Cranfield University

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Evaluation of WATSAN technologies in developing countries: Development and testing of a diagnostic tool

School of Applied Sciences

PhD Thesis
Academic Year: 2010 - 2011

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Supervisor: Dr. Paul Jeffrey

August 2010

This thesis is submitted in partial fulfilment of the requirements for the degree of PhD

ABSTRACT

For decades the problems of access to and sustained use of water and sanitation (WATSAN) technologies in developing countries has dominated the political agendas of international organisations and governments. Despite the significant investments made and the apparent appropriateness of technologies transferred, the effective implementation and sustained use of WATSAN technologies remains a chimera. More importantly, improving access to water and sanitation does not necessarily guarantee the longevity of those systems transferred. Lessons from past interventions suggest that the success of WATSAN interventions depends on the ability of ensuring users' broad acceptance of the technologies and sustained used after donor assistance ends. Yet, in the academic literature users' feedback and experiences in the post-implementation stage of technologies has received scarce attention.

Against this background, this thesis aims to contribute to understanding the dynamics involved in the process of WATSAN technology adoption and sustained use in developing countries by reporting the design and evaluation of a diagnostic post-implementation tool, called RECAP, to address and investigate the problem. This research employs a multiple case study approach to evaluate users' post-implementation experience of WATSAN technologies in South Africa and Indonesia. Semi-structured interviews with technology users as well as in depth interviews with local governments and health clinics were conducted in three case studies. By comparing and contrasting technology intended performance and users' experiences in the post-implementation stage this study aims to identify potential challenges to technology sustained used.

Conclusions relate to the existence of discrepancies between performance and experience, manifested in the post-implementation stage, which suggest the necessity to develop evolving mechanisms to routinely assess users' feedbacks of the technologies and assist them with appropriate interventions. Further conclusions relate to the validity, reliability and flexibility of a post-implementation diagnostic tool in investigating user experiences, diagnosing emerging challenges and suggesting remedial intervention to contribute to sustained technology use.

Keywords: water and sanitation, post-implementation evaluation, developing countries.

ACKNOWLEDGEMENTS

Firstly, I would like to express my sincere gratitude to my supervisor, Dr Paul Jeffrey, for supporting me during these years, for the wise comments provided and for helping me to progress my research skills.

This study would have not been possible without the support of a number of people and institutions in South Africa and Indonesia. To all the people in the villages and communities visited I would like to express my gratitude for their time and for welcoming me in their homes. Thanks also to all respondents from the local governments and NGOs who provided invaluable insights to my research. I am indebted to interviewers and translators who helped me during the fieldwork: Sandile Mbata, Nhlanlha Mgeba, Doni and Leonardo Wardhana, Oka Yogi Utami, Nurhakim Ahmad and the team of facilitators I worked with in the field. Thanks for the help and support and for putting up with hard time in the field. A great appreciation goes to the staff from the University of KwaZulu-Natal and the eThekwini Municipality in Durban, particularly Dr. Zoe Wilson, Siva Chetty, Teddy Gounden, Bill Pfaff; as well as Frank Fladerer, Surur Wahyudi and all the staff from Borda Indonesia; Yuyun Iswamati from Balifokus; Christina Aristanti and Pius Herin and the helpful staff from DianDesa in Yogyakarta and Maumere. All my gratitude goes to Chris Buckley, from KwaZulu-Natal, for the guidance given during my fieldwork in Durban as well as in my career development. Finally, I would also like to extend my gratitude to the EU for the financial support throughout this project and to all the colleagues from Antinomos project, in particular the coordinators: Dino Borri, Laura Grassini and Markus Starkl.

I am grateful to all the people from the Centre for Water Science at Cranfield University who made these three years such a pleasant experience. At Cranfield I met valuable colleagues but also friends for life. I would like to thank all the academic staff at the Centre for Water Science. I am grateful to Dr. Brian Macintosh for having suggested I apply for this project and the support given throughout my PhD; Dr. James Webster and Dr. Roger Seaton, for the valuable comments to my research. Many thanks to Dr. Bruce Jefferson, for the interesting conversations and nice time spent over a pint at the CSA.

Also, special thanks go to Mel, Jitka, Emma, Ewan for their wise advice on how to cope with writing up.

My experience in Cranfield was also great because of some good friends I made. Thank you Ai, Ana, Kat, Nathalie, Richard, Silvia and John; I hope the Cranfield experience will be the beginning of a long-lasting friendship. To all the colleagues and friends who sat in PhD Room 3, thank you for putting up with my "craziness" whilst writing up and thanks for the "occasional" chat over a cup of coffee.

I would like to thank my family, Mamma, Papá and Nico: although you were not physically present, you showed me great emotional support. Last, but not least, my gratitude goes to Dr. Bond, my desk neighbour when I first arrived in Cranfield. Tom, thank you for all you have done for me in these years and for cheerfully supporting me in the most stressful moments of my PhD.

JOURNAL AND CONFERENCE ARTICLES

Journal articles

Roma, E. and Jeffrey, P. (2010). Evaluating public participation in the implementation of community based sanitation in Indonesia. *Water Science and Technology*, 62(5), 1028-1036.

Roma, E., Buckley, C., Jefferson, B. and Jeffrey, P. (2010). Assessing users' experience of shared sanitation facilities. A case study of Community Ablution Blocks in Durban, South Africa. *Water SA*, 36(5).

Starkl, M., Roma, E., Mbata, S. and Hawksworth, D. (2010). Comparative evaluation of community and household based sanitation systems in South Africa (eThekwini case study). *Water Practice and Technology*, 5(4).

Roma, E. and Jeffrey, P. (under review). Using a diagnostic tool to evaluate the experience of urban community sanitation: A case study from Indonesia. Submitted to *World Development*.

Roma, E. and Jeffrey, P. (under review). Evaluating user experience of alternative methods for treating drinking water: A field study in Flores Island, Indonesia. Submitted to *Journal of Water, Sanitation and Hygiene for Development*.

Conference papers

Roma, E. and Jeffrey, P. (2008). Using a conceptual model of Receptivity for innovation management in the sanitation sector of LDCs. Paper presented ad the IWA Conference The Sanitation Challenge, 19-21 May 2008, Waegenigen, The Netherlands.

Starkl, M., Roma, E., Mbata, S. and Hawksworth, D. (2009). Comparative evaluation of community and household based sanitation systems in South Africa. Paper presented at 3rd IWA Conference on Decentralized Wastewater Treatment Solutions in Developing Countries, 23-25 March 2010-Surabaya, Indonesia.

Starkl, M., Phansalkar, M., Srinivasan, R.K. and Roma, E. (2010). Comparison of sanitation and wastewater treatment technologies: case studies from India. Paper presented at WASH conference Cost Effective Sustainable Sanitation-An Indian Experience, 28-30 June 2010-New Delhi, India.

Starkl, M., Essl, L., Lopez, E., Martinez, J.L., Parker, A., Roma, E. and Stenström, T.A. (2010). Evaluation of household based disinfection systems: two case studies from Mexico. Paper presented at the IWA International Conference on Sustainable Water Management, 15-17 September 2010, Jamshoro, Pakistan.

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LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
AMR	Accessibility, Mobility and Receptivity
AP	Attribute Perception
CAB	Community Ablution Block
CS	Case Study
CSC	Community Sanitation Centres
CVM	Contingent Valuation Method
DEWATS	Decentralised Wastewater Treatment System
DPHE	Department of Public Health Engineering
DRA	Demand Responsive Approach
EIA	Environmental Impact Assessment
EVI	Economic Vulnerability Index
GDP	Gross Domestic Product
GNI	Gross National Income
GT	Grounded Theory
HACCP	Hazard Analysis and Critical Control Point
HAI	Human Asset Index
HDI	Human Development Index
IAIA	International Association for Impact Assessment
IDWSSD	International Drinking Water Supply and Sanitation Decade
IWRM	Integrated Water Resources Management
JMP	Joint Monitoring Programme
LCA	Life Cycle Assessment
LLDC	Landlocked Developing Country

LDC	Least Developing Country
MDG	Millennium Development Goal
NGO	Non-governmental Organisation
NPV	Net Present Value
ODA	Overseas Development Agency
ODI	Overseas Development Institute
O&M	Operation and Maintenance
PAR	Participatory Action Research
R&D	Research and Development
SIA	Social Impact Assessment
SIDS	Small Island Developing State
SSS	Simplified Sewerage System
TAG	Technology Advisory Group
TAM	Technology Acceptance Model
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNSD	United Nations Statistical Division
UTAUT	Unified Theory of Acceptance and Use of Technology
VIP	Ventilated Improved Pit
VLOM	Village-Level Operation and Maintenance
WATSAN	Water and Sanitation
WCED	World Commission on Environment and Development
WHO	World Health Organisation
WSP	Water and Sanitation Programme

STATEMENT OF AUTHORSHIP

This thesis includes one original paper entitled "Assessing users' experience of shared sanitation facilities: A case study of community ablution block in Durban South Africa", published in the *Water SA* peer-reviewed journal and two original papers entitled "Using a diagnostic tool to evaluate the experience of urban community sanitation: A case study from Indonesia" submitted for review to the academic journal *World Development*; and "Evaluating user experience of alternative methods for treating drinking water. A field study in Flores Island, Indonesia", submitted to the *Journal of Water, Sanitation and Hygiene for Development*.

In accordance with Cranfield University *General regulations on theses and other work of students*, 35.5 and 35.6:

I hereby declare that the ideas, data collection, analysis, development and writing up of the papers were the principal responsibility and intellectual input of myself, the candidate, working under the supervision of Dr. Paul Jeffrey. The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges inputs into team-based research.

CHAPTER 1: WATER AND SANITATION IN DEVELOPING COUNTRIES: ARE SUSTAINABLE SOLUTIONS A CHIMERA?

1 WATER AND SANITATION IN DEVELOPING COUNTRIES: ARE SUSTAINABLE SOLUTIONS A CHIMERA?

"Let's call the advocate of the traditional approach the Planners, while we call the agents for change in the alternative approach the Searcher. A Planner thinks he already knows the answers; he thinks of poverty as a technical engineering problem that his answer will solve. A Searcher doesn't know the answers in advance; he believes that poverty is a complicated tangle of political, social, historical, institutional and technological factors. A Searcher hopes to find answers to individual problems only by trial and error experimentation. A Planner believes outsiders know enough to impose solutions" (Easterly, 2006:5).

For decades the problem of Water and Sanitation (WATSAN) in developing countries has been at the centre of the political agenda of governments and international organisations. Nowadays, the provision of adequate WATSAN technologies and services remains one of the principal fields of international aid intervention, with enormous financial resources invested (Annamraju *et al.*, 2001). Yet coverage levels remain inadequate (WHO and UNICEF, 2010) and, as will be argued below, the achievement of sustainable WATSAN solutions in developing countries is still a *chimera*.

This thesis aims to contribute to a better understanding of the dynamics involved in the process of WATSAN technology adoption and sustained use in developing countries by suggesting and evaluating a novel approach to address and investigate the problem. Section 1.1 provides an overview of the problems related to water and sanitation in developing countries, discussing the most important initiatives undertaken, progress made and lessons learnt. Against this background, Sections 1.2 and 1.3 encourage an emphasis on WATSAN technology users as a means to foster sustainable and successful implementation of the transferred systems. Section 1.4 outlines the aim, objectives and scope of this research. A definition of the terms used in the thesis is provided in Section 1.5. Sections 1.6 and 1.7 explain the research approach and rehearse the contribution of the thesis to existing knowledge. The chapter concludes by providing an overview of the thesis structure.

1.1 Water and sanitation in developing countries: An overview

The United Nations (UN) summit held in New York in September 2000 established the Millennium Development Goals (MDGs), an ambitious agenda of international political commitment to foster world development by 2015. The Millennium Declaration places water and sanitation among one of its main objectives and commits with Target 10 to "*halve by 2015 the proportion of people without sustainable access to safe drinking water and sanitation*" (UN, 2000).

The importance of WATSAN interventions in tackling development is indisputable. Lack of appropriate water and sanitation is both a cause and effect of the vicious poverty cycle in which million of people are trapped (Abrams, 2001). Human history proves that access to adequate water resources is the most important driver of poverty alleviation and growth in several ways (UNDP, 2006). Progress towards Target 10 would substantially enhance the performance of the other MDGs (Hutton and Bartram, 2008). Improved WATSAN conditions would reduce mortality rates in children under-five, caused by waterborne and water related diseases (Goals 4 and 5), which currently reach 10 million annually (Fewtrell *et al.,* 2005). Sustainable WATSAN conditions would promote school attendance (Goal 2), increase employment rates, improve gender equality (Goal 3), and quality of life. Appropriate management practices would enhance agricultural production, providing economic revenues from the sale of produce and securing food provision to face increasing global food prices (Goal 1). From an environmental perspective, progress towards Target 10 would contribute to the mitigation of urgent climatic changes such as water stress, unexpected natural disasters, environmental degradation and excessive resource depletion (UN-Water, 2009). Finally, economists argue that investment in the WATSAN sector could have immediate as well as long-term pay offs. The World Health Organisation (WHO) estimates a rate of return of 3-34 $ for each 1$ invested in water and sanitation, depending on the context and technology adopted (Hutton and Haller, 2004).

Over recent decades, the humanitarian rationale behind water and sanitation interventions has translated into a significant financial commitment, characterised by grants, loans and disbursements of billion of dollars. Table 1-1 presents an overview of the main WATSAN initiatives and the investments made.

Table 1-1 Investments for water and sanitation initiatives

Time frame	Initiative	Leading Agency	Annual investment (Billion US $)
1981-1990	International Drinking Water Supply and Sanitation Decade (IDWSSD)	UNDP	10
1992	Water and Sanitation Programme	World Bank	12 *
2000	MDG Target 10	UN agencies, World Bank, bilateral donors	14-16 **
2005-2015	International Decade for Action- Water for all	UN-Water, bilateral donors, World Bank	Further investment required: 35.8 (sanitation) 36.4 (water)

*Estimates calculated on the average expenditures between 1992-1999. **Excludes wastewater treatment.
Source: UNDP (2006), Toubkiss (2006).

Yet, despite the enormous financial, technical and knowledge contributions, progress towards achieving the MDGs has been patchy. Since 1990, 1.1 billion people in developing countries gained access to forms of improved sanitation. However, 1.4 billion people are still to be served to reach Target 10. In terms of water supply, the provision of reliable systems has advanced from 77% to 87%. However, 884 million people still use unimproved sources of drinking water. Of these 84% live in rural areas (WHO and UNICEF, 2010).

This grim scenario provides a context for the challenges posed by increasing demand for water resources due to population growth, increasing urbanisation, and significant coverage disparities among developing regions (Moe and Rheingans, 2006). Furthermore, as will be discussed in Chapter 2, experience from past interventions shows that access to WATSAN does not necessarily translate into sustainable and reliable service provision. Figures of coverage, in fact, do not always consider the rehabilitation that must be conducted on existing WATSAN technologies (Abrams, 2000). For decades, WATSAN interventions have bypassed the problem of operation and maintenance (O&M), allocating loose responsibilities for post-implementation activities (Easterly, 2006). A *post mortem* evaluation of the International Drinking Water Supply and Sanitation Decade (IDWSS) implemented in 1980s shows poor success rates despite the commitment embraced. Although 1.3 billion and 750 million people were given access to water and sanitation respectively, the majority of the systems failed to deliver the expected benefits to users. Many projects were abandoned before completion (Warner and Laugeri, 1991) and simple systems, such as Ventilated Improved Pit (VIP) latrines, failed to meet recipients' needs. The costs that users were expected to contribute to buy roofed superstructure for the latrines were simply not affordable. When loans were granted to communities these were spent for other impelling needs, such as the enlargement of their houses (Cairncross, 1992). The poor rates of technology adoption resulted in misuse and subsequent falling into disrepair of most of the transferred systems. The main lesson to emerge from the IDWSS decade was the urgency of developing long-lasting solutions for WATSAN technology transfer that take into greater account the beneficiaries of the systems.

1.2 Towards a recipient-focused process of technology adoption

The causes of the scant progress made on WATSAN initiatives are complex and multiple. Lessons from past interventions point towards poor planning, lack of capacity-building, top-down blue print approaches with no participation from end-users, lack of accountability, all of which reflect the elusive goal of sustainability (Easterly, 2006). The appealing goal of universal access to WATSAN technologies is not synonymous with appropriate use, acceptance and sustained use of the systems (Dunmade, 2002). To anticipate some of the research delivered through this thesis, a real life story, presented in Box 1-1, suggests a more complex scenario, where the provision of a technology represents only the beginning of a multifaceted process. Technology adoption and sustained use entails an inclusive and continuous approach

Box 1-1: A real life story of technology acceptance

Mr S.* lives with his wife and six children in a small village in Uttar Pradesh, India. Until 2008, the family did not have a sanitation system. After hearing about the Ecosan toilet from the local NGO, Mr S. decided to build one in his own household, with the objective of preventing his two daughters from practicing open defection. In January 2008, he paid 3000 Indian Rupees, using money saved from his pension to build a double vault Ecosan. A visit to Mr S., conducted in December 2008, revealed that the family has not used the toilet since. His wife does not feel comfortable using the Ecosan and prefers open defecation, as she is not used to an indoor toilet. Mr S. does not have land or practice agriculture, so he does not see the benefits from reusing the human waste.

* Abbreviation used to respect respondent's anonymity.

Source: Antinomos Project, (2009)

based on technical, environmental and economic soundness and focused on users' receptivity (Jeffrey and Seaton, 2004) and acceptance.

A particular point of interest in Mr S.'s experience (Box 1-1), which will emerge also in the case studies investigated in this research, is the role of feedback and monitoring. Political and economic theorists teach the importance of customers' feedback to the wealth of firms, organisations and societies. Studying the problem of decline in organisations, Hirschman (1970) defines "exit" and "voice" as the two options available to express discontent with a product or a service provided. Faced with alternative options, customers will express their discontent for a product by exiting the system, i.e. turning to other suppliers. In political terms, if citizens of a democracy are unsatisfied with the services received by a government they pass judgement through their vote. Conversely, the option of "voice" allows beneficiaries to verbalize their discontent from within the system and enables suppliers to react to inefficiencies by managing recipients' feedback. Customers typically choose to voice their dissent when no viable exit alternatives are available or when a loyalty mechanism is in place. Applying a similar logic to the WATSAN sector, where users are not satisfied with a technology and have other alternative options, they will exit the system (i.e. cease to use the technology). Examples of unused or improperly used WATSAN systems populate the literature (Ludwig and Browder, 1992). Whilst "exit" can be costly for WATSAN providers and bring negative consequences to users, signalling problems through systematic feedback would allow providers to adopt appropriate measure to improve system efficiency or effectiveness.

The literature reflects an increasing focus on WATSAN technology users in planning and pre-implementation phases. These encompass Social Marketing studies exploring users' demand of WATSAN systems (Jenkins and Curtis, 2005; Jenkins and Scott, 2007); pre-implementation investigations of users' willingness to pay or to adopt WATSAN technologies (Whittington *et al.*, 1990; Altaf, 1994); and efforts to establish demand driven development (Davis and Whittington, 1998). Yet, in comparison, the response of users in the post-implementation phase has received little attention. Post-implementation approaches are generally characterised by technical and environmental investigations to evaluate the conditions of the systems and self-evaluation conducted by technology providers. To date, there have been few attempts to evaluate WATSAN systems by giving users an opportunity to frame the agenda for change, gathering the feedback necessary to elicit experiences and problems (or positive aspects).

The concept of feedback drives another poignant issue in WATSAN technology adoption: that of accountability. The success of WATSAN technology adoption is determined by the accomplishment of essential tasks, such as daily operation of the systems, administrative duties and maintenance that are often disregarded due to the difficulty of allocating responsibilities (Abrams, 2000). As will emerge later in this thesis, gaining user participation in the pre-implementation phase does not preclude the occurrence of post-implementation challenges (Harvey and Reed, 2007). Infrastructures will eventually age, technologies may need repair, users may lose interest, local trained people may move and new people settle in, increasing the need for training (Carter *et al*., 1999). The allocation of responsibilities can be a difficult endeavour, undermining the success of implementation. This is because the process of technology transfer and adoption presents multifaceted targets and involves multiple stakeholders (donors, local implementers, local and national authorities, technology end users).

If substantial progress towards the MDGs is to be made, increasing the number and scope of WATSAN interventions is necessary but not sufficient. Improving the institutional and political will of receiving countries is also a priority. More importantly, a shift of focus towards technology users becomes an imperative to guarantee long-lasting and sustained WATSAN technology use.

