basins which is responsible for managing water resources and solving conflicting issues. Building on that, the creation of one organisation for IWRM within the water basin should be promoted to further reduce conflicts of interests.

B.3 Comments on the assessment of indicators *(continued)*

Closer cooperation within the sanitation administration is needed for implementing professional and standardised sanitation systems that allow for reuse of wastewater. Coordination and memoranda of understanding between ministries form the basis for successful implementation, while cooperation between sanitation service providers and farmers or other users at local level is essential for decentralised management. Arrangements between service providers and users must thereby be feasible, e.g. through a choice of formal contracts or informal agreements (related to Key Action 8). However, the setup of regulated sustainable sanitation requires accompanying measures of awareness raising and confidence building as well as the clarification of acceptable rights and obligations.

I-8 Autonomy of service providers (score 1). Autonomy of local service providers for sanitation and water supply is low caused mainly by low revenue generation, poor asset management and dependence on external investments from the government or donor agencies. Other aspects such as strategic planning and HR cannot be managed independently. That also refers to the accountability of service providers related to operational and financial performance. However, ministries are discussing its future role in sanitation and water supply. There is a will to focus on defining performance targets of service provision, setting rules and standards, controlling implementation and monitoring performance. This should be promoted. The management of service providers would then be able to make more autonomous and commercial decisions. The performance of the service providers could be monitored by indicators and compared with others through national or regional benchmarking.

I-9 Regulation of service provision (score 0). Private sector involvement is another aspect of autonomy but also of regulation. There are plans to reduce the involvement of ministries and authorities in O&M of sanitation to more framework setting duties such as developing policies, setting rules and regulations, controlling and monitoring include the delegation of tasks from public to autonomous semi-public service providers or even private firms. That mainly relates to service delivery, e.g. water metering, water loss reduction, other O&M activities, IT services or consulting and engineering services but also to construction measures. However, in both, more autonomy and increased involvement of private firms requires the set-up of an efficient regulatory institution that has full autonomy and enforcing power, which is not in place. Regulation has thereby to be founded on the basis of a legal mandate and refer to systems and projects of all scales.

I-10 Strategic planning and integration (score 1). Sanitation services are monitored, even though with limited methods, using only basic indicators. There is no continuous improvement for sustainability. Furthermore, coordination mechanisms are bureaucratic and time-consuming rather than effective. Especially investment planning suffers from organisational weaknesses which is crucial for developing new projects as in this case study. Projects are planned along institutional lines and a strategic business planning based on the sector-wide strategy and approaches with crosscutting issues is non-existent.

To improve the status it is necessary to develop and implement related strategies and linkages, to give more autonomy to local service providers, to improve coordination and monitoring and to use professional instruments for all those measures. Suitable instruments are basically business plans and utility development plans but also more advanced instruments such as marketing, incentive functions, and Balanced Scorecard adapted to sanitation e.g. through extending traditional perspectives with goals of environment, public health or sanitation development (see Section 4.4).

The integration of projects is likewise important for effective utility management and development in the case study. Planning refers to several systems of different scales, connected with centralised directorial and regulatory structures and managed through decentralised decision-making in relevant fields based on a sufficient grade of autonomy. That refers to sanitation service delivery but also to product delivery in the case of reusing treated wastewater and other products from the sanitation systems.

Organisation of smaller systems incl. pilot projects, e.g. the need for handing over responsibility for O&M of smallest and pilot treatment facilities to the sanitation service provider must be clarified where those structure are still run independently without regular controlling and monitoring. That can also refer to the integration of decentrally managed local partnerships between farmers and operators of small-scale WWTPs in the case of water reuse schemes. Autonomous regulation of service delivery will thereby be important especially where private firms are involved. Besides the integration of micro-projects and small and smallest enterprises with overarching service providers

B.3 Comments on the assessment of indicators *(continued)*

or authorities, integration of local or regional providers in macro organisations such as larger public authorities and future regulators is likewise important. Those organisations bear the overall responsibility for service provision in the region and need to ensure quality control and regulation. However, focus of measures must at first be on the set-up of an effective central organisation in the case region for guidance, consultation and administration of the planned projects.