1.3 Sustainability of water and sanitation technologies

The process of technology adoption is intrinsically related to the concept of sustainability. The notion of sustainable development was first introduced in 1987 by a landmark report of the World Commission on Environment and Development and defined as "development that meets the needs of the present without compromising the ability of future generation to meet their needs" (WCED, 1987). Since the inception of the debate on sustainability policy makers and project planners have formulated strategies to promote sustainable solutions that balance the interplay between natural resources conservation and economic and technical viability. This debate will be extensively addressed in Chapter 2, however, for the moment it is necessary to outline the meaning of sustainability adopted in this thesis. Although recognising the importance of natural resources protection as a prerequisite in WATSAN interventions, this study refers to a more pragmatic definition of sustainability (Carter *et al*., 1999). This draws on a conceptualisation of technology adoption that goes beyond the traditional view of a one-off activity terminating with the transfer and handover of the systems to recipients. Rather, technology adoption is conceived of as a continuous and long-lasting process of service provision (Abrams, 2001). Thus, within this thesis, sustainability refers to its capacity for long-term continuance, as well as users' ability to use a WATSAN system and benefit from it for a substantial period after external assistance has come to an end (Parkin, 2000; Abrams, 2000). As it will emerge from the analysis of the investigated case studies, it is in this conceptualisation of sustainability that challenges to its accomplishment are the greatest. The attainment of universal sanitation coverage does not automatically translate into appropriate use or longevity of the implemented technologies (Dunmade, 2002). Similar conceptualisations of sustainability are found in the literature (Carter *et al.,* 1999; Dunmade, 2002) to stress the importance of adaptability of the system to the recipient context. Although the importance of economic, environmental and technical sustainability has been extensively discussed in the literature (Abrams, 2000), the social aspects that facilitate sustained use of WATSAN technologies are more complex to identify and investigate. These refer to users' receptivity and acceptance of the technology, feeling of ownership, ability to adapt it to the socio-cultural context, and establishment of enabling socio-political support to the systems (Brikké and Bredero, 2003; Gutierrez, 2007).

1.4 Aims, objectives and scope of the research

The complexity of the water and sanitation problem in developing countries has driven the overall ambition of this study, which broadly explores the reasons for success or failure of transferred WATSAN technologies. More specifically, this thesis aims to understand the dynamics involved in WATSAN technology adoption and sustained use provides an evaluation of the challenges to the transferred technologies in post-implementation stage. In support of the research aim a set of objectives were developed:

1. To understand the processes and dynamics affecting WATSAN technology acceptance and sustained use in developing countries.
2. To explore discrepancies between the intended performance and user experiences of WATSAN technologies in the post-implementation stage.
3. To develop and test a novel, valid, reliable and replicable approach to diagnose challenges to technology acceptance and sustained use.

The scope of this research is the process of implementation and sustained use of WATSAN technologies, defined as systems involving the generation and application of knowledge to meet communities' requirements, to solve potential or existing problems and to extend human capabilities (Carter and Byers, 2006). Although this investigation focuses on technologies, it does not exclude future applications of the same approach to study WATSAN policies and services. The study is conducted in developing countries and not in an industrialised world context. The approach takes into consideration and adapts to the unique social, cultural, environmental aspects characterising developing countries. The thesis investigates urban and peri-urban case studies of both water and sanitation technologies. It covers community-based systems and household level technologies.

Two groups of stakeholders, located at the two extremities of the process of technology transfer, are the focus of this investigation. The first of these relates to "providers" of WATSAN technologies: designers, implementers, and national and local governments, who are involved in the implementation and management of the technology. The second group comprises technology recipients. These may be users of technologies in private places (such as households), as well as at community level. The terms users and recipients will be used interchangeably in this thesis. A gap analysis approach guided the investigation of the discrepancies between technology providers' perceptions of the technology and recipients' experience. Fundamental to tackling sanitation problems is an understanding of the nature of the gap between these participant groups, the reasons behind the gap origin and occurrence, which will ideally lead to the design of possible solutions and guide a process of change. This general approach has guided both the fieldwork design and the conceptualisation of a diagnostic tool, called RECAP, which will be extensively described in Chapter 5.

1.5 Definition of terms

Access to Water and Sanitation

In the *Joint Monitoring Program* report (WHO and UNICEF, 2008), access to water and sanitation is conceived as a synonymous of use and defined as the proportion of population using improved drinking water sources and improved sanitation facilities. In this thesis the concept of WATSAN adoption and use will be adopted interchangeably.

Improved Water and Sanitation

Improved drinking water source is defined as a "source of water or a delivery point that by nature of its construction and design is likely to protect the water source from outside contamination, in particular from faecal matter" (WHO and UNICEF, 2008:39). Sanitation is defined in the broadest sense as the "collection, transport, treatment and disposal or reuse of human excreta, domestic wastewater and solid waste, and associate hygiene promotion", (Evans *et al.,* 2009:6).

Although an important element of reference, this terminology will only marginally be employed in this thesis. Water and sanitation technologies are here conceived as innovations involving the generation and application of knowledge to meet the goals and needs of a community, to solve potential or existing problems and to extend human capabilities (Carter and Byers, 2006).

Developing Countries

Developing countries are characterised by low socio-economic performances, structural weaknesses, high population, fragile natural environment and high susceptibility to external shocks. These countries exist in Africa, Asia and Latin and Central America.

Several classification and definitions of developing countries are available in the literature. The United Nation, for instance, classifies developing countries into: Least Developing Countries (LDCs), Landlocked Developing Countries, (LLDCs) and Small Island Developing States, (SIDS) (UNSD, 2006). LDCs are defined using three development indicators: the Gross National Income (GNI) per capita; Human Asset Index (HAI) based on nutrition, health, adult literacy and school enrolment; and the Economic Vulnerability Index (EVI), based on instability of agricultural production of good and services exports. LLDCs are constrained in their development effort by geographical remoteness and lack of access to sea and commercial routes. Finally, SIDS are insular countries that, due to their geographical situations, have poor resources, small domestic markets and weak economies depending on few commodities and on expensive imports.

Another widely employed indicator of development is the Human Development Index (HDI), conceptualised by the UNDP and presented in the first *Human Development Report* (UNDP, 1990). Three basic dimensions used to measure the development of a country are life expectancy, access to knowledge (measured in terms of school enrolment and adult literacy rates); and decent living standards (measured in terms of income and power purchase parity). Countries that achieved HDI inferior to 0.900 are considered not developed.

Finally, an alternative indicator of poverty and development is the GINI coefficient which measures the inequality within a country on the basis of the population’s income distribution. The coefficient varies between 0, to indicate complete equality, and 1, which reflects unequal wealth distribution. Thus, countries with high Gross Domestic Product (GDP) may be characterised by high GINI coefficient and inequality among their population, with a group of population benefitting of high income and consumption opportunities and others having none (Haughton and Khandker, 2009).

This thesis will use the more general term of developing countries to include those nations with low HDI, high GINI coefficient of unequal income distribution. The above-presented indicators must be used with caution as they conceal inequalities related to gender and race and both exclude aspects such as governance, human rights and migrations.

Receptivity

The term “Receptivity” as adopted in this thesis is defined as the “willingness (or disposition) but also the ability (or capability) in different constituencies (individuals, communities, organisations and agencies) to absorb, accept and utilize innovation options” (Jeffrey and Seaton, 2004: 281-282).

WATSAN technologies

As described in the previous section, technologies are defined as systems involving the generation and application of knowledge to meet communities’ requirements, to solve potential or existing problems and to extend human capabilities (Carter and Byers, 2006). Thus, in the context of this thesis the term WATSAN technology refers to both technological systems (such as in the case of SODIS, investigated in Chapter 7) and to the facilities, in which the technologies are embedded (as in the case of community sanitation, investigated in Chapter 4).

1.6 Research approach

This thesis employs a sequential multiple case-study approach undertaken in three phases. In the first phase a theoretical framework based on Receptivity theory (Jeffrey and Seaton, 2004) was employed to investigate users’ experiences and acceptance of implemented WATSAN technologies. The aim of the first phase was to collect evidence that would substantiate, falsify and expand the initial framework. A pilot case study of Community Ablution Blocks (CABs) was conducted in Durban, South Africa, to test the framework developed and explore its usefulness. Data were gathered using semi-structured interviews with users of CABs. Insights gained from the preliminary analysis of the collected qualitative and quantitative evidence served two purposes:

- Summarise evidence of findings and recommendations in an academic journal paper, which will be presented in Chapter 4.
- Stimulate the analytical thinking towards the development of a diagnostic tool to investigate WATSAN technology adoption and sustained use, presented in Chapter 5.

Experience in the field testified the need to further explore assessment methods for diagnosing problems and challenges of WATSAN technologies in the post-implementation stage. Providers' agendas for WATSAN technology implementation do not typically include eliciting knowledge on users' acceptance and sustained technology use in post-implementation. This knowledge gap opened a window of opportunity for conducting further investigation applying a modified approach.

In the second phase, a diagnostic tool (called RECAP) to assess WATSAN technologies was designed, drawing on previously conceptualised frameworks (Receptivity and Attribute Perception). RECAP is characterised by a multidimensional approach that takes into account different technology attributes and incorporates socio-cultural, technical, economic, environmental, ergonomic and hygienic aspects for evaluation. More importantly, RECAP entails a participatory approach based on feedback from technology providers and users. The tool is employed diagnostically to support technology implementation, matching weaknesses and/or failings in the process of technology adoption with local capacity for adaptation. Fieldwork was conducted in two case studies, to apply and test the RECAP tool. Two WATSAN technologies were investigated in Indonesia:

- Community managed Decentralised Wastewater Treatment (DEWATS) technologies, in Java and Bali, Indonesia.
- Water treatment technologies (SODIS and AQUATAB), in Flores Island, Indonesia.

Given the complexity of the phenomena under investigation, this approach proved useful in confirming the findings obtained in the first phase and increase robustness of the diagnostic tool. Following the completion of fieldwork activities, findings from the case studies were synthesised and discussed within the context of the research questions and existing knowledge in Phase 3. Figure 1-1 illustrates the research approach adopted in this thesis.

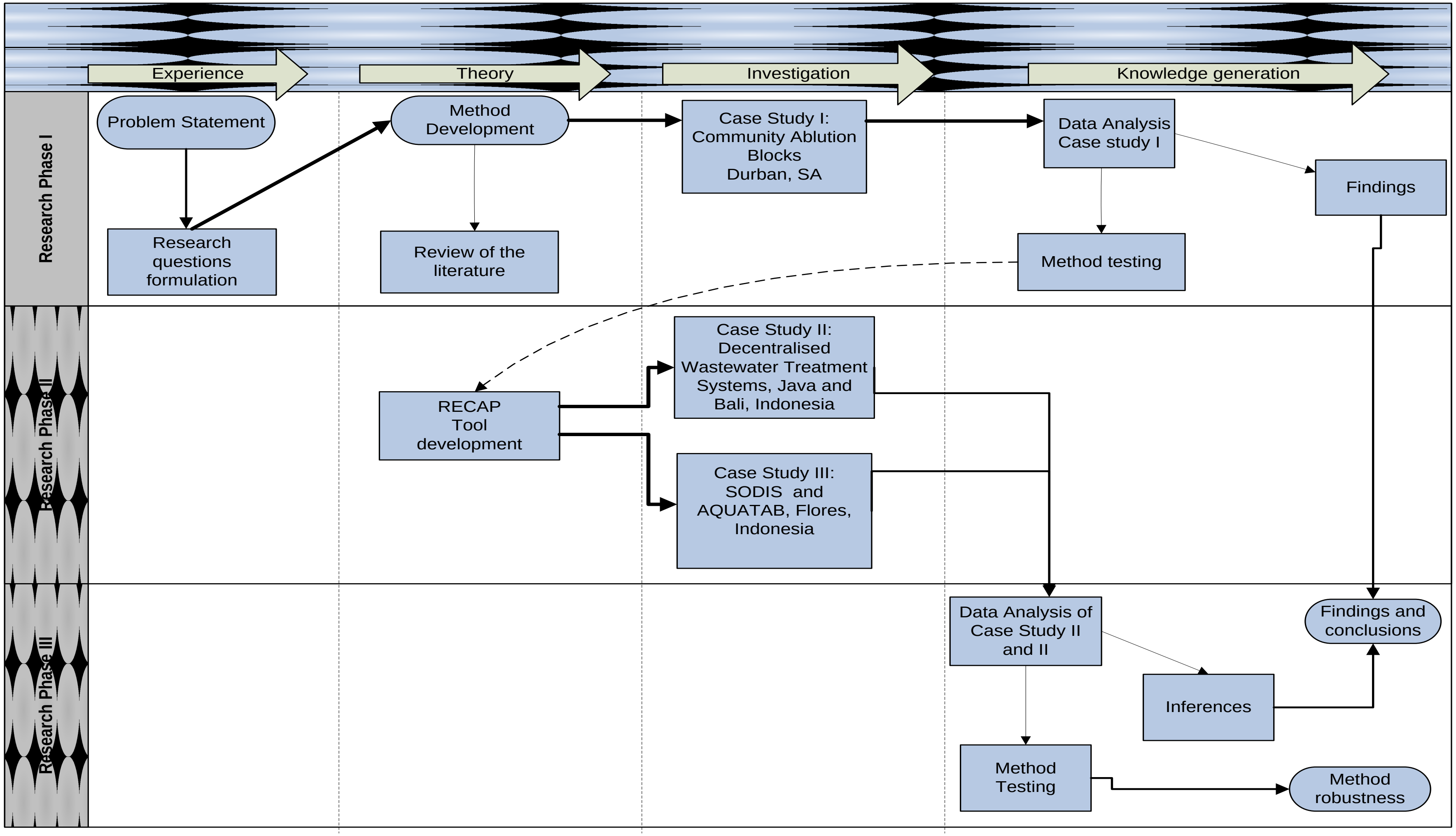

Figure 1-1 Research approach

1.7 Significance of the study

This thesis contributes to the theoretical debate animating the international community on the development of successful interventions in the WATSAN sector and the achievement of sustained system use. At present, existing approaches to WATSAN implementation have not achieved encouraging results and progress towards the MDG Target 10 is patchy, as a sign that novel perspectives should be embraced. By engaging with the relevant literature on origins and development of WATSAN interventions in developing countries, this study contributes to provide a comprehensive understanding of the strategies adopted so far and suggest new ones. Furthermore, this thesis presents elements of novelty, which rest on the development of a diagnostic tool to evaluate WATSAN, by encouraging recipients of the systems to frame the agenda for change. The application of RECAP assessment to WATSAN technology allows the identification and diagnosis problems and/or drivers for success by comparing and contrasting users' and providers' agendas. If appropriately managed, a RECAP assessment can provide evaluators with feedback from recipients to support the framing of future interventions to enhance recipients' acceptance and technology sustained use.

1.8 Structure and overview

This thesis is organised into nine chapters. This chapter has highlighted the rationale behind the study, the importance of exploring the dynamics involved in the process of WATSAN technology adoption and the development of a RECAP tool. On this base the aims, objectives and scope of the study were described.

Chapter 2 reviews the theoretical and empirical approaches relating to WATSAN interventions in developing countries, by comparing and contrasting the international debate embodied in grey literature (namely publications from international organisations, non governmental bodies, development institutes) with the academic publications.

Chapter 3 outlines the multiple case study strategy of inquiry adopted to explore dynamics in technology adoption and sustained use and to develop and test a diagnostic tool to guide investigation. Data collection methods and analysis are outlined.

Chapter 4, entitled *Assessing Users' experience of shared sanitation facilities. A case study of community ablution blocks in Durban, South Africa*, by Roma, E., Buckley, C., Jefferson, B. and Jeffrey, P., has been accepted for publication in the academic journal Water SA. The chapter presents the main findings of the pilot case investigation of users' experience of WATSAN technology in the post implementation phase, revealing recommendations to enhance the process of acceptance and sustained technology use.

Chapter 5 outlines the process of analytical thinking that emerged in the course the pilot case study and drove the conceptualisation of a diagnostic tool to evaluate WATSAN technologies. The chapter explains the theoretical foundations of RECAP and its methodological influences. It briefly discusses alternative methods identified in the literature and provides a description and a set of guidelines to conduct the RECAP assessment (A step-by-step guide is provided in Appendix II).

Chapter 6, entitled *Using a diagnostic tool to evaluate the experience of urban community sanitation: A case study from Indonesia*, by Roma, E. and Jeffrey, P., has been submitted for review to the academic journal World Development. The chapter illustrates the deployment of post-implementation assessment using the RECAP tool, which focuses on the discrepancies between technology performance and user experience.

Chapter 7, entitled *Evaluating user experience of alternative methods for treating drinking water. A field study in Flores Island, Indonesia*, by Roma, E. and Jeffrey, P. has been submitted for review to the Journal of Water, Sanitation and Hygiene for Development. The Chapter presents a further application of the RECAP tool to diagnose post-implementation challenges to the sustained use of SODIS and AQUATAB water treatment technologies.

Chapter 8 discusses the key results generated by the thesis, followed by Chapter 9, which presents the main insights gained, recommendations and implication for future research and practice.

CHAPTER 2: WATSAN INTERVENTIONS IN DEVELOPING COUNTRIES: THE EVOLUTION OF INTERNATIONAL THEORY AND PRACTICE

2 WATSAN INTERVENTIONS IN DEVELOPING COUNTRIES: THE EVOLUTION OF INTERNATIONAL THEORY AND PRACTICE

The previous chapter has outlined the problems of water and sanitation in developing countries and the importance of identifying novel approaches to ensure the sustainability of WATSAN interventions. This chapter discusses the significant trends in the theory and practice of WATSAN interventions embodied in the work of academic circles and international organisations, providing a critical overview of the rationales that guided developments in the field. A review of the literature on WATSAN technologies in developing countries cannot avoid the intrinsic link between theory and practice: theoretical approaches and political agendas developed by academia and donor agencies have shaped users' experiences in the field. National government contributions to water and sanitation in developing countries, although important to the sector development, are beyond the scope of this investigation. A chronological approach was adopted to describe and critically analyse the identified trends and linkages between theory and practice. The period covered in this analysis is marked by two significant events: the first international water conference held in Mar del Plata in 1977 and the United Nations (UN) Millennium Declaration of 2000, which established the Millennium Development Goals (MDGs). The objectives of this literature review are the following:

- To trace the intellectual drivers of and identify the experiences which shaped theories of WATSAN technology adoption.
- To provide a comprehensive overview of theories and practice applied in the field of WATSAN technology in developing countries.
- To identify knowledge gaps as a first step to the formulation of research questions guiding subsequent inquiry.

2.1 Early WATSAN interventions

Typically, the transfer and implementation of WATSAN technologies in developing countries has been driven by external technical assistance. During the colonial period, Western governments contributed to the infrastructural growth of territories overseas, providing water supply, health and social services (Grover, 1998). Technology transfer was characterised by the implementation of conventional or centralized water supply and sanitation systems, such as dams and waterborne sewerage, to serve the upper classes living in urban areas (McGarry, 1980). With decolonization, the burden of WATSAN supply management was shifted to the newly formed governments (Goldman, 2007).

The first reference to water in international development agendas dates back to the 1960s: the focus was on drinking water, considered vital in relation to its health implications in the population of developing countries (Mauser, 2009). The World Health Organisation (WHO) recognized that lack of drinking water was responsible for 10 to 25 million deaths each year and UNICEF stressed the importance of environmental hygiene and water for children in schools. In 1961, the World Bank disbursed the first loans to governments in developing countries to contract infrastructural work to Western engineering companies (Dieterich, 2003). Most of the allocated funds continued to be directed to interventions in urban areas, facilitated by relatively profitable investments with high return rates (Pickford, 1989). These early approaches to WATSAN technology transfer was characterised by isolated efforts with little information and knowledge sharing among international agencies (McGarry, 1980). The supply of water and sanitation technologies was driven by a mixture of public health aspirations and financial probity: water quality was the most important factor in ensuring health progress (Jørgensen, 1984).

Concerns over the health of communities in developing countries were also prevalent in academic circles. Field studies were conducted to assess the links between water supply interventions and the incidence of water borne and water related diseases such as cholera and diarrhoea, which were plaguing populations (Choudhry, 1975; Levine *et al*., 1976; Feachem, 1977). Relevant studies were published in the fields of medicine, public health (Mendia, 1968) and microbiology (Neumann, 1969). Observational methods coupled with laboratory tests and epidemiologic analyses were employed to examine infection rates and health impacts on the populations. The importance of transferring prevention and control techniques to counter the scant progress in the control of diseases was also emphasized (Feachem, 1980).

2.2 Appropriate Technology and the International Drinking Water Supply and Sanitation Decade (IDWSSD)

By the beginning of the 1970s it was apparent that the transfer of sophisticated technologies could neither solve the health problems in developing countries nor keep pace with population growth, but just serve minorities in urban areas bypassing the majority of the poor. The wind of change first blew in academic circles where the conventional engineering approach to technology transfer began to be questioned. In developing countries the large capital-intensive WATSAN technologies were not producing sound results in terms of population coverage and health improvement; unaffordable costs were inflicted on people, preventing them from using the systems as well as developing local skills (Jéquier, 1976). If health aspects were to be equitably addressed, then water and sanitation services needed to be universally accessible.

The concept of “Intermediate Technology” was coined by the British economist E.F. Schumacher to epitomize a novel idea of development based on community self-reliance. Inspired by Gandhi’s philosophy of community self-help (Bakker, 1990), Schumacher argued that development problems could be solved through a dynamic approach that enables communities to select and develop technologies suited for a specific problem and context. The notion of “Intermediate Technology”, which inspired his popular work *Small is Beautiful* (Schumacher, 1974), was conceptualised on the basis of the criteria of low capitalization and complexity. Intermediate technologies stand mid-way between the capital-intensive systems, based on sophisticated engineering and dependent on external resources, and the obsolete indigenous technologies founded on traditional knowledge. Schumacher proposed that the gap between the two can be filled with intermediate-stage systems, which are more productive than indigenous technologies but less costly than the capital intensive ones

(Schumacher, 1974:150). With time, the concept of intermediate technology evolved to embrace the term "appropriate technology", which reflects criteria of simplicity, smallness, human development, equity and justice (Willoughby, 1990). Against the technical sophistication typical of Western conventional systems, appropriate technologies ensured compatibility with local, cultural and economic conditions, and the use of available natural and human resources that minimise environmental damage and avoid negative impacts on work ethics (Lawand *et al.*, 1976; Willoughby, 1990).

The importance of going back to basics, stressed by the "appropriate technology" movement, was received with enthusiasm in academic circles and Research and Development (R&D) centres in industrialised countries. Resultant WATSAN technologies designed in Western laboratories were based on the criteria of appropriateness: low environmental impacts (minimization of waste production and energy use); economic (low-cost capital and labour), and functionality (design fit for use and maintenance) (Morgan, 1989; Jørgensen, 1984). Specific interventions were consequently simple: tube wells with locally produced hand pumps (Morgan, 1989); rainwater harvesting systems (Waller, 1989); slow sand filters (Buhl-Nielsen, 1983); and Ventilated Improved Pit (VIP) latrines (Diamant, 1984; Dunn, 1978). The academic publications reported case studies of transferred technologies, providing details of design specifications, construction methods and materials (Waller, 1989) and technical instructions for operation and maintenance (Diamant, 1984). Recipients' priorities were often translated in design and technical modification of the WATSAN systems after their demonstration in the field (McGarry, 1980). The appropriate technology movement also influenced international organisations, its advocates sitting at the highest ranks of international agencies (Weiss, 2004). At the World Bank, Kalbermatten *at al*. (1982) developed an inventory of appropriate sanitation systems (i.e. VIP latrines, aqua privies, septic tanks), whose selection was based on criteria of capital cheapness, socio-cultural and environmental soundness, and users' ability to maintain them.

At the first UN international water conference held at Mar del Plata in 1977, the appropriate technology approach was deemed the most significant approach for meeting the goal of universal access to drinking water and sanitation in quantity and quality equal to people's basic needs (Schultzberg, 1980). Based on the slogan "basic

WATSAN systems for all", the Mar del Plata Declaration affirmed access to WATSAN facilities as a human right and legitimised the transfer of low-tech and low-cost systems (WHO, 1980). To coordinate actions, an International Drinking Water Supply and Sanitation Decade (IDWSSD), (1981-1990) was launched. Technology Advisory Groups (TAGs) of experienced engineers were engaged by the programme to assist governments in developing countries and to advise on the technical, financial and practical feasibility of onsite sanitation systems (Black, 1998). "Village-level Operation and Maintenance" (VLOM) schemes were introduced to train and educate users to operate and maintain newly installed hand pumps (Arlosoroff, 1983).

With the concept of "appropriate technology" in the ascendency, the rhetoric of community participation started to appear in academic publications and political agendas, its exposure increasing with the advance of the IDWSSD. The first conceptual framework of participation is acknowledged to be that proposed by Shelley Arnstein (1969). In an attempt to describe the interaction among communities and governments, Arnstein defines participation in terms of the redistribution of power that enables individuals to share the benefits of a society. A ladder of participation was established as a continuum ranging from non-participative forms (manipulation) to empowerment of communities (citizens' power). Later, White (1981) defined community participation on the basis of three criteria: users' involvement in decision-making processes, contribution to the development effort during the implementation phase, and benefits sharing. Similarly, Van Vijk-Sijbesma (1979) differentiates between "do by" or "do with" approaches, where communities are consulted to discuss priorities and jointly draw up plans, and "do to" or "do for" strategies, where recipients are confined to a passive role of assistance in the implementation of already set up projects. The concept of participation was further strengthened by Chambers' contribution (1983). In his critique of past development interventions he proposes to put the "communities first" by exploiting local knowledge as a means to achieve human development. Community participation began to be considered the most adequate strategy to improve technology design, to reduce construction and O&M costs, and to encourage self-help interventions by communities (Kalbermatten, 1983; Feachem, 1980). Participatory activities were deemed to infuse a sense of responsibility in users, enabling the transfer of knowledge and skills and strengthening their willingness to sustain the transferred technologies

(White, 1981). More importantly, community engagement in the planning phase was seen to facilitate implementers' understanding of recipients' culture, community structure, preferences and perceptions (Elmendorf and Isely, 1982). In an evaluation study of 121 rural water supply projects implemented during the IDWSSD, Narayan (1995) reports the existence of a positive relationship between participation and project effectiveness, the degree to which expected objectives are achieved. Where a participatory approach was adopted by the implementation agency, the WATSAN systems appeared in good conditions and local capacities were enhanced, increasing the overall economic benefits for all stakeholders involved.

Efforts to involve recipients in the process of WATSAN implementation also generated novel understandings of gender issues. Awareness of the role of women in the management of water and sanitation in households and villages in developing countries drove the focus of training programmes towards activities that involve them in the operation and maintenance of the transferred technologies (Feist, 1987). For example, the literature reports successful individual initiatives of gender involvement in training, construction and maintenance of hand pumps in Africa (Madsen, 1990; Jørgensen, 1984).

During the IDWSSD water and sanitation coverage rates increased consistently: overall, 1.2 million people were provided with safe water and 700 million people with adequate sanitation (WHO, 1992). However, these achievements fell short of the ambition of universal provision, did not keep pace with population growth and often failed to ensure durability of the systems after installation. Evaluation studies conducted at the end of the IDWSSD reported that most of the systems introduced were neither used by recipients nor fully operational, as they quickly fell into disrepair after installation (Warner and Laugeri, 1991). According to Mu *et al.* (1990:521) "there were simply too many leaking taps, abandoned water systems and defunct water committees for anyone to be sanguine about the current rate of progress". In an attempt to evaluate the IDWSSD progress, Morgan (1989) contended that financial efforts were spent mainly in the installation phase, overshadowing the maintenance of the systems.

Despite its avowed supporters, the "appropriate technology" movement encountered intellectual resistance among engineering circles in industrialised countries, as well as governments in the developing world. Criticism related to the idea that appropriate technologies could not be more efficient than modern ones. At the basis of this argument was the traditional view of innovation as a linear process that advances through higher levels of sophistication and efficiency (Willoughby, 1990). Appropriate technologies were deemed not only less efficient, but also less productive than modern ones: since increasing the scale of production corresponds to higher productivity, it follows that small and simple systems, which have lower production rates, cannot ensure economic gains. Further dissent related to semantic aspects of the terminology. Bowonder (1979) argues that the ambiguity concealed in the word "appropriate" led to subjective definitions of what is adequate, which depended on project specific objectives and circumstances. Several conceptualisations of "appropriateness" have favoured inappropriate WATSAN systems to be accepted as best solution. Ranis (1980, as cited in Murphy *et al.*, 2009) argues that a technology can be considered appropriate in many respects: it can be capital or labour intensive, indigenous or exogenous, advanced or more primitive.

Resistance to the "appropriate technology" movement was also encountered among national and local governments in developing countries where the new systems installed were considered second-best technologies and epitomised as a backward conception of development (Bowonder, 1979; Hollick, 1982; Pickford, 1989). Paterson *et al.* (2007) report how, 40 years after their conceptualisation, appropriate and low cost approaches to WATSAN technologies are met with scepticism by local constituencies in developing countries. A further cause of dissent related to the lack of resources and skills of governments in developing countries. Traditionally based on centralized operational structures for water supply and sanitation, these were poorly prepared to deliver maintenance and support at the level of decentralisation required (Black, 1998).

Similarly, scepticism towards community participation approaches began to emerge. Criticisms related to the constraints on participatory implementation of WATSAN due to the lack of an enabling environment, such as scarce funds, lack of efficiently trained staff in the government sectors and weak communication channels between communities and authorities (Feachem, 1980). Furthermore, participation enthusiasts were accused of having given little thought to how the approach could be operationalised by stakeholders in systematic and replicable ways (Jéquier, 1980). Clearly, half way through the IDWSSD community participation required much greater effort than the mere involvement of women and men in manual work and attendance on committees (Munguti, 1989). In his review of participatory strategies in Nepal, Williamson (1983) called for a shift towards a "community-managed" approach, where recipients act as primary agents in planning, construction, implementation and maintenance of the received technologies. This was said to require a behavioural change built on users' motivation to adopt the technology, based on their clear understanding of the problems involved.

2.3 The IDWSSD legacy and the emergence of sustainability as a concern

The IDWSSD terminated with the awareness that although appropriate technologies were the first ingredient in the achievement of WATSAN coverage, a radical transformation of involved societies was necessary (Chaturvedi, 1979). The inspiration of the IDWSSD was still *technocentric*, focused on the linear movement of hardware from development stage to use. WATSAN technologies were typically designed, built and tested in laboratories in industrialised countries and transferred to developing countries (Arlosoroff, 1983). In technical assessments, the appropriate design, materials and manufacturing process were identified and evaluated by Western engineers taking into consideration the contextual aspects of developing countries (Reynolds, 1987). The approach to technology transfer was still supply-driven: typically, communities received the technology playing only a minor role in its planning, implementation and management (Breslin, 2004).

Experiences in the field showed that the goal of universal WATSAN coverage could not be attained unless a fundamental process of change was initiated. Increasingly the recognition emerged that to deliver successful water and sanitation technologies involved stimulating and achieving change in target individuals and communities. New awareness was growing on the process of technology transfer as a people-oriented phenomenon, whose success depends on the existence of communication channels between stakeholders as well as their active engagement in the process (Cavusgil, 1985). This emerging wisdom in international thinking was soon embodied in a new agenda. In the report *Our common Future*, the World Commission on Environment and Development (WCED) defined sustainable development as "a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are made consistent with future as well as present needs" (WCED, 1987:9). This definition of sustainability drove the international community's attention to the interaction amongst human poverty and the environment, by stressing the complex and intricate problems if environmental degradation caused by economic growth and the role of economic factor in fostering human development (Adams, 2006).

Since its conceptualisation, sustainability has been criticised for being an all-encompassing term, leaving room for interpretations and concept development (Redclift, 1992; McCool and Stankey, 2004). Its meaning and definition has evolved to focus on the core ideas of environmental sustainability (natural resources conservation and protection from degradation); social sustainability (stakeholders' involvement in natural resources management); and economic sustainability (affordability and cost-recovery principles) (Adams, 2006; Vishnudas *et al.,* 2008). In accordance to these definitions, several frameworks, tools and indicators of sustainability have been developed, based on both quantitative and qualitative measurements. Dunmade (2002), for instance, defined sustainability in terms of technology adaptability and evaluated it on the basis of economic, technical, environmental and socio-political indicators. Ioris *et al.* (2008) conceptualisation of sustainability focuses on the economic, ecological and social aspects of water resources management of river catchment in Brazil and Scotland. Finally, in their evaluation of sustainable urban water and wastewater system Hellström *et al.* (2000) added a further component of sustainability, health and hygiene, to the array presented above. Discussion on the validity and reliability of sustainability indicators, which dominated the academic debate, rests on the subjectivity and value laden definitions of the criteria chosen and on the difficulty of integrating these indicators to produce a pragmatic value to assess what is sustainable (Morse *et al.*, 2001). Precisely, this problematic emerges during attempts to measure sustainability in practice and to replicate the assessments to similar case studies. Sustainability is a context specific term that means different things to different people (Addo-Yobo and Nijuru, 2006): a sustainability assessment conducted by implementation agency engineers clearly differs from what is understood and considered sustainable by local authorities, village leaders and users.

In the field of WATSAN technologies in developing countries sustainability has been increasingly defined in terms of a system capacity for long-term continuance (Parkin, 2000; Abrams, 2000). According to Carter *et al.* (1999) a constancy of water supply and sanitation services can be obtained through "evolving and adaptive delivery mechanisms" which guarantee continuous stakeholder participation and support to users. Accordingly, evaluation studies of implemented WATSAN technologies identified operation and maintenance as the main indicator of sustainability (UNDP-WSP, 2006; Montgomery *et al.,* 2009). In line with a more pragmatic view of sustainability, new models have been developed. Carter *et al.* (1999) conceptualised a sustainability "chain", whose success depends on the linkages among user motivations, system maintenance, cost-recovery and continuous support to communities. Drawing on this conceptualisation, Montgomery *et al.* (2009) identified three components for sustainability: effective community demand, entailing demand-responsive approaches and user participation; local financing and cost-recovery and finally operation and maintenance. As discussed in Chapter 1.2, this thesis embraces a pragmatic vision of sustainability, conceived as sustained technology use, which highlights capacities and opportunities for long-term continuance and acceptance by end users.

2.4 The software aspects of WATSAN technologies

The importance of the sustainability paradigm and of new management practices was reaffirmed at two international gatherings on water, environment and development: the International Conference on Water and the Environment held in Dublin in January 1992, and the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992. In Dublin, a new global awareness on the finiteness of water (and natural) resources drove a focus on WATSAN management approaches that consider the economic value of water resources, and involve all relevant stakeholders, policy makers, planners and users with particular reference to women, See Box 2-1 (Mauser, 2009). The need for efficient and equitable use of the world's natural resources was reiterated in *Agenda 21*, the key document to emerge from the Rio Summit (UNDESA, 1992), where action was called for improving sustainable water supply and sanitation. This was to be achieved through Integrated Water Resources Management (IWRM), capacity building, participatory approaches and decentralisation of mandates and responsibilities (Grover, 1998; Biswas, 2001).

Box 2-1: The Dublin Principles, 1992

Principle 1: Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.

Principle 2: Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.

Principle 3: Women play a central part in the provision, management and safeguarding of water.

Principle 4: Water has an economic value in all its competing uses and should be recognized as an economic good.

Source: United Nations, (1992).

The Dublin Principles and *Agenda 21* shared an important aspect: a novel shift towards "software" components of water and sanitation (i.e. education, knowledge management and social mobilisation) that concentrate on "today" issues to ensure "tomorrow" sustainability. These principles guided the formulation of the Millennium Declaration of September 2000 and reiterated at the World Summit on Sustainable development of 2002. The strategies to meet human and environmental needs and achieve MDGs Target 10 ("to halve the proportion of people without sustainable asses to safe drinking water and basic sanitation") were based on the recognition of the importance of fostering demand, increasing participation in planning decision-making, empowerment women and communities and sustainable resources allocation (UN, 2002).

The most overriding practical implication for WATSAN management was the emergence of Demand Responsive Approaches (DRAs), as a critical change of direction from to past supply-driven interventions. Experiences from the past suggested that the main obstacle to sustained use of the transferred technologies was users' acceptance. The drivers for transfer of WATSAN systems were now determined by users' demand and felt needs for them (Black, 1998). More precisely, priority was given to planning strategies driven by economic rationales, users' willingness to pay for the systems; and improvement of the organizational and institutional management of the transferred systems (Alaerts, 1996).

2.4.1 Demand Responsive Approach

The Demand Responsive Approach (DRA) to WATSAN technology implementation soon became the dominant strategy to ensure cost-effective impacts of the development efforts undertaken by implementing agencies and governments (Lockwood, 2004). DRA was founded on the Dublin Principle of water as an economic good and supported by a reformulation of national and local governments' roles through a process of decentralisation, and stakeholder participation (World Bank, 1997). The overriding implication of this principle was that WATSAN interventions were to be driven by users' demand and willingness to contribute to the systems as mechanism to ensure their sustainability (Giné and Pérez-Foguet, 2008). The key characteristics of DRA can be summarised as follows (Katz and Sara, 1997; ODI, 2003; Breslin, 2004):

- Users (and/or communities) are empowered by means of participatory approaches in planning, decision-making, and implementation.
- Users are to prove their eligibility to obtain a WATSAN technology by showing willingness to pay for and maintain it.
- Community understanding of and commitment to pay for the costs involved in the implementation, construction and maintenance of the WATSAN technologies are fundamental to allow recovery of the implementation costs.

Demand-driven approaches encapsulate other forms of participatory WATSAN technology implementation, such as Community-Driven development and community managed models (Lockwood, 2004). These are based on the principle of community participation, ownership and control of the systems transferred, and sharing of the implementation and maintenance costs. Examples of successful community managed models undertaken under the umbrella of DRAs, which are increasingly being adopted in developing countries, are provided in the literature (Satterthwaite *et al.,* 2005; Roma and Jeffrey, 2010). Katz and Sara's (1997) comprehensive study on the impacts of DRAs to WATSAN technology implementation concluded that strategies were still adopted inconsistently by project officers, with recipients not being informed of the actual costs of the technologies or not being offered the possibility to choose among technology options. However, where a DRA was properly applied, WATSAN sustainability, measured thorough indicators of system performance, physical status, users' satisfaction, willingness to maintain the system and financial management of the systems, obtained high scores.

Since its adoption, the concept of DRA has shaped the international discourse on WATSAN technology interventions. Meanwhile, new approaches to software aspects of WATSAN technology implementation were developed in the academic sector to complement the DRA. These are discussed in the following sub-sections.

2.4.2 Market oriented strategies

Planners' inability to judge recipient demand for WATSAN technologies has long been considered one of the main causes of poor performance of WATSAN systems (Altaf and Hughes, 1994). The Dublin Principle linking water to its economic value was translated into approaches that employ market oriented strategies to relate the adoption of WATSAN technologies to the costs of implementation and use (Winpenny, 1994). The "water demand school" (Merret, 2002b), emerged in the 1990s and had its major exponent in Dale Whittington. The water demand approach was defined as an "improved planned methodology" (Whittington *et al.*, 1990: 294) for eliciting information on the value placed by users on a water and sanitation service. According to its advocates, assessing recipients' willingness to pay could provide a clear indication of users' future ability and motivation to maintain a system, providing at the same time opportunities for generating policy recommendations (Davis and Whittington, 1998). The methodology adopted by the water demand school was the Contingent Valuation Method (CVM), a mixture of structured questionnaires and bidding games to elicit estimates of users' willingness to pay. Typically, users' willingness to pay was measured for water supply systems, i.e. tap, standpipe, water vendor (Briscoe *et al.*, 1990; Mu *et al.*, 1990; Whittington *et al*., 1991; Whittington *et al.*, 1992; Whittington *et al.,* 1998); however, attempts to elicit preferences and options for sanitation technologies (such as water closet with sewer connections or VIP latrines) have also been conducted (Whittington *et al.,* 1993; Altaf and Hughes, 1994).

Some scholars have questioned the validity and reliability of the CVM. Yacoob (1990) maintains that such hypothetical methods to forecast users' adoption of a WATSAN system do not always succeed in matching observed behaviours. This discordance between intentions and behaviours is explained with the intervention of other important determinants, such as users' private agendas, bad services provided by suppliers or no sanction for lack of payment (Merrett, 2002b). Merrett (2002a, 2002b) concludes that understanding patterns of WATSAN use is important to develop accurate analysis and improve behavioural forecasts. Furthermore, attention is drawn to the fact that the concepts of "willingness" and "ability to pay" have different meanings and implications. In his study, Merrett (2002b) asserts that the difference is not clearly spelt out in the "water demand" studies analysed, nor it is clear whether respondents understand the implications related to the two concepts. Finally, scholars who challenge the principles of willingness to pay justify their criticism on ethical grounds. Rejecting the principle of water as an economic good, they contend that the poor cannot always afford to pay for water and sanitation, which are necessary for their survival, and which therefore should be supplied on free basis (Black, 1998).

Emphasis on the marketing aspects of water and sanitation was characteristic of another discipline active in this period, that of social marketing. The approach, however, takes distance from the "water demand school", arguing that its economic evaluation of willingness to pay ignores the real life constraints caused by social, cultural and behavioural determinants that may affect demand and fails to suggest a process of behavioural change; a process that can be captured through behavioural studies (Jenkins and Scott, 2007). The origins of social marketing can be traced back to Kotler and Zaltman (1971: 5) who defined it as the "the design, implementation, and control of programs calculated to influence the acceptability of social ideas and involving considerations of product planning, pricing, communication distribution and marketing research". As early as the 1960s, marketing techniques to solve societal problems were adopted in campaigns for family planning, drug control and prevention of infectious diseases (Fox and Kotler, 1980). Social marketing was more formally established as an academic discipline towards the beginning of the 1990s, with increasing emphasis on the WATSAN sector in developing countries. The use of marketing techniques to achieve social goals was translated by Kotler and Zaltman (1971) in a theoretical construct based on four elements: Product, Promotion, Place and Price. *Product* refers to technologies designed to meet users' desires and needs. In this respect, market research can help to scope and identify people's preferences. *Promotion* relates to a process of communication with users to inform and explain them the product benefits, to increase their desirability and acceptability. *Place* entails the necessity of installing technologies in the appropriate place for users. Finally, *Price* refers to a cost for the technology that takes into account affordability and adopts necessary measures to it. The use of "4Ps" model has been advocated in the WATSAN sector to help the achievement of successful strategies of technology implementation (Cairncross, 2004).

Academic works on social marketing emphasize the intrinsic link between theory and practice in identifying the key determinants of recipient decision-making process to adopt WATSAN systems. Jenkins and Scott (2007) modelled recipients' decisions to adopt improved sanitation systems in Ghana, based on the concepts of user preference, intention and choice. The authors identify the important role played by constraints in the decision-making process of recipients, with a lack of perceived constraints acting as a strengthening aspect of decision. A further example of applied social marketing was the UNICEF/DPHE (Department of Public Health Engineering) programme of social mobilization and communication in rural Bangladesh. The approach focused on raising awareness of hygiene aspects related to existing WATSAN practices as well as disseminating information on technical options available to potential users. The approach created a framework for social change, which involved local planning strategies and multi-stakeholder cooperation (Galway, 2000). A further evaluation study by the Water and Sanitation Programme (WSP) in India (World Bank, 2000) reported how the demand for 5,000 new sanitation systems was created thanks to a social marketing programme based on effective hygiene education and promotion of the social and cultural benefits of sanitation.