I-11 Processes and organisational functions (score 1). Processes and functions in the organisations responsible for sanitation (mainly the authority, but also municipalities and water units) are extremely bureaucratic and control-oriented, not monitored or not regularly improved. Decision-making is highly centralised. In contrary to that processes and organisational functions in the planned new sanitation utility need to be unbureaucratic with decentralised decision-making. That requires clear coordination mechanisms with the responsible authorities. Effective chains of processes need to be developed according to international standards (e.g. of IWA or DWA) that reflect the different category processes of management, business and support. Once introduced or improved, those processes must be monitored and regularly improved.

I-12 Performance monitoring (score 1). The general operational and financial performance of water and sanitation service delivery in the case region was sub-optimal (see Table 6.2). A weak regulatory system enforced low service and performance standards. PIs were partly introduced but the performance of the sanitation system (here, only sewer network) was neither monitored nor documented. To improve the situation and to take the significant development of the sanitation infrastructure into account, PIs need to be updated and aligned with international standards (e.g. of IWA or DWA). Furthermore, professional procedures of performance monitoring need to be introduced. Monitoring data need thereby to be consistently documented and integrated with internal management systems.

I-13 Strategic approach to HR capacity building (score 0). There is no strategic approach to HR capacity building at local level. There is technical training of staff in the water and sanitation authority to a limited extent but training activities are not linked up with any utility or sector strategy. Staff responsible for sewer maintenance in the municipalities is generally untrained. Accordingly, there is a need for developing and implementing a strategic approach to HR capacity building. It should evolve from the utility development strategy to be developed by Key Action 4, and planned and implemented as a holistic and demand-driven HRD concept including effective monitoring and evaluation procedures. There should also be a link-up to the sector strategy in related aspects.

I-14 Status of HR, HRM and HRD (score 1). The sanitation service providers and authorities have a No. of 5.8 staff per 1,000 connections, which is less than other governmental institutions in the region but better than other comparable developing countries and overall relatively close to best practice in developing countries (see Table 6.2). However, especially, training in modern planning and management techniques is missing and low salary level does not stimulate the performance of staff. With the assumption that the lowest categories of staff receives a smaller proportion of allowances, about 70% of the staff members earned less than the equivalent of €100 per month. This is a sensitive topic, because that amount is generally below living costs in the region. Academic staff earns a basic salary of over the equivalent of €150 per month; in addition to some allowances. Those earnings are based on governmental rates and can be considered generally low. A consequence is that it is difficult to attract and retain qualified staff. Furthermore, the salary system is not performance-oriented, i.e. salaries do not relate to individual achievements of staff, which is not motivating.

More HR is required at necessary qualification. Training plans need to be developed according to needs (training needs assessment) while at the same time an overall HR concept needs to be developed and implemented that enables a performance-based staff and career planning. Data of staff and related data of service providers should be integrated into internal management systems, possibly by a computerised HR information system which would need to be acquired. The single systems in the different service providers and related units should be linked up with the authority responsible for the entire region and there linked up with the sector strategy.

I-15 Effectiveness of training (score 1). The effectiveness of training needs to be improved significantly. A new set of demand-oriented formal and alternative (on-the-job) training courses need to be developed and provided. The basis should be a training needs analysis and assessment to be implemented first and regularly updated. Furthermore, effective procedures for the documentation, monitoring and evaluation of training measures need to be introduced.

B.3 Comments on the assessment of indicators *(continued)*

I-16 Commercial and financial management (score 1). Processes of commercial management are developed to basic level including billing and collection. However, processes are not as effective as financial and accounting functions. There is no effective software support. The situation needs to be significantly improved by introducing effective processes of commercial and financial management, raising capacity and awareness of staff (see Key Action 5: HR capacity building and Key Action 9: CRM) and introducing effective software support which integrates data with internal management systems. Furthermore, economic criteria need to be introduced in project and investment planning which goes together with measures to reduce organisational weaknesses and bureaucratic and time-consuming coordination (see Key Action 4: Utility management and development).

I-17 Revenue generation (score 1). Revenues are generated to a limited extend, and do not even recover the full costs of O&M, financing and major repairs. Sanitation charges do not exist, while water sales that are partly used for O&M in sanitation are low as well; not referring to a demand-oriented management of water resources. Not all costs, related to water supply and sanitation, are included; charges are often used for other public services. Sanitation is characterised by a lower level of cost recovery compared with water supply. That only refers to O&M and major repairs and means that financing and all investments have to be financed through external sources. That in turn results in low autonomy of local service providers and responsible authorities. In total, extremely low water tariffs and a lack of sanitation charges affect the financing of the service providers and hinder sustainable sanitation and water supply as well as the development of existing or new systems.