Criticism of the social marketing approach mainly stems from the orthodox school of marketing, which maintains that combining market approaches with societal goals is an inherently different approach responding to different mechanisms. Whether marketing approaches are determined by profit orientations or not, the social marketers' goals are purely altruistic. Furthermore, the products traded by social marketing approaches often lack the benefits deriving from competition. Consequently, product, use and prices are not defined by market dynamics. Finally, it is argued that social marketing approaches do not embrace the economic supply-demand mechanism. Rather, social marketers act where there is no demand for a product trying to generate it through the use of persuasion (Buchanan *et al.,* 1994). On ethical grounds, social marketing has been accused of being a manipulative and top-down practice based on suppliers' assumptions of what is good for recipients' health, trying to change their behaviour (Budds *et al.,* 2002).

2.4.3 Approaches to capacity building

As mentioned in Section 2.4.1 Demand-responsive approaches were supported by a reorganisation of the national and local government sector. This new development highlighted the need to improve capacity building of institutional stakeholders. The disappointing results of previous WATSAN interventions were partially explained by the inability of the institutional systems to create an enabling environment that ensured users' needs and the sustainability of WATSAN systems were addressed (Alaerts *et al.,* 1997). In most developing countries, local and national institutions were still characterised by supply-led mentalities, focused on the delivery and construction of WATSAN technologies rather than on users. Furthermore, lack of both intellectual and operational training in national and local institutions was considered one the main causes for resistance to the decentralisation required by the "appropriate technology" approach. At the UNDP Symposium-A strategy for water resources on capacity building, held in Delft in 1991, the concept of capacity building was defined on the basis of three components (Alaerts *et al.,* 1991):

- Creation of enabling environment with appropriate policy and legal frameworks;
- Institutional development including community participation (and participation of women in particular), and
- Human resources development and the strengthening of managerial systems, which involves skills and knowledge transfer but also a process of learning by doing.

Capacity building was more precisely defined by Alaerts (1996:61) as:

"The process to provide individuals, organizations and the other relevant institutions with the capacities that allow them to perform in such a way that the sector can perform optimally now as well as in the future. Capacity building helps initiating and supports institutional strengthening and reform. It is the process of implementing institutional development. The capacity building process (i) assists tin the diagnosis of the sector performance and intuitional strength and weakness; (ii) articulates and prioritizes the required capacities that need to be imparted to the individuals and institutions (e.g. through capacity building need assessments); and (iii) implements the support by using a variety of tools and instruments."

Capacity building is a supportive process characterised by a multidisciplinary approach to knowledge transfer that strengthens institutional development to improve awareness of environmental challenges and people's need in their constituencies, by acquiring the ability to address policy and implementation choices (Hamdy *et al.,* 1998). Okun and Lauria (1991:44) ague that capacity building depends on two interrelated activities: the strengthening of institutions in all aspects of sustainable water development and the development of human resources, which include educational and training packages, as well as the creation of working conditions that favour good performance. In devising a strategy for effective interventions in the WATSAN sector, Okun (1991) calls for efforts to build new capacities, whose demand is generated within the countries. He identifies two-dimensional levels of capacity building: at the national level capacity building would focus on the development of a favourable policy environment, the establishment of legal and regulatory frameworks and the use of information and communication systems. At local level, capacity building would involve learning alternative water management models, devise new strategies for involving users in planning, decision-making and implementation; developing appropriate water quality assessments, and ensuring financial feasibility of O&M.

Tools to support capacity building abound in the academic literature. Abrams (1996), for instance, developed a framework based on a concept of threshold. In his model it is argued that, although varying with type of technology, the process of capacity building focuses on three categories. These are: relevant skills (technical, administrative, governance and conflict solving); public awareness towards users' demand and willingness to pay for water and sanitation technologies; and economic and infrastructural aspects (infrastructural supports, flow of revenue to recover costs). A threshold of these capacities can be predetermined and the differential between existing institutional abilities in the defined categories and the threshold together with the characteristics of service technology chosen determine the capacity building needed. In seeking an empirical solution to sustainable development, Downs (2001) developed a conceptual framework for integrated capacity building which was tested in the water and sanitation sector in some Mexican cities. The developed framework indicated six interventions areas, where strategic capacities were to be strengthened: policy and finance, human resources, information resources, regulations and enforcement; infrastructure and market for water supply and sanitation. Subsequently, further models of capacity building have been developed as part of the IWRM approach (Lamoree and Harlin, 2002).

At the verge of the new millennium the international and academic discourse on WATSAN technology transfer and adoption expanded to embrace a multidisciplinary approach focused on environmental, social, cultural and institutional aspects. The technical and health considerations that first inspired WATSAN investments in the 1970s were now coupled with software aspects: users' involvement, gender issues and institutional capacity building. Table 2-1 summarizes the most relevant conceptual shifts that have occurred since the 1970s.

Table 2-1 Conceptual trends in WATSAN technology transfer

From	To
Water as a social good	Water as an economic good
Focus on water only	Increased importance of sanitation
Supply-driven approach	Demand-driven approaches
Helping governments to deliver	Helping government to create their own capacity and that of communities
Community involvement/ community participation	Community management and empowerment
Hardware aspects	Software aspects
Water Coverage	Sustainability of Water and Sanitation technologies

Source: Adapted from Black, 1998; Seppälä, 2002.

2.5 The implementation gap in the new millennium

Fifty years of technical assistance, aid interventions, R&D and political ambitions in the WATSAN sectors have brought radical changes in both thinking and practice, (presented in Table 2-2).

Table 2-2 The evolution of theory and practice in the WATSAN sector

Period	Theory	Practice	Landmark events
1950-1970	Health concerns for water and sanitation. Water is a social good.	Identification of prevention and control techniques for health. Engineering approach: transfer of sophisticated water supply and sanitation technologies.	First reference to the importance of water and by international organisations. World Bank disbursed first loan for WATSAN projects (1961).
1970-1980	Appropriate technology movement. Preparation for IDWSS decade. Stress on appropriate technology and access for all.	Design, production and transfer of small-scale and low cost technologies in rural areas of developing countries.	UN Conference on the Human Environment (Stockholm, 1972). UN Water Conference (Mar del Plata, 1977).
1981-1990	Low cost appropriate technologies. Supply-driven approaches. Community participation. Role of women.	Installation of appropriate technologies in developing countries. Timid attempts to community participation (mainly labour force and committees setup).	International drinking water supply and sanitation decade, (IDWSS 1981-1990) Women decade, 1975-1985. WCED Commission on sustainable development, 1987.
1991-2000	Community management. Demand –Responsive Approach. Sustainability. Water as economic good. Capacity building.	Water demand school (willingness to pay). Social marketing approaches to promote WATSAN technologies. Capacity building models.	International conference on Water and the Environment (Dublin, January 1992). United Nations Conference on Environment and Development (Rio de Janeiro, June, 1992). UNDP Capacity Building Symposium, (Delft, 1991)
2000-2015	Community Management. Capacity building. Integrated water resource management.	Sustainability assessments	UN Millennium Declaration, September 2000. International Water Decade: 2000-2015.

Source: Adapted from Black, 1998; Seppälä, 2002.

However, despite these developments, at the beginning of the new millennium the picture was still grim. In 1997, the United Nation Special meeting on the implementation of *Agenda 21* declared that "the overall trends with respect to sustainable development are worse today than they were in 1992" (UN, 1997: para. 4). Approximately 2.6 billion people were reported to lack improved sanitation facilities, and 1.1 billion did not have access to drinking water sources (WHO and UNICEF, 2005). In 2000, the UN summit once again put the problem of water and sanitation at the centre of the international agenda, by dedicating Target 10 to the achievement of further progress in the water and sanitation sector and proclaiming the period from 2005 to 2015 as the International Decade For Action (WHO and UNICEF, 2005). The urgent need to tackle WATSAN issues, which transpired from the recent international commitments, is a symptom that old problems still hamper the achievement of beneficial results. Why has the 50-year international effort to effective WATSAN technology implementation failed to achieve the expected results?

2.5.1 Problems with participation and Demand-Responsive Approaches

As discussed in Section 2.2, community participation became an important feature of WATSAN technology transfer during the IDWSS Decade. Since then, the discourse of participation has evolved to include different practices and approaches: from the mere contribution of volunteer labour that characterised participation in 1970s and 1980s, to the establishment of "community managed" projects undertaken under the umbrella of a Demand-Responsive approach, comprising full community control of decision-making and management of WATSAN systems (McGarry, 1991). Yet it is argued that the changes in community participation practices lie more in what was proposed rather than in its practice. Experiences in the field document that participation is not always implemented and is far from being an "inherently good" approach that ensures project effectiveness, technology sustainability, and community empowerment (Cleaver, 1999; Nance and Ortolano, 2007). Some scholars (McGarry, 1991; Cleaver, 1999) judge the difficulty in incorporating social empowerment through participation as being a function of the inherent features of WATSAN projects: tight deadlines, output orientation and practical needs. In a review of a water supply project in Ghana, Botchway (2001) defined the activities conducted as a "managerial and technocratic' exercise, where participation becomes a label for imposing top down agendas by foreign implementers.

The criticism of participatory practices and DRAs related to fallacious assumptions, advanced by practitioners and project implementers, of high responsiveness from the communities and users involved in participation. Firstly, there is a strong argument for the existence of homogenous communities with no social divisions and stratification, whose voice can be represented by selected leaders. Conveniently, this assumption enables implementing agencies to address their resources and commitment to more swiftly implement the technology within the project timeline (Narayanan, 2003). In so doing, participatory methods have the potential to exacerbate existing divisions within communities, further marginalising groups and promoting the views and needs of those people who are more easily accessible (Platteau and Gaspart, 2003; Hayward *et al.*, 2004). Secondly, it is assumed that individuals are willing to take part in participatory activities, because of the realised benefits and an inherent sense of responsibility (Cleaver, 1999). Hayward *et al.* (2004) argue that this postulation may lead to non-voluntary forms of participation that ultimately generate “fatigue” in respondents, imposing costs and reducing willingness to take part in future projects. Furthermore, technology ownership, which users are said to develop through participation and DRAs, implies cost-recovery responsibilities that they are not always able or willing to afford (Yacoob, 1990). Similarly, as argued by Harvey and Reed (2007), there may be no automatic relationship between user (community) ownership of the technology transferred and the development of a sense of responsibility for their participation in the management operation and maintenance of the systems. A final related assumption refers to the role of local authorities, and introduces the problem of institutional capacity building. The continuous support of local governments and agencies is said to ensure the sustainability of WATSAN schemes. However, in most cases participation constituted an opportunity for local government to transfer their responsibility for sustaining the technology to communities (Kleemeier, 2000; Botchawy, 2001; Acey, 2010). In his attempt to strengthen institutional support to WATSAN technology users, Lockwood (2004) argues how local and national governments may conceive DRAs to WATSAN implementation as a means of disenfranchising from activities of operation and management, for which skills and capacities are scarce. The above-described challenges with DRAs and participation cast light on potential emerging problems for the sustained use of WATSAN technologies, which, as will be discussed in Chapters 6 and 7, may undermine sustained system use.

2.5.2 Problems with institutional capacity building

Demand-responsive approaches and other community development interventions depend on the existence of cooperation and commitment from local institutions in the project. As discussed in Section 2.4.1 the need to frame a strategy for capacity building was one of the lessons from the IDWSS experience; and its importance was reaffirmed in the context of Integrated Water Resource Management. Yet today, capacity building presents challenges that vary across sectors and countries. Scholars recognise that the traditional tools of technical assistance and training have failed to build sustained capacities in developing countries institutions (Franceys and Weitz, 2003; World Bank, 2005).

Three main barriers to effective capacity building for water management have emerged from the review of the literature. Firstly, lack of harmonization between institutional departments and uncoordinated actions, which often characterizes government in developing countries, may slow down the decision making process in the WATSAN sector and generate misunderstandings in terms of responsibility allocation (Hamdy *et al.*, 1998; Sajor and Thu, 2009;). This often results in inaction and/or fragmented interventions by governments. Furthermore, as reported in the case of Southern Africa, coordination is often problematic due to jealousies and competition for fund allocation among departments (Mulenga and Fawcett, 2003).

Secondly, the centralised structure that still characterises governments in some developing countries may reduce the opportunities for multiple stakeholder interactions, leading central bodies to blindly take decisions concerning local realities. In some African countries, for example, national institutions are characterised by scarce awareness of the implementation procedures required by DRAs, as well as of the environmental and social development aspects of water and sanitation (Swatuk, 2005; Gumbo *et al.*, 2005; Gutierrez, 2007). Finally, the mandate for decentralizing responsibilities entailed by DRA has been met reluctantly by governments who fear loosing power and control over traditionally centralised policy-making modes (Sajor and Thu, 2009). Furthermore, where applied, decentralisation is often interpreted as an opportunity to transfer enormous managerial responsibilities to communities (Giné and Pérez-Foguet, 2008).

2.5.3 The MDGs and the post-implementation challenge

As we approach the deadline to achievement of the MDGs, the current shortfall in Target 10 represents a considerable challenge to the achievement of the planned outputs. Despite the appropriateness and ease of use of the WATSAN technology transferred, and the promotional and participatory and educational activities undertaken in support of implementation, progress towards Target 10 is characterised by discrepancies between regional areas and countries and between rural and urban areas. As reported by the WHO/UNICEF (2010), 884 million people still require access to improved water sources and 2.4 billion need to receive improved forms of sanitation for Target 10 to be met.

In investigating the reasons for lack of progress on Target 10, the academic community has advanced several reservations on the approaches adopted to meet the MDGs. Easterly (2009), for instance, has criticised the arbitrary use of both negative and positive indicators in selecting benchmarks against which progress on water and sanitation access is measured. Giné and Pérez-Faguet (2008) argue that the formulation of and strive to the MDGs by 2015 is driven more by the need of increasing WATSAN coverage rather than the necessity of adopting appropriate strategies to achieve long-term solutions. In their evaluation of performance to Target 10 based on an empirical desk study Castelló *et al.* (2010) reaffirm the lack of progress made to date towards Goal 7 and maintain the need for new studies focusing on the reasons for lack of success. An important observation, which refers back to the definition of sustainability in terms of technology longevity, is that the benefits from access to water and sanitation facilities may become meaningless if the longevity of the transferred systems is not guaranteed. Defining progress on the basis of the longevity and sustained use of WATSAN interventions subtly shifts the focus for analysis to the post-implementation phase of technology transfer. As seen in Section 2.3, the high percentages of abandoned WATSAN technologies were cited as examples of failure of the IDWSS Decade. Yet, evidence of unused water supply and sanitation systems is reported also in more recent assessments (Mackintosh and Colvin, 2002; Haysom, 2006; Rodgers *et al.,* 2007), reaffirming the importance of diagnosing problems after implementation. The post-implementation challenge and its urgency are exhaustively outlined in the literature (Carter *et al*., 1999; Harvey and Reed, 2007; Ademiluyi and Odugbesan, 2008). Focusing on the end users, these authors identify the following problems:

- Communities and households have not been convinced (or sufficiently persuaded) of the desirability of the WATSAN technologies;
- Financial costs which communities are expected to pay for technology operation and maintenance may result unaffordable and or unacceptable;
- Users are too poor to allocate funds for replacement of infrastructure and broken parts when they break down.
- User ownership of the technology does not translate necessarily in sense of responsibility for maintaining it.
- Benefits in terms of service quality, continuous support and improvement of socio-economic conditions may never materialise;
- Even when training and full participation has been achieved in the planning phase, individuals may lose motivation, or trained individual move away.
- Users may have no contact with local institutions (or the implemented agency) and they feel abandoned and unmotivated to manage and maintained the technology.

The post-implementation challenge appears to be defined by the discrepancy between users' intentions and willingness to use and adopt technologies, (which is typically measured by the pre-implementation approaches discussed in Section 2.4), and their actual behaviours after installation. In industrialised countries, the relations between intentions and actions in water-related behaviour have been extensively analysed and discussed in the literature (Hurlimann *et al.,* 2009). Studies assessing the predictive validity of Ajzen's (1985) Theory of Planned Behaviour have shown the existence of weak correlations between intentions and behaviour and contributions have tried to explain this discordance by introducing further behavioural determinants (Bagozzi *et al.* 1990; Sparks and Shepherd, 1992). In developing countries, however, the discrepancy between motivations and willingness in pre-implementation and subsequent experiences of use in post-implementation remains largely unexplored (Yacoob, 1990).

2.6 The knowledge gap and research questions

Ensuring acceptance and sustained use of WATSAN technologies drives the focus of attention towards end users and their ability to provide feedback. As discussed in the previous sections, the majority of research on WATSAN technology users and their behaviour in developing countries has often focused on the development of predictive theories, based on willingness to pay (i.e. Whittington *et al.* 1991), determinants of technology diffusion (i.e. Moser and Mosler, 2008) and effectiveness of participatory planning in the pre-implementation phase (i.e. Narayan, 1995). Although necessary to drive and increase the effectiveness of technology adoption, hypothetical scenarios emerging from planning tools do not necessarily or always translate into sustained technology use after the implementers leave and may not prevent the occurrence of those post-implementation challenges, discussed in Section 2.2.3. Confounding processes and phenomena may intervene after implementation, which need to be understood and diagnosed to ensure the longevity of implemented schemes.

Post-implementation analyses and evaluation of poor success rates of WATSAN technologies have focused mainly on the technical and engineering aspects of the process (see Harvey and Drouin, 2006). Although useful these types of assessment have failed to address the human and social aspects of technologies, which may affect users' post-implementation behaviour. Rightly, scholars (e.g. Hoos, 1979; Palm and Hosson, 2006) have argued that dominant paradigms of technology assessment still under-investigate the social aspects and user perceptions of technologies. Alternative diagnosis of technology assessment based on the human interface of the systems can be traced back to the work of Linstone *et al.* (1981) who conceived of technologies as multi perspective entities, that should be assessed on the basis the technical aspects as well as the personal and organisational features in which the system is embedded.

As discussed in Section 2.4, a growing body of literature has argued the importance of involving users at all levels of WATSAN technology transfer in developing countries (i.e. planning, management, monitoring and evaluation). To date, however, few studies have addressed the problem of emerging challenges to sustained technology use by evaluating users' experiences and perceptions of the implemented technologies. These contributions have investigated the reasons why users' drivers for change did not translate into appropriate actions (e.g. Mukheli *et al*., 2002; Simms *et al*., 2005). Their findings attribute project failure to non- technical aspects such as the empowerment and capacity building of recipients (Burra *et al*., 2003); the ease and convenience of using the technology (Burra *et al.*, 2003; Diallo *et al*., 2007) and social-cultural aspects (Rainey and Harding, 2005). However, there is still a pressing need for systematic approaches and tools that provide practical guidance for practitioners and project managers to routinely evaluate WATSAN technologies focusing on users' feedback.

Perhaps one of the most important attempts to develop a systematic approach to evaluate WATSAN projects through increasing user involvement is participatory evaluation, conceptualised by Narayan and the World Bank team (Narayan, 1993) and tested in the field in several developing countries. Participatory evaluation is defined "a process of collaborative problem-solving through generation and use of knowledge" (Narayan, 1993: p.9). As a tool for managing change, participatory evaluation provides the most beneficial results when conducted in partnership with communities and users of WATSAN systems. To support the process of participatory evaluation is the measurement of progress towards three main objectives: *sustainability* (the capacity to maintain the services without detriment to the environment); *effective use* (the optimal hygienic and consistent use of water and sanitation systems); and *replicability* (the capacity to duplicate the processes and benefits of a set of development activities) (Narayan, 1993). To measure progress towards the above-described objectives a series of indicators are conceptualised by the evaluators. The importance of participatory evaluation in the WATSAN sector rests on its focus on human capacities, constituting an important step to legitimise user involvement in project assessment and to foster collaboration among project stakeholders.

The approach, however, is not without criticism. Although participatory evaluation allows for flexibility of those indicators measuring progress and suggests adaptable data collection and analysis methods, the approach structure (objectives and indicators), and thus agenda for evaluation, is still pre-defined by the project evaluators. The establishment of rigid objectives and indicators of the evaluation may decrease users' and communities' freedom and flexibility to express their own priorities and goals in terms of water and sanitation and frame the agenda for evaluation.

Against the above-described background and in order to tackle the implementation challenges discussed in Section 2.5, the temporal focus of this thesis is fixed on the post-implementation stage of technology transfer, seeking to evaluate interventions through user feedback of the service and technology transferred. In so doing, this investigation takes distance from the *technocentric* approaches of technology transfer and implementation (discussed in Section 2.3) by embracing Linstone *et al.*'s (1981) imperative of considering human and organisational aspects of technology use. Furthermore, differently from the above-described participatory evaluation approach, this research employs the conceptual framework of Receptivity (Jeffrey and Seaton, 2004) that guides users in framing the agenda for assessment of WATSAN system. Similarly to the participatory evaluation method, Receptivity entails a greater involvement of WATSAN technology users', marking a novel focus for assessing progress in the WATSAN sector. Unlike the participatory evaluation approach, however, Receptivity does not impose objectives or indicators for evaluation, rather it allows recipients to frame the agenda for change, by focusing on their feedback of the most salient aspects of the WATSAN technologies implemented. The main premise that rests behind the idea of Receptivity, in fact, is the inability to understand the responses and behaviours of people/communities to a technology (or a policy) without also understanding the perceptions, attitudes and agendas for change which are relevant to them.

Relevant precursors of the work on Receptivity adopted in this thesis (Jeffrey and Seaton, 2004) are the Accessibility Mobility and Receptivity (AMR) framework (Seaton and Cordey-Hayes, 1993) and the 4As model (Trott *et al.*, 1995), which all stem from dissatisfaction with *technocentric* approaches of technology transfer. The origin and development of Receptivity will be further discussed in Chapter 5, however, for the moment it is necessary to state that conceptual framework of Receptivity is employed in this research as a guidance to frame agenda for evaluating users' willingness and ability "*to absorb, accept and utilize innovation options* (Jeffrey and Seaton, 2004: 282) in the water and sanitation sector. In adapting Trott *et al*.'s model to the water sector Jeffrey and Seaton's (2004) redefined the main components of the Receptivity framework as described below.

Awareness concerns people and/or communities' perceptions of an existing problem related to water and sanitation. This component of the framework is employed to explore a community's or a group's ability to develop a set of beliefs towards an emergent phenomenon or problem, such as poor water quality or maintenance problems. *Association* refers to recipient's ability to understand the link between certain policies and behaviours related to water and sanitation and their consequences. Association requires a mapping activity between two different knowledge domains. The first refers to the attributes that have to be addressed in order to solve a particular issue, while the second domain represents the potential for a technology to deliver those attributes. In the case study of water recycling presented Jeffrey and Seaton (2004), association involves households' ability to understand the positive impacts of water reuse in terms of financial savings and of sustainable environment purposes. *Acquisition* involves a process of learning through which the recipients gain the knowledge and skills necessary to incorporate a technology and/or to absorb a policy. This could be households' ability to install water purification systems, as analysed in the water filter case study (Jeffrey and Seaton, 2004). Finally, *application*, describes a community's capability to receive long-term benefits from technologies applied or policy implemented. This implies the ability of internalising the innovation in the recipients' routine, organising maintenance and managing risk.

The importance of Receptivity to the evaluation of WATSAN technologies in developing countries rests on its focus on the feedback from users of WATSAN facilities by directing attention to those aspects of their experiences that influence acceptance of the systems and thus their sustained use. By focusing in the post-implementation stage and exploring users' experiences of WATSAN technologies in developing countries, this thesis contributes to the theoretical and practical debate of WATSAN technology sustained use, diagnosing problems and suggesting timely solutions to increase support of recipients in the post-implementation.

This research is characterised by the investigation of an exploratory Case Study I (CS-I), which aimed at eliciting users' experiences and acceptance of Community Ablution Blocks (CABs) in eThekwini municipality in South Africa. The research questions that guided the investigation of CS-I are presented in Table 2-3.

Table 2-3 Research Questions

RQ 1	What are the aspects that affect recipients' ability to adopt WATSAN technologies?
RQ 2	What are the key processes that affect recipients' acceptance the WATSAN technologies in developing countries?
RQ 3	What are the key processes that affect recipients' ability to use and sustainably use WATSAN technologies?

These research questions will be partially answered in Chapter 4. However, the critical analysis of results from CS-I prompted the development of a novel approach to investigate post-implementation acceptance and sustained of WATSAN technologies by comparing and contrasting providers' and users' perceptions of the implemented systems. Thus, the above-presented research questions were modified to reflect the research's evolved scope and greater ambition, which comprises the development a diagnostic tool, called RECAP, to evaluate intended performance and experience of both provider and users' of WATSAN technologies in post-implementation. The development of the RECAP diagnostic tool was prompted by the analysis of results of CS-I, as well as by the urgency to understand post-implementation challenges and suggest solutions to their sustained use. The new research questions will be presented in Chapter 5, after an exhaustive description of the process of RECAP development. The RECAP tool is deployed and tested in the investigation of Case Study II (CS-II), community managed DEWATS in Java and Bali, discussed in Chapter 6 and of Case Study III (CS-III), water disinfection methods in Flores Island, Indonesia, presented in Chapter 7. Finally, a reflection of the experiences gathered as well as an evaluation of the RECAP tool are provided in Chapter 8.

CHAPTER 3: PARADIGMS AND METHODS OF ENQUIRY

3 PARADIGMS AND METHODS OF ENQUIRY

This chapter describes the adopted methodological approach, which employs multiple case study analysis to generate a diagnostic tool, called RECAP, to evaluate WATSAN technologies. Sections 3.1 and 3.2 provide an overview of the main aspects of those philosophical paradigms and strategies of enquiry adopted in designing research. A justification of the method chosen and detailed account of the research design is presented in Section 3.3. Sections 3.4 to 3.6 illustrate in detail the procedures for case study selection and sampling, the data collection techniques and methods adopted in this study. Section 3.7 describes the process of data analysis. Section 3.8 explains the validity and reliability of this research. The final Section, 3.9, outlines the measures undertaken to ensure ethical conduct of this research. Throughout this chapter the theoretical approaches that guided the empirical research and the development of the RECAP tool are illustrated and justified.

3.1 Researching social reality: philosophical paradigms

The research reported in this thesis investigates WATSAN technologies and the interactions of stakeholders with such technologies in the context of developing countries. The study of socio-technical interactions is a complex activity, which requires development of an understating not only of the technical but also of the social, organisational and contextual dimensions involved (Linstone *et al.,* 1981). The investigation of social reality is informed by philosophical paradigms, each encompassing a distinctive *axiology*, considerations about moral and ethics; *ontology*, beliefs about nature of reality; *epistemology*, assumptions on how to know reality; and *methodology*, the means for investigating reality (Blaikie, 1993; Denzin and Lincoln, 2003). In formulating a research design, philosophical paradigms guide the researcher in selecting an appropriate strategy of enquiry and methods of data collection and analysis to answer the research questions. Major variations of such paradigms considered are labelled: positivism, post-positivism, critical theory, constructivist-interpretive, and feminism. A summary (Blaikie, 1993 and 2000; May, 2001; Lincoln and Guba, 2003; Schwandt, 2003) of their underpinning features is presented in Table 3-1.

Table 3-1 Philosophical paradigms

	Positivism	Post-positivism	Critical theory	Interpretivism	Feminism
Representative traditions and references	Bacon (1620); Mill (1879)	Popper (1959, 1961); Lakatos (1970)	Habermas (1972); Fay (1975)	Phenomenology (Schutz, 1967; Garfinkel, 1967) Hermeneutics (Gadamer, 1970; 1975);	Harding (1987); Bloom (1998)
Ontology	Naïve realism; There is an ordered universe of observable events. Only what can be experienced by senses is real.	Critical realism; Reality only imperfectly and probabilistically understandable.	Historical realism; Virtual reality is shaped by social, political, cultural, economic, ethnic values.	Relativism; Local and specific constructed reality.	Natural and social world are social constructions, which differ from location and experience.
Epistemology	Knowledge derives from sensory experience.	Observations are theory dependent. Theories are invented to account for observations	Researcher's cognitive interests determine the procedures to discover knowledge	Knowledge derives from everyday concepts and socially constructed meanings	Women's experience is the basis for knowledge
Methodology	Experimental; manipulative; Verification of hypotheses	Modified experimental; manipulative; falsification of hypotheses	Dialogical, the observer is involved in the shared framework of cultural meanings	Hermeneutical, dialectical	Dialectical; Objectivity draws on commonality of feelings and experience
Mode of enquiry	Inductive	Deductive	Abductive	Abductive	Abductive
Nature of knowledge	Verified hypotheses are established as laws	All knowledge is tentative and subject to continuous critical evaluation	Structural/ historical insights.	Individual reconstruction coalescing around consensus	Description and explanation are guided by theory and story
Aim	Establish universal generalisations to explain and predict	Test theories to eliminate false ones and corroborate those that survive.	Criticise and transform the investigated reality.	Describe and understand social life in terms of actors' accounts	Transform and emancipate the investigated reality.
Role of researcher	Unbiased; conducts research from the outside, ignores subjects' meanings and adopts standardised methods		Researcher and researched engaged in dialogical communication.	Researcher as participant and facilitator of multiple voices reconstruction	Researcher uses feelings and intuitions as part of the research process

Source: Adapted from Blaikie, 1993; Schwandt, 2000; Lincoln and Guba, 2003

An analysis of the features of the above-described paradigms has informed the selection of interpretivism as the theoretical approach guiding this study. The interpretive paradigm is defined as "*the systematic analysis of socially meaningful actions through the direct observation of people in natural settings in order to arrive at understandings and interpretations of how people create and maintain their social world*" (Neuman, 2003:7). The purpose and distinctive features of interpretivism support the goal of this study, which broadly seeks to explore the problems at the basis of scarce success of WATSAN intervention by exploring and understanding challenges through the lenses of the relevant stakeholders involved. Reflecting the interpretivist ontology, this study maintains that interactions between technology providers and users are fundamental to understanding the discrepancies between performance and experience of WATSAN technologies. The view of social reality as a series of interactions among social actors places interpretivism on opposite ground as to positivist traditions, which conceive social life an ordered pattern of events that must be decoded by the researcher. Furthermore, the interpretivist approach conceives the meanings and interpretation that people attach to everyday life as the basis for understanding social reality. By embracing an interpretivist epistemology, this study seeks to uncover these meanings by examining different viewpoints, those of users and providers of WATSAN technologies, to understand and interpret the problems and challenges to their sustained use. In this process of understanding phenomena through stakeholders' accounts of reality, the researcher reconstructs and interprets the meanings of the subjects investigated.

Although in this research a process of quantitative data collection was adopted to gather responses from technology users, the tension between quantitative and qualitative approaches to data collection and analysis, as advocated by positivist and interpretivist traditions respectively, was mitigated by means of some actions. Firstly, the developed questionnaires focused on eliciting respondents' accounts of their experiences and perceptions of WATSAN technologies. The questions formulated went beyond the mere investigation of descriptive aspects and sought to explore and understand reasons for technology use and non-use. Furthermore, users' perceptions of and suggestions for WATSAN technology improvement were explored, allowing respondents to express their feedback on the technologies based on their own priorities. Moreover, the analysis of the data gathered employed simple statistical tests to emphasize the richness of respondents' views and meanings related to the technologies investigated. As will be discussed in Section 3.7.1, the use of univariate statistics allowed the interpretation of the responses obtained, which conforms to the intepretivist strategy of enquiry.

3.2 Strategies of enquiry in field research

This study gathers and analyses primary data in the field in two developing countries. The concept of "fieldwork" first emerged from Alfred Haddon's speech addressed to the Anthropological Institute of London in 1902, where the need for "fresh investigation in the field" was emphasised (Haddon, as quoted in Tedlock, 2000). Nowadays field research epitomises a need shared by scholars in many disciplinary areas, such as education, politics, social sciences, nursing and management for new practices to directly gather their own information in natural settings, as opposed to desk-based research.

When facing the choice of a strategy of enquiry in fieldwork, a researcher must select the most appropriate approach among several genres, considering aspects such as resources and time available, researcher's skills and capacities, personal inclination to research investigation. Among the genres available for selection, some of the most important and most commonly adopted in field research are: Ethnography, Participatory Action Research (PAR), Grounded Theory (GT) and Case Study research. An overview of these genres their strengths, weakness and application in research, (summarised in the following sub-sections), provided evidence to support selection of an appropriate strategy of enquiry tailored to the specific purpose and characteristics of this study.

Ethnography

Ethnography is defined as the long-term engagement and immersion of a researcher in the daily lives of subjects, recording what is observed and heard (Hammersley and Atkinson, 1995). Originated as a method in anthropology, Ethnographic research aims to provide a contextualised interpretation of human life in a natural environment (Tedlock, 2000). Examples of Ethnographic studies in the field of water and sanitation in developing countries are several. They are mainly experienced accounts of health practices related to water and sanitation services used by people living in poor and remote communities (e.g. Rutherford and Roux, 2002; Segers *et al.*, 2008). Ethnographic research, oriented to naturalism, values the adoption of a respectful attitude towards the observed and the understanding of the symbolic world in which subjects live (Hammersley and Atkinson, 1995). The notion of a researcher who creates an "intimate reciprocal involvement with the community based on trust" (LeCompte and Schensul, 1999) is one of the main tenets of Ethnography.

In ethnographic research the main modes of data gathering are unobtrusive techniques, such as participant observation, informal conversations and interviewing. Participant observation is said to grasp meanings that subjects attribute to their behaviours (Malinovski, 1929). In Ethnography, fieldwork preferences have evolved from using covert observation of subjects as an unbiased way to depict events, to researchers behaving as active members of a community interacting with the subjects investigated (Angrosino and Myas de Pérez, 2000). One of the most important instrument used to record observation are field notes (Fielding, 2008), which contain records of what was experienced through verbal communications as well as descriptions of events. The analysis of field notes involves the identification of patterns and categories, by checking the data against interpretation whilst still in the field. This provides a focus for further collection and analysis on the themes identified (Fielding, 2008). Advocates of ethnographic research argue its usefulness as method to test and generate theories through identification of patterns of observed reality that are anchored in time and context (LeCompte and Schensul, 1999). The main findings of ethnography, however, are accounts of the reality observed through narratives; and memoirs, characterised by rich data and thick descriptions.

Possibly one of the most interesting strategies for investigating culture and traditions in the field, ethnography is often criticised on the grounds of the resources engaged by the method, its validity and ethics (LeCompte and Goetz, 1982). Ethnography is a time-consuming strategy that requires significant amount of time in the research setting. It is also extremely demanding on the researcher who is required to familiarise themselves with the norms and culture of the people observed, often learn their language, their habits and take part in daily interaction. Concerns about this practice cluster around the risk of the researcher "going native" (Chambers, 2000), and transforming into an advocate of the observed group.

Questions of validity refer to inaccurate representation of reality produced by ethnographic research, due to the genuine difficulty of objectively interpreting the events investigated. Concerns from a positivist perspective (see Table 3-1) are raised about whether different observers, working independently in the same setting, would produce the same findings; and whether the same findings would be replicated in different settings. Ethnographic research aims at investigating process of change in a context, whose replicability may be difficult to achieve the unique character of the events investigated (LeCompte and Goetz, 1982). A further criticism of participant observation is advanced on ethical grounds (Chambers, 2000). The request of professional research bodies to obtain informed consent from research participants have imposed several constraints on the adoption of ethnography as a fieldwork technique, especially when the subjects investigated are likely to resist the inquiry. Furthermore, observing participants, who aware they are being studied, may decrease the value of the knowledge generated, with observed subjects not acting naturally.

Participatory Action Research

Participatory Action Research (PAR) originate from the tradition of "Action Research" (Lewin, 1946) which founds on the core assumption that study of human behaviour is more likely to produce valid result when humans participate in investigating those behaviours (Argyris and Schön, 1989). From the Lewinian tradition several forms of action strategies have emerged, such as action science, (Argyris and Schön, 1974), which focuses on solving critical problems to society and organizations placing emphasis on a set of theories that participants developed in practice and Participatory Action Research. PAR is "a form of research involving practitioners as both subjects and co researchers" (Argyris and Schön, 1989: 613), linking capacity building and change through action in the social system (Whyte, 1989). As PAR was developed as an approach for poor and disadvantages groups in developing countries (Kindon *et al.*, 2007), examples of this strategy of inquiry in these countries are numerous. In the field of water and sanitation, PAR has been adopted to build and improve water management practices (Schaap and Nandi, 2005), to plan and allocate natural resources within projects (Tippet, 2005) and introduce new water systems (Socheat *et al.*, 2004). The Participatory Action researcher views reality as constructed interpretations of a phenomenon, which can be known and changed. Given participants' awareness of their own condition, PAR posits that their involvement is fundamental to discern the reality and transform it (Kemmis and McTaggart, 2005). Research is oriented to evaluate, solve problems and emancipate people through a cyclic process of action and reflection about social meanings and values to create new knowledge and abilities (Hart and Bond, 1995; Reason and Bradbury, 2008). The most common techniques adopted in PAR are dialogues between researchers and participants, story telling and visual methods. However, qualitative and quantitative techniques of data gathering may be used and combined according to the aims given by the subject of research (Bradbury and Reason, 2003). The validity of PAR is not measured in terms of the objectivity of the results and rigorous methodology, but rather in its ability to bring about the initiated process of learning and change in the participants involved.

There are several practical and ethical considerations to be addressed when adopting a PAR approach. Participants' ownership over the research process, data and outcomes must be ensured, so that participants agree not only with the methods adopted but also with the process of change (Silver, 2008). Participatory Action researchers may find it difficult to involve communities and keep them motivated throughout the process. A community is never a homogenous entity and divergent needs and opinions may undermine the group's motivation to contribute to the investigation (Cornwall and Jewkes, 1995). Furthermore, PAR is criticised for producing results that are too context-specific and idiosyncratic (Frideres, 1992; Silver, 2008), undermining generalisation or theory building. Whether or not this concern relates also to other qualitative research strategies, such as Ethnography, the problem in PAR is more accentuated due to the emancipatory goal of the research. In PAR findings, recommendations and changed attitudes must be transferable to participants to ensure sustainable change.

Grounded Theory

The Grounded Theory (GT) method was developed by Glaser and Strauss in the course of a study on dying hospital patients (1967). GT embodies a set of guidelines to inductively generate theory from empirical data (Glaser and Strauss, 1967). Theory development starts at the very onset of investigation. The researcher enters the investigation setting with no preconceived theories or hypotheses, maintaining a neutral attitude towards the phenomenon explored. Collection and analysis of data occur simultaneously: open and selective coding procedures serve the purpose of organising data into categories and identifying relationships among them. The process of constant comparison helps to compare incidents (units of text) within a category with more incidents in the same category, to build up properties of that category. The process of coding and comparing instances direct further empirical investigation and sampling to explore only those data relevant to the categories identified (Glaser and Strauss, 1967). Throughout the entire investigation an important step is the writing of memos to capture emergent and mature ideas and links among codes and categories (Glaser, 2004). The validity of the theory which emerges from GT study is judged by its ability to predict, explain and be clearly understood by other scholars familiar with the subjects and to be used by them (Glaser and Strauss, 1967).

Glaser and Strauss' approach has been adopted and adapted by academics and practitioners in several fields, such as education (i.e. Blay and Ireson, 2009), nursing (i.e. Jacobsson *et al.,* 2004) and management (i.e. Geiger and Turley, 2003). The application of GT in research in developing countries, although modest, is limited to the study of health and social-care areas (Regmi and Madison, 2009). One of the main strengths of GT is said to be its "open-endedness and flexibility" (Charmaz, 1990:1168): the simultaneous process of data collection and analysis, allows the researcher to produce exhaustive investigations by filling the gaps that may emerge during the analysis (Turner, 1983; Charmaz, 1990; Orlikowski, 1993). Furthermore, GT provides a flexible tool to analyse a substantive area of research, which if repeated at multiple sites can generate potential for generalisations and predictions (Charmaz, 2003).

The GT method, however, is not without criticism. GT is dismissed on the grounds of its epistemological and methodological assumptions, which reopen the traditional debate between the positivist and interpretivist traditions (See Table 3-1). The classic approach is said to embrace a positivist view of a reality, characterised by events and facts that can be objectively analysed, described and predicted (Charmaz, 2000; Kelle, 2005). Hence the notion of the researcher as an unbiased observer, who passively lets the data shape the development of theory (Glaser and Strauss, 1967; Glaser, 1978). Besides reinforcing a core positivist postulate, this aspect casts doubts on one's ability to analyse data without reference to one's own experience, pre-existing knowledge or formed ideas related to the investigated phenomena (Bryant, 2002; Kelle, 2005). Further concerns about GT reside in the methodological rigour of its analytic procedures that are said to inhibit the researcher's creativity and interpretation (Hodkinson, 2008). The rigid data coding procedures create distance between the researcher and the phenomena under analysis, concealing in-depth understanding of the phenomena from subjects' viewpoints (Conrad, 1990). A final critique to the method refers to a lack of clear explanations of its constituting elements, such as imprecise definitions of "theory" and of the concept of "theoretical saturation" (Charmaz, 1990). Confusing terminology and misinterpretation has inevitably resulted in questionable applications of the method. Misuse and misinterpretation of GT are symptomatic of differences in the founding fathers' intellectual and research backgrounds: Glaser was influenced by Lazarsfeld's quantitative background and the Columbia tradition of doing research whilst developing theory and Strauss was inspired by interactionist and pragmatist studies (Strauss and Corbin, 1998). Strauss took distance from the positivistic underpinnings of the classic methods to focus on meanings and process. In their reformulation, Strauss and Corbin (1990; 1998) maintain the core assumptions of the classic conceptualisation, such as "theory grounded into data", open and selective coding procedures, comparative methods; but also introduce novel elements. These include new analytical procedures, such as "axial coding, dimensionalising and conditional matrix" (Strauss and Corbin, 1990; 1998); as well as a much stronger emphasis on the interplay between induction and deduction in theory generation.