While most customers are willing to pay for sanitation services based on the current water tariff levels, there is generally little idea of the level of cost-recovering charges. Willingness to pay such charges is in question and will need to be assessed together with the ability to pay. Moreover, the concept of ability and willingness to pay for water and sanitation services hardly exists in policy and needs to be implemented as well (see Key Action 1: Policy setting). However, there is a discussion between authorities and politicians about the introduction of an adapted tariff structure taking into account the various users and polluter groups. That process should be supported.

Furthermore, significant measures are required to develop more revenue generation towards full cost recovery of O&M, financing and major repairs, while customers must be able and willing to pay for it. One element in a solution for this extremely difficult situation can be the development of new sources of revenues. New sanitation charges related to wastewater reuse and an effective collection system for those charges can be one element, which, however, must be established from scratch. Before that the demand and ability to pay should be analysed in close cooperation with the potential user groups, e.g. farmers' associations.

I-18 Affordability of products and services (score 2). Sanitation products and services, where available, are generally affordable for most users as there is little or even no charge for it. But for potential users who are not yet connected to the sanitation systems, mainly the poor, services and products may not be affordable. Furthermore, once new sanitation systems are implemented or the existing ones improved and tariff schemes are adopted to fully recover the costs, the resulting new charges can bring users in a situation where sanitation services or products are no longer affordable. That complex needs to be solved, possibly by a step-wise and first subsidy-based introduction of appropriate tariff schemes. Therefore, affordability must be assessed in a comprehensive study which is based on specific local criteria which also include the affordability of new products in the system, especially treated wastewater.

I-19 Processes of O&M (score 1). Processes of O&M in sanitation are only developed to a basic level. Responsibilities are not completely defined, the organisation of O&M is not flexible and workflows, documentation, reporting and monitoring are not effective. Furthermore, processes of O&M are only partly integrated with other functions. While there are local service providers for water supply (water units), O&M of the sanitation infrastructure is carried out by the municipalities. That refers basically to the sewer systems as there are only few functioning small treatment facilities in the region. Workers of the municipalities have only basic skills, while the operational staff of the water units is generally better skilled and educated.

For the sewer network, no regular operation activities and no regular and preventive maintenance activities are carried out. Machines are available for basic O&M, e.g. equipment for sewer flushing. Work safety is underdeveloped. Replacement works of broken pipes are carried out in projects, while new house connections are installed by people themselves without supervision by the

B.3 Comments on the assessment of indicators *(continued)*

municipalities. Often even the position of the sewer pipes is not known. There is no professional network documentation. Indirect polluters are not professionally inventoried and monitored.

Staff at WWTPs has more skills than those responsible for the sewer network, but still various skills needed are not available. The treatment performance of the few plants in the region is regularly controlled by the responsible ministry, although the documentation in reports lacks efficiency and regularity and sometimes even consistency. That means that processes of O&M must be developed to a higher level of efficiency together with significant staff capacity building (see Key Action 5: HR capacity building) that reflects the envisaged technology of the new sanitation systems.

I-20 Standardisation of tools and procedures (score 1). Tools and procedures for O&M must be improved to much more efficiency. That includes standardisation in the utility, according to national and international guidelines and regulations. Tools and procedures should thereby be prepared for later benchmarking. Finally staff and others involved in O&M need to be sensitised to the new O&M management.

I-21 Monitoring of O&M (score 1). Indicators for O&M monitoring are introduced and O&M is basically controlled with data documented, but the monitored is not effective and the data is not integrated with internal management systems which again rarely exist. While improving those processes in a support project, indicators also have to be checked and up-dated for relevance and completeness. For reuse in irrigation, e.g. the treated wastewater must achieve the nationally acknowledged standards of the quality guidelines of the relevant national or international organisation, e.g. of the WHO or the FAO.

I-22 Processes of production and reuse (score 0). Processes are not developed and health risks from reusing wastewater cannot be excluded. Existing sanitation systems are conventional and most of them are technologically insufficient. Only a certain amount of wastewater is collected, treated and reused for irrigation in a planned or almost planned manner in the region. Moreover, a large amount of wastewater is used untreated directly from sewers which often have been illegally broken. The planned new or improved sanitation systems should not only enable the collection, transport and treatment of wastewater but also a planned and restricted reuse of wastewater and other products from treatment processes. Treated wastewater should be used for irrigated agriculture as there is an increasing demand for irrigation water. Pilot projects in the region show that as practice examples on a small scale. To implement those practices on a large scale in the region, however, the development of professional reuse management from scratch is necessary.

Firstly, effective processes of production and reuse must be introduced in close cooperation with the investment project that relates to the construction of sanitation infrastructure. Those processes must be fully integrated with the O&M of wastewater treatment and fully coordinated with the anticipated users which could be farmers, farmer associations or even households with small farming facilities. Secondly, while developing those processes and procedures, health risks must be excluded and an effective quality control must be installed. That requires procedures of troubleshooting in production and effective monitoring.

While the products and services must be excellent and available in adequate quality and quantity to secure the success of the reuse approach on a large scale, prices and charges must be cost-covering and affordable for users. The treated wastewater should be discharged directly from the WWTPs to the irrigation areas which requires a suitable site of the plants. The reuse should thereby be restricted. The sludge can be reused as humus or soil conditioner after dewatering and soilisation and possibly composting depending on the final treatment technology. The reed of the plants can be harvested according to availability and demand, and sold to farmers, private households or companies in the building industry.

As no regulatory framework for reuse is in place, related standards including rules and regulations are necessary. This requires accompanying confidence-building measures and the clarification of mutually acceptable rights and obligations as well as contracts between farmers and service providers. There is also the need for establishing a tariff collection system for wastewater reuse which is reflected in Key Action 6: Financing.

I-23 Logistics of product delivery (score 0). Professional logistics are required for the delivery of products which is mainly the treated wastewater. It must be available to wastewater users (farmers) in right composition, place and time, fully meeting their needs. The place of the treatment facilities must therefore be close to the farming fields to ease the use of the products. Furthermore, the

B.3 Comments on the assessment of indicators *(continued)*

necessary infrastructure must be planned by the investment project together with the sanitation infrastructure. Clarification of land ownership is needed especially in areas for new WWTPs. Suitable areas for future plants need to be identified near agricultural areas. However, farmers may organise the distribution of irrigation water by themselves or own associations.

I-24 Marketing of reuse (score 0). Marketing measures that are effective in informing and attracting potential users need to be developed and implemented. Related activities should highlight the advantages of the new systems and products but also the need to pay for it. Arguments can be that irrigation water is available in a planned manner, being safe, controlled and bringing a fertilising effect as the treated wastewater still contains sufficient N and phosphate. So farmers could save fertiliser and be part of a reliable and sustainable system.

I-25 Management of customer data (score 1). Customers are only partly known as there is only irregular customer surveillance and no professional customer database is in use. The connection rate to sanitation systems is thereby much lower than the connection rate to water supply systems. Furthermore, many informal settlements lack any sanitation services while even the correct No. of people to be served is unknown. Measures will need to focus on implementing customer surveys and establishing a professional customer database that links-up data with the utility management systems. Surveys may include small-scale baseline studies in areas without service and where users are unknown. Furthermore, improving customer surveillance procedures will be important as well as the measures for the legalisation of house connections.

I-26 Service orientation and customer satisfaction (score 0). There is generally little service orientation among the staff of the service providers, the municipalities and the water and sanitation authority. Customer satisfaction is generally not assessed. Procedures of CRM are hierarchical and bureaucratic and the people who use the sanitation systems are not considered to be customers and are sometimes even neglected. The staff members in particular do not reflect the business relations between the service providers and the users of sanitation related services or products. To improve the situation sensitisation activities must be carried out in service providers and responsible authorities that raise the staff's awareness of those relations to increase service and customer orientation. Furthermore, effective processes, procedures and organisational functions need to be introduced for assessing customer's satisfaction which needs to be carried out and monitored on a regular basis.

I-27 Management of complaints and suggestions (score 1). Complaints and to a limited extent suggestions are received from customers, mainly related to water supply. However, the No. of complaints and suggestions received is not representative being probably too low for the service areas. Furthermore, there is no timely response to complaints and suggestions and no regulation of them. Complaints and suggestions are not recorded, processed, analysed or reported. Measures should therefore focus on establishing professional procedures for managing complaints and suggestions. Also responsible staff needs to be sensitised about timely response to complaints and suggestions, to be monitored by the management.