Case Study research

Case-study research is defined as a strategy that "investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 1994:13). Case study research can involve single and multiple cases and numerous level of analysis (Eisenhardt, 1989). Single case study investigation can be used to build a "critical case" (Yin, 1994) that challenges or tests an existing theory. If the theory survives the test, it will gain strength and credibility. Secondly, a single case study can be adopted as an extreme example of a phenomenon that is worth being studied for its exceptional character. This approach is commonly used in psychology to study deviant instances (Blaikie, 2000). A third rationale for using the case study is to present a unique case that has never been investigated before, whose validity is justified by the descriptive information provided. Furthermore, a case study may be *embedded*; that is, it involves multiple units of analysis with units and subunit levels (Yin, 1994). Case study research must not be confused with qualitative research: it can adopt both qualitative (interviews, participant observation) and quantitative (surveys) data gathering techniques.

Scholars have used case study design for a variety of purposes: to explore, describe and explain dynamics within a context, to test existing theories (Pinfield, 1986), or to stimulate a process of change (Gummesson, 1991). There are several examples of case study based research in the field of water and sanitation in developing countries. These typically involve in-depth accounts of environmental, social, health and technical aspects related to water or sanitation services in villages and communities (e.g. Osumanu, 2008; Godfrey *et al.,* 2009;). Interestingly, the use of multiple case study research in developing countries is less common, because of the time, financial and personal efforts required by this type of investigation. However, the most interesting use of case study research is the adoption of multiple-case design to generate theory (Eisenhardt, 1989; Yin, 1994; Eisenhardt and Graebner, 2007). Whilst single case studies can richly describe or explain a phenomenon, multiple case study research creates the basis of theory development through comparison of emerging findings and grounding in empirical evidence.

Central to theory building in multiple case study research is the logic of replication, which has the purpose of predicting or contrasting results or extending emerging theory. Theory building through multiple cases is a process that cycles between the inductive and deductive logic of theory building and testing (Eisenhardt and Graebner, 2007). A fundamental step in multiple- case studies is to define the research problem and identify a theoretical gap in the existing literature. This focus is extremely important to avoid “getting lost” in empirical data (Eisenhardt, 1989; Eisenhardt and Graebner, 2007).

However, the questions and theoretical constructs developed should not be treated as definite, because they can be modified and remodelled by subsequent data collection and analysis. Case selection is important as it entails a selective approach, which focuses on those incidents that can offer insights for expanding and refining theory.

The strengths of multiple case study research reside in the empiric validity of the theory generated: the process of theory building is linked to data and accurately represents the phenomenon investigated. The theory developed is reliable as it can be repeated using the same methods. Finally, theory shows external validity in that results can be generalised through the logic of replication (Kidder and Judd, 1986; Yin, 1994). Concerns about multiple case study research are made on the ground of its ability to produce generalisation. Dissenters focus on the fact that case studies are too unique and idiosyncratic to establish any element of comparison among them (Blaikie, 2000). A further criticism to case study research relates to being a time consuming endeavour, which produces a high amount of data. This criticism derives from confusing cases study as research strategy with ethnography, or with data collection techniques such as participant observation (Yin, 1981).

The above-presented overview of strategies of inquiry has highlighted valuable strengths as well as weaknesses of each approach, and, in some cases re-formulations and adaptations. These strategies, whose salient features are summarised in Table 3-2, should not be hierarchically classified as “good” or “bad”, but considered as a set of equally useful approaches to research.

Table 3-2 Strategies of enquiry

	Ethnography	PAR	Grounded Theory	Multiple Case Study
Enquiry mode	Inductive	Inductive	Inductive	Inductive-deductive
Enquiry purpose	Describe and understand	Emancipate participants and solve problems	Generate theory from data	Generate theory and understand
Sampling	Small sample, dependent on access, time and context	Small groups in need	Theoretical sampling	Theoretical sampling
Data collection	Qualitative: participant observation and informal conversations	Interviews, focus groups, visual aids	Both quantitative and qualitative (preferred)	Both qualitative and quantitative
Data analysis	Narrative, description of field notes	Continuous reflexive process to plan action and change	Coding and constant comparative method	Within case and cross case patterns identification
Role of existing knowledge	No preconceived theories	Only participants' knowledge is considered valuable	Conceptualisation to be avoided. Existing literature only as source of primary data	Frame research design, focus data collection and conceptualisation
Role of researcher	Member of the observed group	Collaborator that fosters change	Objective, Unbiased and free from pre-existing conceptualisation	Instrument of research whose experience and previous knowledge shape process
Validity	Researcher's ability to immerse in the setting and represent reality	Change in action	Theory fits and work	Internal and external validity

The process of selecting a strategy of inquiry depends on the interplay between theoretical issues (research's aim, epistemological and ontological assumption of the investigated reality) and practical consideration (available time, resources, and researcher's skills and inclination). This study's purpose is to explore and understand the problems and challenges to WATSAN technology acceptance and use, by investigating the experiences of WATSAN users in the post-implementation stage. The interpretive paradigm, which drives the investigation of the reality, is accompanied by a multiple case study strategy of enquiry, which allows for exploring post-implementation experiences of WATSAN technologies in three sequential Case Studies. Furthermore, a multiple case study approach was selected, for it allowed the author to validate the RECAP tool, through repeated application in various cases studies. The sequential process of collection and analysis follow the inductive-deductive logic to strengthen the RECAP tool validity and reliability. Admittedly, a similar approach to build “theory” from data is advocated by Glaser and Strauss’ GT. However, this study takes distance from the positivist ontology and epistemology, which guides GT. The researcher is not considered an unbiased observer entering the research setting with no preconceived ideas; conversely, the researcher’s values, assumptions and previous experience play a pivotal role in understanding and analysing data. It follows that the foregoing review of existing literature on the subject was a fundamental aspect in this research to identify potential gaps and develop a diagnostic tool to be verified and modified in subsequent investigations.

Finally, practical considerations have influenced the selection of a multiple case study approach as the appropriate strategy of enquiry. On this ground, ethnographic studies would have required significant time and resources to enable the researcher to become immersed into natural settings of the investigated communities, which was not available for this research (Chambers, 2000). Similarly, although PAR represented a suitable candidate strategy for achieving this study’s objectives, time and resources available were not sufficient to action the transformation of social reality advocated by the approach (Kemmis and McTaggart, 2005).

3.3 Research design

This thesis is characterised by a complex research design, guided by an interpretive ontology and epistemology, employing a multiple case study approach. An initial exploratory Case Study (CS-I) was conducted to provide an answer to the initial set of research questions, introduced in Chapter 2.6. This was followed by the investigation of two explanatory Case Studies (CS-II and CS-III), which aim to explain and understand the assumptions that emerged from the analysis of CS-I. This strategy of enquiry based on reiterated investigations of a phenomenon provides an account of the challenges to acceptance and sustained technology use in the case studies investigated, as well as the development and testing of a diagnostic tool to evaluate WATSAN technologies in post-implementation. The case studies were investigated and analysed sequentially through a mix of inductive and deductive methods to produce both substantive knowledge, explanatory accounts of each case study investigated, and to construct a valid and reliable diagnostic tool, (see Figure 3-1).

The development of RECAP tool was prompted by the process of data analysis and conceptualisation derived from coding and subsequent generation of new understanding of the phenomena investigated. As highlighted in Section 3.2, theory generation through the logic of replication constitutes one of the main strengths of multiple case study approach. Defining theory is a hard task, as many meanings, perspectives and referents exist. The definition of theory used in this research is that of an integrated set of concepts and propositions that assert relationship among concepts (Land, 1971; Willer, 1967). Similarly, theory building can be defined as "the process of modelling real-world phenomena" (Torraco, 1997: 123) through the testing and validation of identified relationships. Theory building is dynamic: it captures not only the causes of the phenomena investigated but also the process through which they occurred and evolved. Thus, the RECAP tool is conceived as a theoretical construct developed to explore relationships between intended performance and experience of WATSAN technologies, through a sequential process of data collection, analysis, hypotheses generation and verification. The research design adopted in this study provides a multiple output. At a case study level, the investigation aims to generate substantive exploratory and explanatory accounts of the phenomena under consideration. These accounts provide insights and recommendations that, although not generalisable, may be useful to understand processes for similar WATSAN technologies. Concurrently, on a theoretical level, the development of a diagnostic tool, applied and tested in two case studies (CS-II and CS-III), can enhance its validity and reliability to be applied in other post-implementation evaluations of WATSAN technologies in developing countries. Thus, on a theoretical level, the RECAP tool development achieves the desired degree of generalisability that satisfies the ambition of this research.

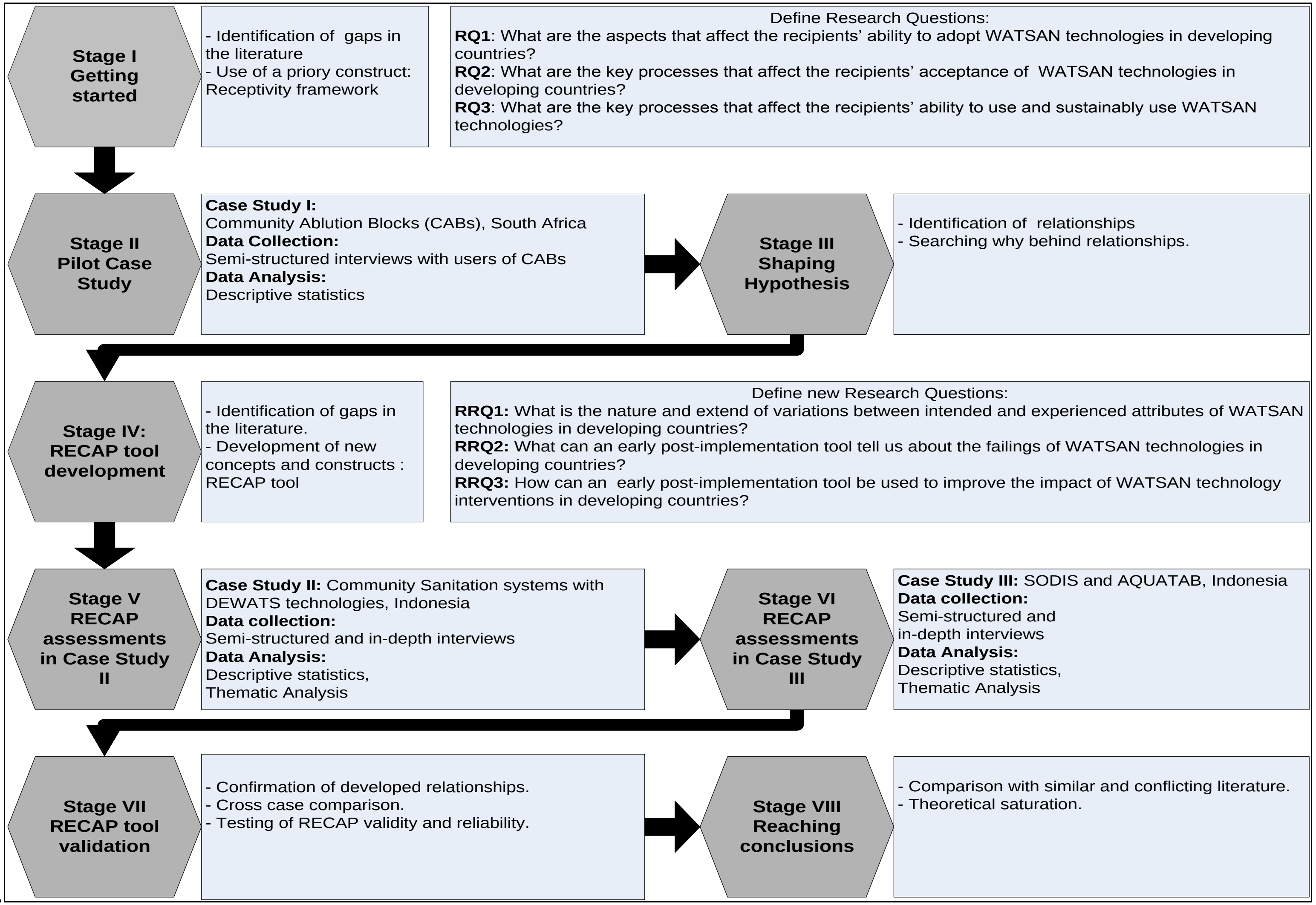

Figure 3-1 Research design

The dual role of RECAP

The previous Section briefly illustrated the role of RECAP as diagnostic tool to evaluate problems with WATSAN technology in post-implementation stage. An exhaustive description of RECAP as diagnostic tool, the theoretical background informing its development, its structure and application will be provided in Chapter 5. For the purpose of this methodological Chapter, it is necessary to highlight the role played by RECAP tool as a research support method to generate data for analysis. The tool investigates discrepancies between intended performance and experience of WATSAN technologies in developing countries. This approach identifies two realms for investigation that guide the process of data collection and analysis. To assess technology performance, data from providers, through in depth interviews, as well as secondary data are generated; whilst to investigate experiences of technologies users' perceptions of the systems are elicited by means of semi-structured interviews. This iterative process of enquiry cycles between eliciting understandings and experiences from technology providers and users, and, through a comparison of the results obtained, problems and challenges to WATSAN technology are explored.

3.4 Case Study selection and sampling

This research investigates three case studies characterised by different types of WATSAN technologies, in South Africa and in Indonesia. These are the following:

- *Case Study (CS-I):* Community Ablution Blocks (CABs) in Durban, South Africa.
- *Case Study (CS-II):* Community Sanitation Centres (CSCs) and Simplified Sewerage Systems (SSS) with Decentralised Wastewater Treatment Systems (DEWATS) managed by communities in central Java and Bali, Indonesia.
- *Case Study (CS-III):* Solar bottle disinfection systems (SODIS) and water disinfection tablets (AQUATAB) in Flores, East Nusa Tenggara province of Indonesia.

The selection of CS-I was justified by the need to explore the gaps identified in the literature and answer the preliminary research questions presented in Section 2.6. After the analysis of the data gathered in CS-I and the subsequent development of RECAP tool (see Chapter 5), the process of Case Study selection was informed by the guidelines provided by the developed approach. CS-II and III were selected as they fulfilled the criteria necessary for the application of a RECAP assessment: accessibility to technology users and providers' willingness to participate and early post-implementation opportunities. Furthermore, the investigation of a different spectrum of WATSAN technologies, water and sanitation, as well as community and household level systems, was sought in order to test the applicability of the tool to different types of cases and technologies, thus improving its reliability.

Within each Case Study, the implemented WATSAN technologies were selected through a process of theoretical sampling. Neuman (2003) defines theoretical sampling as a method that uses the researcher's judgment to choose cases that are specifically informative for the study. In the exploratory Case Study (CS-I), three community ablutions blocks were selected for investigation on the basis of their operational age. Specifically, in the first two units -CAB A (Clermont) and B (Amaoti)- had been in use for two years and four months respectively, and the third one -CAB C (Clermont)- had just been completed at the time of the investigation. This selected sample allowed the exploration and comparison of users' experiences and also those of future users of the implemented systems, important to explore aspects that may affect acceptance of the implemented technologies and their long-term sustained use. As previously explained, the conduct of the exploratory case study and the subsequent analysis of results stimulated further thinking which allowed for the development of a diagnostic tool, deployed to investigate CS-II and CS-III. The selection of areas for investigation in CS-II and CS-III were dictated by the criteria needed for a RECAP assessment: access to technology users, providers' willingness to participate and technology operational age. Thus, within CS-II, 13 communities served by DEWATS technologies were selected in Central Java and Bali; and in CS-III, three villages, where SODIS and AQUATAB had been recently implemented, were investigated. In CS-III the researcher was informed by the local NGO that in Village A the population was primarily using SODIS; in Village

B, households used AQUATAB; and in Village C, the communities had abandoned both SODIS and AQUATAB.

Each case study was considered as being characterised by embedded subunits of analysis (Yin, 1994), which involved the two developed categories of "users" and "providers" of WATSAN technologies. Responses from semi-structured interviews aimed to provide explanatory accounts of the systems implemented, which allow for an evaluation of the technologies based on users' feedbacks. Thus, for this purpose a quantitative approach was adopted to enable the researcher to capture a wide spectrum of responses. To elicit experiences of WATSAN technologies (CS-I, CS-II, and CS-III), users were randomly selected during transect walks in the communities and villages. Random selection promoted increased investigation reliability, preventing the emergence of bias in selecting respondents. Random sampling techniques are often used in surveys to accurately select a sample frame and calculate the representative sub-sample based on considerations of degree of confidence and degree of variation within the population (Neuman, 2003). Several methods for determining sample size are provided in the literature: use of census for small populations; application of equations corrected for a finite population; and use of pre-existing tables, (Israel, 1992; Sapsford and Jupp, 2006). A formula commonly employed to determine the sample size requires the total population, and the desired level of precision, (called the sampling error), which is defined as the range, expressed in percentage points in which the true value of the population is estimated to be (Israel, 1992). This formula is:

$$n= N/1+N (e)^2$$

Where: n= sample size; N= total population; e=sampling error.

A further parameter to be considered in the selection of a sample is the level of confidence, namely the confidence the statistics falls within a specified interval of the parameter. A confidence level of 95% is conventionally used (Babbie, 2001). Employing the above-reported formula, Israel (1992) provides a table presenting the appropriate sample sizes for different size of population and with different levels of precision at a confidence level of 95%, (see Table 3-3). Table 3-3 was adopted as guidance to determine the samples size in the investigated cases studies.

Table 3-3 Indicative sample sizes for given population

N	Sampling error ±5%	±7%	±10%
	n= sample size		
100	81	67	51
200	134	101	67
300	176	121	76
400	201	135	81
500	222	145	83
600	240	152	86
700	255	158	88
800	267	163	80
900	277	166	90
1000	286	169	91

Source: Adapted from Israel (1992).

The sample obtained, illustrated in Figure 3-2, allowed for sampling errors of 8% in CS-I and CS-II and 5 % in CS-III, at a confidence level of 95%.

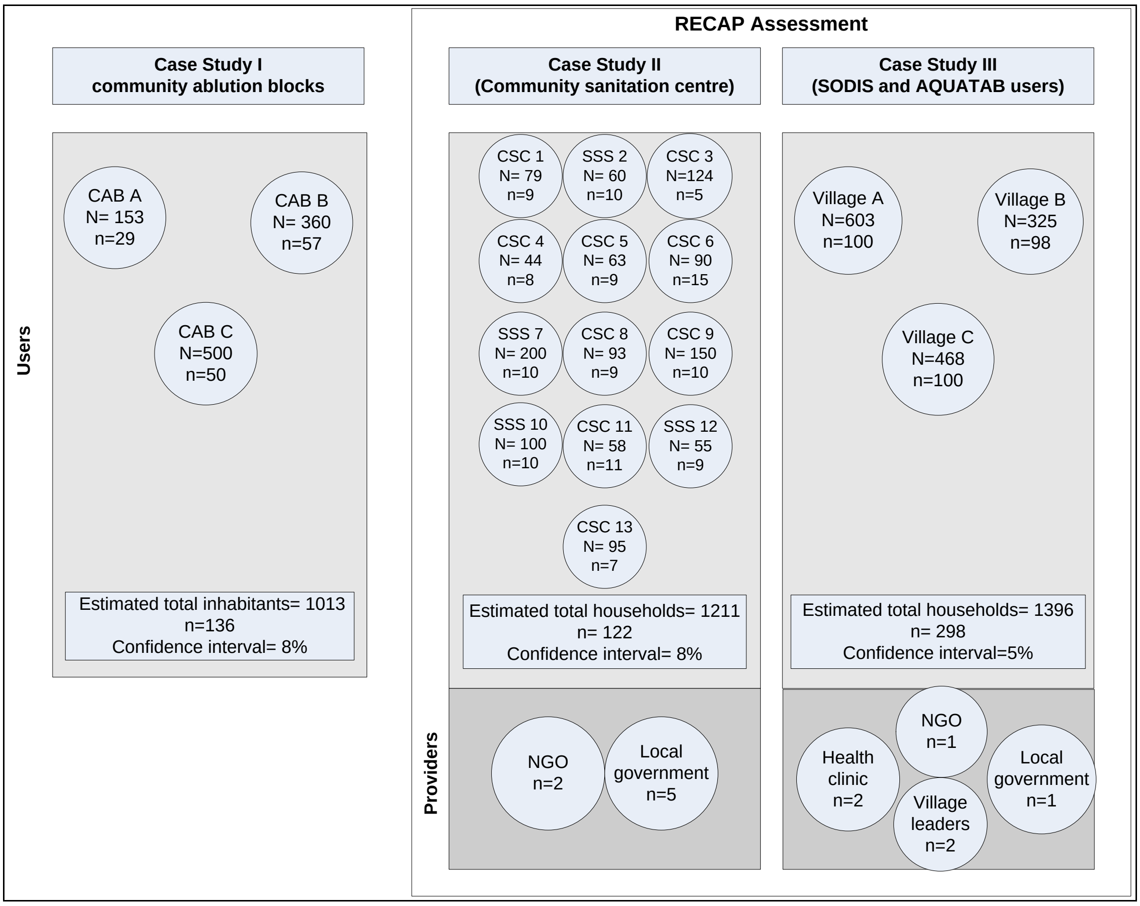

Figure 3-2 Case selection and sampling

Although the sample sizes did not match exactly the required size presented in Table 3-3, it must be noted that in the selection of the samples the level of accuracy is only one of several considerations to be taken into account (Israel, 1992; Neuman, 2003; Sapsford and Jupp, 2006). The level of accuracy a research aims at must be balanced with other important considerations (*i*) type of study; (*ii*) the number of variables simultaneously investigated and analysed; and (*iii*) time and resources available. The main purpose of this research is to understand and explain users' perceptions of technologies and their acceptance of them. Thus, although accuracy plays an important role in this study, the complexity of the social reality investigated required more attention to achieve quality and richness of information, capable of explaining the problem under consideration. A further aspect to be considered relates to the type and mode of analysis. Scholars argue that for analysis such as descriptive statistics, virtually any type of sample size is appropriate (Israel, 1992). Conversely, high levels of accuracy and a good sample size are required for multivariate statistical analysis to produce reliable results. In this study uni- and bivariate descriptive statistics have been employed, thus the samples size selected were appropriate to satisfy the ambition and purpose of the analysis. A final consideration that constrained sample selection must be highlighted. The limited time and resources available to the researcher, as well as the availability of translators, have constrained the opportunity to collect a more extensive sample size.

The sample selection for in-depth interviews with technology providers (CS-II and CS-III), guided by the RECAP assessment, also followed the theoretical sampling logic. Respondents were selected and invited to participate in the interviews on the basis of the information that they would have provided to answer the research questions. For example, health clinic operators (CS-III) were selected because they could provide important information on the performance of water disinfection methods, by illustrating trends in diarrhoea incidence among users. The number and type of respondents selected within CS-II and CS-III, as well as the role played in the process of WATSAN implementation are reported in Table 3-4.

Table 3-4 Sample size for providers' interviews

Case Study II **Selected number of technology providers = 7**		
Sector/Area	**Position**	**n**
Local NGO	Community based Sanitation programme coordinator	2
	Head of technical section	
Local Government	Department of Public Work, Head of Department Sanitation Task force Executive Environmental Service Agency, Head of Department Department of Planning and Development, Head of Department	5
	Solid Waste Management Agency Senior officer	
Case Study III **Selected number of technology providers=6**		
Area	**Position**	**n**
Local NGO	SODIS and AQUATB programme coordinator	1
Local Government	Environment and Health Department, Head of Section	1
Public Health	Local village health clinics, Head of clinics	2
Community management	Village leader	2

3.5 Data collection techniques

Two types of data were gathered during the fieldwork investigations: (i) primary data were collected in the field by the researcher; (ii) secondary data, comprising a series of unpublished documentation used for internal purposes by technology providers. Three techniques were adopted to collect primary data: semi-structured interviews based on administered questionnaires, in-depth interviews based on open-ended questions and observation checklists. These techniques and the process of questionnaire design and development are illustrated in the following subsections.

3.5.1 Primary data

Semi-structured interviews

Semi-structured interviews were employed to gather evidence from technology users in all the three Case Studies. Interviews were administered by translators and where necessary (such as in CS-II), by village leaders and field facilitators to ensure respondents' comfortableness.

The purpose of using a semi-structured questionnaire characterised by close and open questions was manifold. Pre-coded questions, using both bipolar (Yes/No) and standardised response categories, avoided potential bias deriving from variations in data that may arise when a number of different interviewers are used (Neuman, 2003). The adoption of pre-coded questions helped data processing and comparison between respondents and replication of results were facilitated by the opportunity to conduct statistical analysis. On the other hand, the exclusive use of pre-coded questions would have precluded an in-depth investigation of the problems. Thus, open-ended questions were also included to unveil respondents' thinking process and identify the motivations behind the most complex answers (Neuman, 2003), providing respondents with some freedom to explain issues and events. Beside the above-illustrated methodological rationale for selecting semi-structured interviews, a precautionary approach also played an important role in the decision. The researcher did not speak the respondents' local languages, thus constant support from translators and interviewers was needed. Although interviewers had been trained by the researcher on the questionnaires to be administered, the use of semi-structured interviews were considered the most appropriate option to minimise interpretative bias both in questionnaire administration and translation of responses, as they allow a reasonable degree of control to be maintained over the topics whilst investigating other aspects in more depth (Babbie, 2001).

The questionnaires administered to WATSAN technology users (and future users in CS-I) sought to investigate and explore recipients' post-implementation experiences and perceptions of WATSAN technologies. Guided by the theoretical framework of Receptivity (as deployed in CS-I) and by the RECAP assessment (CS-II and CS-III) the questionnaires sought to achieve understanding of recipients' ability to adopt and use the technologies and their acceptance of the transferred systems. Semi-structured interview questionnaire development employed Patton's (1990) typology of questions conceptualised for the process of qualitative interviewing. In his attempt to build a framework through which respondents can express in their own terms, Patton developed a flexible typology of questions, which can be used to explore any topic. Patton's typology and its use in questionnaire design are described in the following paragraphs:

- *Experience/behaviour* questions, aimed at investigating descriptions of behaviours, experiences and actions, which could have been observed, had the interviewer been present.

- *Opinion/belief* questions have the purpose to understand the cognitive and interpretive process of respondents.

- *Feeling* questions aim at exploring respondent's feelings, perceptions and emotions towards an event, activity and experience.

- *Knowledge* questions focus on eliciting factual information possessed by respondents.

- *Sensory* questions are used to know about what is seen, heard, touched, tasted and smelled by respondents.

- *Demographic/background* questions are employed to elicit characteristics of respondents.

To further increase the validity of Patton's typology, examples of use of the above-described types of questions were identified in the existing literature featuring surveys conducted on WATSAN technology users in developing countries (i.e. Rainey and Harding, 2005; Bewket, 2007; Wilson *et al.*, 2007). The use of Patton's typology to develop the questionnaires items is justified by the need of exploring non-technical and human dimensions of WATSAN technologies may affect users' acceptance and sustained use of the systems, by means of a framework that allows respondents to express their own understanding. The following paragraphs illustrate the use of each of the above described question type in the context of this research.

The adoption of *experience* type of questions aimed at understanding recipients' past and present experiences with the technology, the surrounding circumstances and the events related to it. Patterns of technology use, such as frequency of use and the presence of problems experienced with the implemented systems were explored. In the literature, examples of questions eliciting experiences with technology use and maintenance have been widely employed in surveys of WATSAN technology users (Mukheli *et al.,* 2002; Diallo *et al.,* 2007). In this research an example of experience question use is: “What are the main problems you and your household experienced with the systems?”

Questions eliciting respondents’ *opinions* were employed to explore respondents’ judgements of the technologies. Investigated aspects were recipients’ perceived benefits of the systems/service adopted, opinions on potential challenges to using the technology and its longevity, as well as suggested improvements to the current situation. Whilst few studies investigating users’ opinions of implemented technologies are found in the relevant academic literature (Bewket, 2007), no contributions eliciting users’ feedback in the form of suggested improvement were identified. An example of opinion/belief question employed in CS-I is: “Do you consider CAB positive for yourself and your family?”

Feeling questions were used to explore respondents’ inner thoughts and perceptions of the technologies. These related to sense of inclusiveness in the implementation process, positive and negative associative aspects related to the systems, and their willingness to continue to use them. A further important question, which allowed comparison of the relationship between technology users and providers, investigates of recipients’ trust in service providers, such as in the question “Whose advice concerning SODIS and AQUATB do you trust most?” This question provided a useful indication of motivational aspects to use and maintain the technologies. In the academic literature, an example of study focusing on WATSAN technology users emotions and feelings is Rainey and Harding’s (2005) research of the acceptability of SODIS method in Nepal. Similarly, an excellent contribution investigating WATSAN technology users’ perceptions of trust is that provided by Wilson *et al.* (2007).

Recipients’ *knowledge* of WATSAN technology performance was gathered to explore the degree to which respondents absorb information related technology use. An appropriate way to elicit respondent’s internalisation of information was the investigation of the technology training and educational activities provided to users.

Examples of knowledge type of questions to elicit ability to internalise information is provided by Bewket's study (2007) of acceptance and adoption of water (and soil) conservation technologies of Ethiopian farmers. In this research, knowledge type of questions were used were "Please describe the steps you take in preparing water with AQUATAB", adopted in CS-III. Furthermore, respondents' awareness of aspects of maintenance and knowledge of interventions to undertake in case of problems with the technologies were also employed to further characterise recipients' experiences of technology use.

Sensory questions were used to explore aspects related to respondents' perceptions of smell, taste as well as visual experience (i.e. cleanliness) associated with the use of the technology or its by-products (i.e. treated water). Sensorial aspects related to WATSAN technologies have been widely addressed in the literature (Rainey and Harding, 2005; Altherr *et. al*, 2008). In this research, sensory questions were of particular importance for the questionnaires used in CS-III, where aspects related to taste and odour of SODIS and AQUATAB-treated water were investigated. Example of sensory questions employed is "Do you like the taste of SODIS water?" used in CS-III.

Finally, demographic questions were employed to capture the identifying characteristics of the interviewed person and household (such as age, education, occupation), as well as their religion or ethnicity to explore the role played in acceptance of the technologies (as will be seen in CS-III). Table 3-5 illustrates the use of Patton's typology, its link with the questionnaire items in CS-I (example from questionnaire of CAB A and B); CS-II and CS-III (example provide is from questionnaire A on SODIS); as well as the factors elicited through the use of the question types.

Table 3-5 Application of Patton's typology to questionnaires and aspects elicited

Types of Questions	Elicited aspects	Questionnaire numbers CS-I	CS-II	CS-III
Experience	• Technology introduction and use • Frequency of technology use • Use by family members • Technology maintenance • Type of problems experienced • Behaviours in case of problems • Technology acquisition	1 (1.1, 1.2) 2 (2.1) 3 7 (7.1, 7.2) 8, 9 10, 11 12, 15 17, 18	1 (1.1, 1.2, 1.3) 2 4 (4.1) 5 (5.1) 6	2 (2.1, 2.2) 3 (3.1) 4 (4.1, 4.2, 4.3) 7 10 (10.1) 11 12 (12.1, 12.2, 12.3) 13, 14 15 19 (19.1, 19.3)
Opinions	• Habits change since using the technology • Opinion about benefits provided by the technology use • Improvement(s) suggested • Opinion about affordability of the systems • Opinion on technology ability to address needs and traditions • Opinion related to responsibility in terms of maintenance	6 (6.1) 13 16 (16.1)	3 8 (8.1) 9 (9.1) 10 (10.1) 12 13 14	18.1 20 21 (21.1) 22 23 (23.1) 25 (25.1)
Feelings	• Feeling of trust in terms of technology advice • Feeling of inclusiveness in community technology management • Feeling of satisfaction with the technology • Willingness to continue to use the technology	5	11 (11.1) 15 16	18 24 26 (26.1)
Knowledge	• Knowledge of training • Knowledge of roles for maintenance and breakage • Technical knowledge of technology use (i.e. preparation of SODIS/AQUATAB water)	4, 9 14,15	6 7 (7.1)	1 5 (5.1) 6, 8 9 (9.1) 19.2
Sensory	• Appreciation of taste and smell of technology product (i.e. SODIS/AQUATAB water)			16 (16.1) 17
Demographic	• Gender • Age • Household number and composition • Employment and/or economic status • Ethnic origin and/or religion	A-H	18-21	A-E

Questionnaire format

Both adapted questions used from previous research and novel questions were utilised for constructing questionnaires (See Appendices I, III and IV for details of the questionnaires). The drafting of questionnaires involved several consultations with colleagues as well as with local implementing agencies and translators to evaluate the applicability of the questions and the appropriateness of wordings. Two questionnaires for CS-I were adopted, one for users of CABs, containing 18 questions and one for future users of the systems, which included 14 questions. Furthermore for both questionnaires eight identical demographic questions were employed. In the investigation of CS-II a questionnaire comprising of 21 questions was adopted. Finally for CS-III, three slightly different questionnaires were adopted, one specifically addressed to the analysis of the use of SODIS, which contained 26 questions; a second one, comprising 25 questions, investigated AQUATAB use; and finally a third one exploring reasons for stopping use SODIS and AQUATAB, containing 12 questions. This last questionnaire contained a lower number of questions because, in this instance, the investigation focused on eliciting respondents' reasons for abandoning the technologies, without asking questions related to their experiences and knowledge of technology use.

The questionnaires consisted of a mixture of closed and open-ended questions. Closed questions included standardised response categories (Yes/No), offering the option "other, please specify" to capture potential novel issues prompted by the question. Furthermore, five point Likert scale types ("strongly agree- agree") and ("strongly disagree- disagree") with a neutral category ("neither agree nor disagree") were adopted to elicit respondents' level of agreement or disagreements with developed propositions (Sapsford and Jupp, 2006). Finally, a series of multiple-choice lists of questions were employed. The advantage of using this type of question was twofold. Firstly, closed questions facilitate answers to more sensitive topics (Neuman, 2003). The questionnaires required respondents to express opinions and judgement of services provided, which were more likely to be obtained by reading to them a list of answers and leaving them the freedom to add more information with the option "other, please specify". Secondly, closed questions allow less articulated and disadvantaged respondents to provide an answer. In most cases people interviewed were illiterate, thus the use of closed questions allowed the gathering of indications of their perceptions of a particular issue. Among the disadvantages in using closed questions the simplistic nature of the answers provided to complex issues is often argued (Neuman, 2003). This disadvantage was reduced by mixing open and close-ended questions on similar topics of investigation to identify discrepancies within answers.

In-depth interviews

In-depth interviews, which comprised face-to-face conversations between interviewer and the respondent, were adopted to gather evidence from technology providers in CS-II and CS-III, as part of the RECAP assessment. In-depth interviews were employed to investigate the intended performance of WATSAN technologies, by means of discussions, guided by list of open-ended questions, with key stakeholders (local government, implementing agencies, health clinics and village leaders). In-depth interviews were used for their ability to unveil managerial and implementation aspects related to the investigated technologies, to elicit respondents' opinions and thinking process and explore the investigated issues in greater details (Babbie, 2001). In the interviewing process, the researcher was seeking to answer the research questions by eliciting stakeholders' knowledge, rather than obtain structured responses facilitating generalisation. Furthermore, the degree of flexibility provided by open-ended questions was deemed necessary to further explore and elaborate novel thoughts and concepts which may have emerged from the interviewing process (Neuman, 2003). Thus, the questionnaire developed for providers' interviews did not follow a rigid structure, rather it revolved around a series of main themes, aiming to explore providers' perceptions of benefits of and challenges to technology implementation and use; strategies and approaches to technology implementation, management, monitoring and longevity; as well as their perceptions of user acceptance of the technologies. The development of these themes for investigation was informed by the RECAP tool and aimed to answer the novel research questions by gathering information on technology performance. These themes were adapted to the stakeholders investigated and the type of technologies investigated (See Appendices III and IV for questionnaires templates).

Observational Checklists

Where possible, interviews were coupled with observational checklists of the investigated technologies, completed by the researcher in the field. The purpose of using this complementary technique was to record additional evidence on users' experiences with the technologies. This strategy allowed to substantiate and validate the results generated from interviews with technology users and provides a triangulation of methods, which increase this study's reliability. Aspects observed referred (inter alia) to level of cleanliness of the systems, their performance and status of maintenance (see Appendices I and III for reference).

3.5.2 Secondary Data

Furthermore, secondary data, such as technical specification of the technologies, implementation plans and management guidelines were collected from the providers and other key informants (i.e. health clinics) and treated as sources of information to analyse the intended performance of the technologies. These documents provided informative accounts on technology implementation and operation and maintenance, as well as aspects of and approaches to building users' awareness and training. An example of how these secondary documents were classified is provided in Table 3-6. The illustrated document, entitled "Sanitation in Informal Areas: Action List", presents a list of the Community Ablution Blocks under construction or to be constructed which was extremely useful to guide the process of CAB selection in CS-I. A comprehensive description of these secondary data is provided in each Case Study Appendix (I, III and IV).

Table 3-6 Secondary data collection template

DOCUMENT SUMMARY	**Site: eThekwini Municipality, Health Department** **Date received:09/07/2008**
Name and description of the document:	Sanitation in Informal Areas: Action List
Event or contact with which the document is associated:	Circulated during an internal meeting of the eThekwini Municipality, which took place in Durban in May 2008.
Significance of document:	Provided the criteria for selection the case study areas of Ablution Block users during fieldwork.
Brief summary of document:	Provides a list of the areas of the municipality where community sanitation facilities have been installed, as well as the date in which implementation started and the percentage of completion at date.

Source: Template adapted from Miles and Huberman (1994:55)

3.6 Data collection

This section provides a description of the data collection undertaken in this study, generating a detailed account of the activities undertaken in the course of each Case Study. Whilst in the pilot CS-I only interviews with technology users were conducted, fieldwork in CS-II and CS-III had the purpose of applying and testing the RECAP tool. Thus, as described in the previous section, interviews were conducted with both users and providers of WATSAN technologies. In all case studies access to the areas of investigation was gained through support from gatekeepers, formal and informal authorities that control entrance into the field. These were the University of KwaZulu-Natal and eThekwini Municipality in CS-I, field facilitators (NGO personnel) in CS-II and cadres (NGO employees) in CS-III.

Exploratory Case Study I

Fieldwork for the exploratory CS-I was conducted in Durban, South Africa between June and July 2008. The developed questionnaire for data collection was further discussed with colleagues from the University of KwaZulu-Natal to check the validity and applicability of the questions developed. After minor modifications to the questionnaires, a workshop was conducted with two interviewers, MSc students from the Department of Planning Studies of University of Kwazulu-Natal, to explain the purpose of the research and the meaning of each question. Interviewers, who speak Zulu and Xhosa and had pervious experience of conducting research in Durban townships, were invited to translate the questionnaires and discuss the validity of meaning and wording. Translators were provided with a written document, produced by the researcher, explaining the appropriate code of conduct to perform interviews, whilst adhering to the ethical requirements imposed on research that involves human subjects (See Appendices I, III and IV).

Questionnaires were administered face to face to respondents in the selected areas. Interviewers randomly selected respondents in their households, in the course of transect walks in the areas. Respondents were requested to express their willingness to participate and where a positive response was received a box was checked in the questionnaire. Interviews were conducted in the daylight due to the danger associated with being in townships in the evenings. Each interview required on average 40 minutes. Figures 3-3 and 3-4 illustrate the context of investigation in Durban townships.

Figure 3-3 A community ablution block in Durban township

Figure 3-4 Children practising open defecation in Durban township

Figures 3-5 and 3-6 illustrate episodes of data collection for CS-I in Durban informal settlements.

Figure 3-5 Interviewing CAB user in Durban townships

Figure 3-6 Interviewers team in Durban

Case Study II

Interviews with members of communities with implemented DEWATS technologies and sanitation centres in Java and Bali were conducted between July and September 2009. The questionnaire developed for the RECAP assessment was translated in Bhasa Indonesian by local English-speaking translators and cross-checked for validity and reliability of meaning and wording with staff from the local implementing agencies. In CS-II interviews were conducted by field facilitators, local field workers, who liaise between communities and Borda, the local NGO which designs and implements community managed DEWATS technologies. The choice of a field facilitator was important to gain entrance to the communities and build a relationship of trust with the interviewees. The field facilitators, who had previous experience of conducting surveys in the communities, were briefed on the purpose of the RECAP assessment and on the questionnaire code of conduct. Communities were notified of the visit by the researcher and field facilitators and most visits involved informal group talks with provision of food and drinks. After liaising with the communities, interviewers randomly selected respondents during a transect walk in the area and conducted interviews, which lasted on average 40 minutes. The interviewing process took place mainly in the evenings to allow for the presence of community members, who are busy working in the rice fields during the day. Figures 3-7 and 3-8 illustrate an example of community sanitation centre and a biogas plant (respectively) in Java.

Figure 3-7 A community sanitation centre in Java

Figure 3-8 A biogas plant in a sanitation centre in Java

Figures 3-9 and 3-10 presents episodes of data collection in Java and Bali, respectively.

Figure 3-9 Data collection in Java

Figure 3-10 Data collection in Bali

Simultaneously, a data collection process was undertaken with technology providers and members of the local NGO, Borda. These interviews were conducted in English where respondents had a good command of the language, or in Indonesian with the help of an interpreter. The interviewee was briefed on the scope of the research, whilst an information sheet was left with him/her for record (see Appendices for references). Upon interviewees' consent, the conversations were tape recorded to facilitate the process of data analysis. At the end of each interview, respondents were requested to sign a consent form to obtain permission for treating the data with confidentiality. As described in Section 3.5.1 interviews with providers were based on open-ended questions, which allow for new themes and concepts to be discussed if emerged in the conversation. The duration of the interviewing process varied depending on information provided, respondent's time and willingness to participate.

Case Study III

In CS-III the RECAP evaluation was conducted on Flores Island, located in the East-Nusa Tenggara province of Indonesia in August 2009. In this Case Study, two alternative types of water treatment technology were investigated, as simultaneously implemented in the villages. The questionnaires prepared for the investigation of SODIS and AQUATAB were translated by into Bhasa Indonesian and each question was discussed for applicability and validity. Questionnaires were administered by *cadres*, field facilitators that liaise between the villages and the local NGO DianDesa. A workshop was conducted with the cadres, the NGO project manager and the researcher to explain the goal of a RECAP assessment and the questionnaire code of conduct. Where possible, the researcher accompanied cadres in the interviewing process. Cadres selected respondents through a random transect walk in the villages. Interviews were undertaken in the evenings to ensure most householders had returned from their working activities in the fields or the sea. Figure 3-11 illustrates the area of investigation in Flores Island, whilst Figure 3-12 shows SODIS bottles exposed to sunlight outside one dwelling.