I-28 Communication with stakeholders (score 1). Stakeholders are regularly informed about sanitation activities by the service providers but the communication is ineffective and stakeholders are generally not involved in decision making related to sanitation activities. There is basic communication about sanitation activities to the public and users, which, however, does not reach the attention of all stakeholders. Furthermore, internal information and communication within service providers is limited to managing staff, which is a problem in bureaucratic structures as it does not always reach O&M staff. Analysing stakeholders and introducing effective communication routines will therefore be important measures. Those include defining responsibilities within the service provider and establishing regular contacts to stakeholder organisations. Suitable activities comprise communication campaigns, e.g. reports in the local media and spread of newsletters, as well as organisation of meetings, seminars and conferences and invitations to visit pilot projects.

I-29 Sensitisation of users (score 2). Public awareness is generally low regarding health and environmental problems and a lack of sanitation. Despite official prohibitions, many farmers use untreated wastewater for irrigation, thus importing significant health risks into the food chain. Deterioration of services and inappropriate investments in sewer systems and WWTPs increase this problem. With this background knowledge improvement measures should aim at sensitising stakeholders for sustainable sanitation and achieving public acceptance before planning and implementing systems. As for household installations impressions from discussions with

B.3 Comments on the assessment of indicators *(continued)*

stakeholders let to assume that people are willing to use improved, modern and conventional sanitation facilities, e.g. water-saving toilets, and people are also willing to change their behaviour towards new practices, e.g. water-saving, but most people are not willing to pay more for non-conventional solutions, e.g. waterless or urine diverting toilets. This impression needs to be clarified in the respective assessments. Considering the basic problems in sanitation, important elements of sensitisation campaigns will be the awareness of proper installations, importance of functioning connections to sewers, and the negative effects of discharging medicals or chemicals lowering treatment efficiency. Specific topics in campaigns need to be coordinated with the investment projects and their requirements to new technology and its use.

I-30 Promotion to potential users (score 1). Potential users (*non-users* such as the unserved poor and farmers that can use treated wastewater) are not adequately informed about sanitation activities and no specific promotion activities are carried out. Accordingly a new set of related activities is required. Both promotion and sensitisation activities should thereby be demand-oriented. They should generally inform about sanitation and its needs and about related activities in the public areas, but also about the specific problems in the region such as illegal groundwater depletion, use of raw wastewater for irrigation and disposal of it into open landscape. Besides common users, farmers need to be in the focus of awareness campaigns to prepare for effective reuse schemes related to the sanitation system. Moreover, farmers could become multipliers as they will probably have an interest in a functioning sanitation system when profiting from reuse of wastewater for their agricultural activities in the water scare region. But also the still unserved population, primarily the poor, need to be the focus of campaigns, i.e. promotion to potential or *non-users*. Finally, learning from other projects means that targeting children with campaigns can be very effective, e.g. at schools, and in a participatory approach.

B.4 Project profile of the implementation concept

Project profile	**Project client** NN	**Project director** NN	**Project No.** Case-1
Project title/short description TA in implementing a management strategy for upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region			
Project start event According to contract		**Project start date** To be defined	**Project duration** 7 years (84 months)
Project end event According to contract		**Project end date** To be defined	
Project objectives and expected results • *Overall objective:* Sustainable sanitation using constructed wetlands implemented on a large scale in a semi-arid Middle Eastern region • *Purpose:* Management strategy implemented for upscaling sustainable sanitation using constructed wetlands in a semi-arid Middle Eastern region • *Result 1:* Institutional framework supportive (Strategic Area 1 implemented) • *Result 2:* Organisation effective (Strategic Area 2 implemented) • *Result 3:* Technology effective (Strategic Area 3 implemented) • *Result 4:* Users cooperative (Strategic Area 4 implemented)			**Non-objectives** N/a

Milestones

- M-1: Project approved
- M-2: Project started (kick-off)
- M-3: Strategy prepared
- M-4: Strategy implemented
- M-5: Strategy follow-up completed
- M-6: Project completed

Main risk

General delay of the development in the country and sector

Management committee

NN

Project resources and budget

Resource category	Unit (months)	Budget (€)
Expatriate staff w/ accomm.	246	3,159,000
Local staff w/ support staff	360	730,000
International travel		100,000
Local transport		50,000
Project office		300,000
Procurements		80,000
Reports		20,000
Miscellaneous		1,300,000
Total		5,739,000
Physical contingencies 20%		1,147,800
Grand total		6,886,800

Project team members

To be planned (*international:* wastewater specialist, reuse expert, CRM specialist, financial expert, other short-term experts; *national*: organisational specialist, other short-term experts, support staff)

Date of approval	**Signature project client**	**Signature project director**