Figure 3-11 Typical dwelling in Maumere, Flores island

Figure 3-12 SODIS bottles exposed to the sunlight in Maumere, Flores

Figures 3-13 and 3-14 show village and community activities into which the researcher participated in the course of data collection.

Figure 3-13 Demonstration of AQUATAB in a church in Maumere

Figure 3-14 Village festival in Gunung Sari island, Flores

A simultaneous process of data collection was undertaken by the researcher accompanied by a translator to interview technology providers, members of the local government, village leaders, operators of health clinics in two villages (see Appendix V for further information). Interviews with village leaders were conducted informally and involved participation into local activities, such as village festivals. Furthermore, the interview with the NGO project manager was conducted directly by the researcher in English. Interviews were tape recorded, upon respondent's permission, and an information sheet on the research scope and aims was left with interviewees.

Limitations to data collection

In this study the researcher investigates experiences and perceptions of WATSAN technologies, which are embedded into culturally different contexts. The cross-cultural nature of this research and the circumstances in which fieldwork was undertaken generated some limitations to data collection (Tabane and Bouwer, 2006). The researcher's ability to conduct interviews in person, hindered by cultural and language barriers, restricted the full participation in the data collection process. Although the researcher accompanied interviewers during the majority of the data collection activities and participated in the explanation of the purpose of the research to village leaders, full control over the interviewing process was not possible. Consequently, although administered face-to-face by interviewers, a small proportion of missing responses were identified in questionnaires. The following reasons have been identified as potential causes for invalid responses (Babbie, 2001; Neuman, 2003):

- Interviewers, field facilitators and *cadres* may have not been sufficiently or appropriately trained in conducting research and/or were unable to formulate questions appropriately and to capture the correct response.
- Respondents may have refused to answer to some questions considered inappropriate or meaningless.
- Respondents were unable to understand the administered questions and/or presented a genuine lack of knowledge of the answer to be provided.

3.7 Data analysis

Data collection generated qualitative data in the form of interview transcripts, audiotapes, observational checklists and internal documentation. Considering the dual purpose of this study, to generate substantive explanatory accounts from the experience of technologies within the investigated case studies and develop a diagnostic tool, the analysis of data was conducted at multiple levels: within case analysis, cross-case pattern identification, hypotheses generation and testing (Eisenhardt, 1989, 1991; Yin, 1994). Within case analysis can be conducted following several procedures of pattern-matching, in case of descriptive and exploratory case studies, and explanation building, used with explanatory case studies. The main purpose of the first stage is to let the patterns of each case study emerge. Cross-case pattern identification involves the comparison between identified patterns and categories among case studies. This leads to emergence of themes, concepts and relationships that constitute the basis of theory building. The process of hypotheses shaping is the comparison of the emerging theory with data, through subsequent data collection. To build hypotheses constructs are constantly refined and operationalised. The relationships among constructs emerging from the analysis are verified against data, through a deductive process. In the replication process, cases confirming the emergent relationships strengthen their validity, whilst cases that disconfirm it generate need for further refinement of the theory. Data collection and theory refinement continues up to when the categories are established or some clear patterns among data emerge (Lincoln and Guba, 1985; Dooley, 2002). A final step in theory generation involves the comparison of the emergent theory with existing and contrasting theories, models and concepts present in the literature.

3.7.1 Within Case-Study analysis

Analysis of data generated from each Case Study has the purpose of producing explanatory accounts and context specific evaluations of the investigated technologies. Two analytical methods were used for this purpose: statistical analysis, employed to analyse the results of semi-structured interviews; and thematic analysis, adopted to elicit meanings from in-depth interviews. These are illustrated in Table 3-7 and discussed in the following sub-sections.

Table 3-7 Case studies data collection and analysis methods

Case Study	Response group	Elicitation method	Data set	Analysis method
CS-I	CAB users and future users	Semi-structured interviews	136 questionnaires	Univariate descriptive and bivariate inferential statistics
CS-II	DEWATS users	Semi-structured interviews	122 questionnaires	Univariate descriptive statistics
	DEWATS providers	In-depth interviews	7 interviews	Thematic analysis
CS-III	SODIS and AQUATAB users	Semi-structured interviews	298 questionnaires	Univariate descriptive statistics
	SODIS and AQUATAB providers	In-depth interviews	6 interviews	Thematic analysis

Analysis of semi-structured interviews

Upon return, questionnaires were numbered to facilitate data processing. The responses to semi-structured interviews were inputted into Microsoft Excel 2007, for coding and data reduction purposes. Codes are defined as "tags or labels for assigning units of meanings" (Miles and Huberman, 1994:56) to interview transcripts, questionnaire answers and free flow texts. The purpose of coding is threefold (Babbie, 2001):

- To reduce wide sets of information to a more limited set of attributes composing a variable.
- Interpret the test, by contextualising the codes and linking them to the research questions.
- Infer meanings from the test, by highlighting the existence of patterns, rules, causes, effects or relationships.

A thematic coding process was applied to the open-ended questions employed in the semi-structured interviews. Boyatzis (1998) identifies three different ways of developing codes: from existing theory, inductively from data, and from prior data. In this research, codes were generated by a mixture of inductive and deductive process. Questionnaire answers were categorised to follow in the main questionnaire sections (i.e. technology use, maintenance, acceptance). As data-driven development of codes from the text necessitates the identification of anchored or reference criteria (Boyatzis, 1998), questionnaire responses were coded inductively by the guidance provided by the Attribute Perception framework created for the generation of RECAP. The purpose of this coding process was to identify users' perceptions of the technology and their link with attributes. A comprehensive explanation of the Attribute Perception framework will be provided in Chapter 5, for the purpose of this section, a list of most relevant and attributes that were used in the coding process is provided in Table 3-8.

Table 3-8 List of attributes identified in the coding process

Attributes identified	Description
Space	The spatial and geographical requirements imposed by the technology
Economic/Financial	The costs related to technology implementation, use, maintenance
Environmental	The environmental aspects associated with the technology
Health	The health aspects related to the system and its use
Social	The social and behavioural aspects related to implementation management and longevity to the technology
Function	The technology capability to perform its related functions
Institutional and legal	Aspects related to technology use implementation and longevity
Knowledge	Capacity building, knowledge management and educational aspects related to the technology

The above-illustrated technology attributes were employed to code the responses into categories to conduct the appropriate statistical analysis. For close-ended questions a coding procedure was established, by attributing a number to each obtained answers (Neuman, 2003). A process of data cleaning was undertaken to code missing responses. Finally, for each investigated Case Study a codebook, a document describing the list of the developed variables and the meaning attached to them, was generated.

Coded data generated from the questionnaires were transferred to the Statistical Package for Social Sciences (SPSS) version 17.0. The exploratory and explanatory nature of the case studies investigated favoured a qualitative approach to the analysis, which allowed to understand and interpret respondents' reasons and meanings. Furthermore, the relatively small sample size generated and the richness of questionnaires, characterised by both close and open-ended questions, allowed the adoption of statistical procedures that retain data richness. Univariate (single-variable analysis) and bivariate (analysis of relationship between two variable) statistics were used for the analysis of data. Frequencies distributions, averages and grouped data were employed to identifying general patterns and themes in each case study were generated. For the analysis of close-ended questions featuring Likert scales, the percentage of in the categories indicating strong and mild agreement to the propositions developed were aggregated for ease of interpretation. A similar procedure was adopted for responses indicating strong and mild disagreement. Bivariate analysis focused on the association of independent and dependent variable was also employed by means of Pearson's chi Square tests. The Chi Square test is a useful technique to measure the existence of association between nominal (qualitative) variables. This test is suitable for variables that are not normally distributed. A chi-square analysis is used to test the null hypothesis (H_0), which assumes there is no significant difference between expected and observed data. The chi-square test was selected for analysis upon checking satisfaction of data with the test's main assumptions: non-biased sample; independent observations, mutually exclusive row and column variable categories that include all observations and large expected frequencies (usually larger than 5) (Kinnear and Gray, 2004).

Analysis of in-depth interviews

Qualitative data, generated from the in depth-interviews with technology providers, were translated into English by professional translators, with the help of the tape recordings. The interviews were transcribed and inputted in Nvivo 8, software for qualitative data analysis. Thematic analysis was employed to analyse interview data. Thematic analysis is defined as a process of encoding qualitative information to identify patterns/themes that can describe and interpret respondent observed phenomena (Boyatzis, 1998). The units of investigation employed in the data analysis of interview transcripts are referential units, defined as "particular objects, events, persons, acts and ideas to which an expression refers" (Krippendorf, 2004:61). Respondent interviews were grouped as a single case to maximize the amount of information provided.

In the analysis of providers' interviews, codes were developed both deductively, (informed by questionnaires structures), and inductively, (following the guidance provided by the AP framework). Deductive coding was used to organise interviews' responses on the basis of the structure of the interviews template employed. A second coding cluster was identified in the interview responses, to identify providers' perceptions of the technology and its link with attributes. The coding structure was organised as a set of sub-codes under the cluster codes Technology Performance (deductively derived) and Technology attributes (inductively inferred from transcripts).

For both case studies a matrix-coding query was performed in Nvivo 8. The matrix coding query, defined as "qualitative cross-tabulation" (Bazeley, 2007:143) was useful in identifying patterns within the text by comparing co-occurrence between items in the coding cluster. The matrix-coding query significantly strengthened the comparative process between cases of respondents, by showing the frequency distribution of how often a case reports a particular experience. An example of the matrix coding query is provided below.

Cluster 1 (sub-code n) AND Cluster 2 (sub-code n)

for example

Technology Attribute (environment) AND Indicator (benefits)

Within each of CS-II and CS-III results of the data analysis from semi-structured and in-depth interviews, coupled with secondary data from existing documents, were aggregated to compare users' perceptions of technology attributes with those of providers. This analytical process enabled the generation of accounts substantiating the existence of discrepancies between technology performance and experience and understanding its nature and degree of variation.

Analysis of secondary data

Secondary data including scoping studies, existing documentation on technology specification and planning documents were collected and filed following the process described in Table 3-6. In CS-II and CS-III analysis of secondary data was important to provide information concerning technology performance. Those secondary data, selected for their significance to the study, were subdivided into units, usually sentences and paragraph in a text, whose content was matched with the technology attributes illustrated in Table 3-8.

3.7.2 Cross-case study analysis

The identification of themes and categories within case studies is a salient aspect in the process of validation of the RECAP tool. The analysis of data gathered in the first exploratory CS-I generated new hypotheses and categories, which contributed to the process of RECAP development. The assumptions inferred from CS-I related to the existence of a discrepancy between users and providers of WATSAN technologies that challenge sustained technology use in the post-implementation stage. From this hypothesis, the categories of providers and users emerged. The two categories evolved in the course of the research. Through an interpretive process of theme comparisons between cases studies and theoretical refinement, the concepts of technology intended performance and experience emerged. The test of the RECAP tool in CS-II validated the hypothesis of existence of a discrepancy between intended performance and experience of the technology and a subsequent reiteration of the RECAP assessment in CS-III strengthened the tool validity as well as providing a general account of the discrepancies identified (as discussed in Chapter 8).

3.8 Research validity and reliability

3.8.1 Validity

For research to be valid it must guarantee a match between the social phenomena investigated and the constructs developed by the researcher to understand it (Neuman, 2003). The validity of this study rests on the adoption of a multiple case study approach to develop a tool, which is deployed and tested on different types of WATSAN technologies. The combination of semi-structured interviews with users and in-depth interviews with providers was used in this study to strengthen its face, construct and convergent validity (Babbie, 2001; Neuman, 2003).

Face validity represents the degree of agreement among the scientific community on that the measurements and approaches developed by the researcher adequately reflect the phenomenon investigated. In this study, face validity was achieved by crosschecking the wording and applicability of the questionnaires developed with colleagues from Cranfield University, as well as with members of the local University and implementation agencies in the field, who have extensive experience of field research. Furthermore, the developed questionnaires satisfied the principle of *concurrent* validity, the ability of an indicator to be associated with a pre-existing one that is judged to be valid (Neuman, 2003). Questionnaires were designed by researching similar categories and lines of questioning adopted by studies featuring investigation of WATSAN users in developing countries. Furthermore, this study meets the criterion of *convergent* validity, achieved by use of multiple indicators operating in a similar way. The adoption of multiple data collection techniques, semi-structured and in-depth interviews as well as observational checklists and secondary documents (see Sections 3.5.1 and 3.5.2) not only enabled the crosschecking of the validity of the concept and phenomena measured, but also allowed representation of different viewpoints of a similar phenomenon, increasing the validity of the accounts of reality obtained. Finally, as indicated by the inner nature of this study, field research conducted in person by the researcher increased its content validity. Babbie (2001) argues that conducting the research in the first person and personally observing the investigated phenomena greatly enhances the ability to understand the nature and meaning of the social phenomena under consideration.

A point of warning needs to be highlighted. The cross-cultural nature of this investigation, which involves the researcher in exploring phenomena embedded in different cultures, may have generated some constraints to the achievement of the research's validity (Tabane and Bouwer, 2006). A series of pre-emptive strategies were adopted to minimise the impact of cross-cultural investigation on the study's validity (Wallin and Ahlström, 2006). Firstly, questionnaires developed by the researcher were accurately crosschecked with local bodies involved in the investigation (NGO and University) and with professionals who have extensive experience of field research in the areas investigated. Their comments on the questionnaires were discussed and incorporated in the final design. By incorporating views of local experienced people, this strategy prevents the generation of misunderstandings that may arise when investigating a different culture. Furthermore, this approach allowed the minimisation of a further challenge to cross-cultural research, namely an inherently ethnocentric approach to the investigation, defined as the evaluation of other cultures according to preconceptions originating in one's own culture (Oxford Dictionary, 1999). Finally, the researcher participated in community and village activities during the interview process, in an attempt to build a relationship of trust with the communities and villages.

3.8.2 Reliability

For a research to be reliable, it must produce measurement techniques that deliver the same answer when applied at different times to different sub-groups and across various indicators (Neuman, 2003). The reliability of measures can be increased by clear conceptualisation of constructs, use of multiple indicators and use of replication of tests. Attempts to achieve reliability were undertaken in this study by clearly describing the intellectual process that guided to the conceptual development of RECAP tool (see Chapter 5), describing its theoretical background, its purpose and structure. Furthermore, multiple indicators were adopted to evaluate WATSAN technologies in developing countries through the use of interviews with providers and users of WATSAN technologies. Finally, a reiteration of the RECAP assessment was undertaken to test its ability to provide valuable results in different types of case study technologies (community sanitation as opposed to water disinfection methods). An in-depth discussion of the validity and reliability of the RECAP tool will be provided as part of the assessment of the developed tool in Section 8.4.

3.9 Ethical considerations

Data collection and analysis were carried out with reference to both the ethical guidelines provided by the Social Research Association (2003) and in accordance with the 1998 Data Protection Act. The fieldwork activities were submitted to and received the approval of Cranfield University Research Ethics Committee.

Informed consent

All participants were informed about the project and its aim, as well as the methodology adopted. Information sheets were distributed to the participants (Appendices I, III and IV). In case of illiterate subjects, the interviewer made sure he/she read the information sheet and ticked the relative box prior commencing the interview. A copy of the information sheet was left with key informants, such leader of visited communities and villages, and with technology providers.

Debriefing

Participants were provided with contact details of the researcher should any query about the research arise. A summary of results can be obtained on request.

Deception

The research methodology does not require disguising the study purpose. Participants were fully briefed on the project.

Freedom of participation and withdrawal

Subjects' participation was completely voluntary. Only those participants that agreed on taking part on the research were interviewed. Participants were made aware of their entitlement to refuse to participate at any stage for whatever reasons and to withdraw their data up to the point at which their contribution could no longer be distinguished within the data set.

Confidentiality of records

Throughout the study participants data were referenced with identification umbers; where participants' identities and records were recorded they were kept confidential and not released by the researcher in any form that can identify respondents, unless explicit consent has been given by respondents themselves. The researcher, however, was not responsible for anyone that freely chose to reveal his/her own participation in the study.

Protection from harm and professional conduct

As far as possible, the researcher sought to ensure protection of participants against potentially physical or any other harmful effects. Particularly, with regard to potentially embarrassing questions on sanitation practices and personal hygiene, the study attempted to protect subjects from any psychological harm related to unwanted intrusion into their private habits. The impact of questions on this topic was minimised by making clear to participants the purpose of the study, its scientific rigour as well as its role in supporting improvements in water and sanitation provision. Furthermore, disturbance of subjects themselves and to their relationships with the environment was minimised. Researcher's contact details were provided should participants be concerned about this issue. Finally, the study was carried out in accordance with standard professional conduct principles. Comprehensive information was provided on study purpose, process and duration, and a summary of results provided on request. Scientific rigour was maintained as far as possible by avoiding inappropriate questions, inadequate language, judgemental behaviour or bias.

The following Chapter presents the analysis of the data collected during the exploratory fieldwork investigation conducted in Durban, South Africa. The chapter is presented as a manuscript "Assessing users' experience of shared sanitation facilities: A case study of Community Ablution Blocks in Durban, South Africa", accepted for publication in the academic Journal *Water SA*.

CHAPTER 4: ASSESSING USERS' EXPERIENCES OF SHARED SANITATION FACILITIES: A CASE STUDY OF COMMUNITY ABLUTION BLOCKS IN DURBAN, SOUTH AFRICA

4 ASSESSING USERS'EXPERIENCE OF SHARED SANITATION FACILITIES: A CASE STUDY OF COMMUNITY ABLUTION BLOCKS IN DURBAN, SOUTH AFRICA

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Abstract

Despite significant financial investment, the effective implementation and sustained use of water and sanitation (WATSAN) systems remains a chimera, with one billion people using unimproved water facilities and 2.5 billion not benefitting from adequate sanitation. The poor success rate of WATSAN interventions results from a predominance of supply-driven approaches which lack recipients' inputs into planning and implementation so that technologies are successfully adopted and deliver the intended benefits. In the academic literature, users' feedback and experiences of technologies in the post-implementation phase have received scarce attention. The purpose of this study is to investigate users' experience of sanitation facilities in the early post-implementation phase when opportunities for remedial intervention are still available. Fieldwork comprising semi-structured interviews was undertaken with users and potential recipients of three Community Ablution Blocks (CABs) in informal settlements around Durban. Results suggest that non-technical aspects such as affordability or cleanliness of the facilities can affect acceptance among the investigated communities. The extent of training and education impacts on the level of maintenance of the facility as well as satisfaction with its functionality. A comparison between users and potential recipients of CABs shows that perceived health benefits, attitudes in case of problems and trust are affected by use of the facilities. Conclusions relate to how early post-implementation assessments of users' experience could enhance the process of acceptance and management of the technology, thereby increasing progress towards the achievement of the related Millennium Development Goals.

Keywords: Shared sanitation facilities, users' acceptance, eThekwini municipality, Durban.

4.1 Introduction

The most recent WHO/UNICEF Joint Monitoring Programme report suggests that achievement of the Millennium Development Goals (MDGs) for water and sanitation remains a chimera with one billion people still using unimproved water facilities and 2.7 billion not benefitting from improved sanitation. Progress on both targets is slowest in Sub-Saharan Africa (WHO and UNICEF, 2010). Recent years have witnessed the launch of several initiatives to alleviate the problem of inadequate water supply and sanitation services by investing in the transfer of appropriate technologies. However, despite the financial resources and institutional commitment involved, post-interventions reviews suggest that most programmes have failed to deliver the expected benefits (Younger, 2007; Rodgers *et al.*, 2007). Typically, unsuccessful interventions have been characterised by top-down approaches to services delivery with little consideration of recipients' demand or their participation in the planning, construction and implementation process (Burra *et al.*, 2003; Breslin, 2004).

In the post-implementation stage of technology transfer, analyses of poor success rates of water and sanitation (WATSAN) projects focus mainly on the engineering aspects of the process, attributing lack of success to intrinsic technical faults and failings (Harvey and Drouin, 2006). Alternative diagnoses which address the social and human aspects of technology transfer can be traced back to the work of Linstone (1981) and his conceptualisation of technologies as multi-perspective entities: possessing not only technical aspects, but also a set of organisational and personal dynamics in which the system is embedded. In the context of WATSAN initiatives in developing countries, few contributions have focused on the post-implementation phase of technology transfer, or investigated the reasons why users' desire or willingness to adopt have not translated into appropriately encouraging impacts (e.g. Mukheli *et al.*, 2002; Simms *et al.*, 2005). Findings from these studies attribute project failure to scarce attention to "software" aspects in the implementation, such as lack of users' participation and capacity building (Burra *et al.*, 2003) or their perceptions of ease and convenience of using the technology (Diallo *et al.*, 2007). Although addressing the human dimensions of largely technology based interventions, these contributions provide evaluations of WATSAN technologies which are not guided by strong theoretical foundations and are conducted several months or years after implementation took place (Mukheli *et al.*, 2002; Simms *et al.*, 2005). The consequential lack of a constructive time frame for remedial action makes it difficult to establish accountability and to plan interventions.

The driving concern providing a context to this study is the need to secure high levels of improved sanitation interventions through an investigation of user's experience of and satisfaction with the services provided. eThekwini municipality was selected as a case study as, in line with South Africa's ambitious programme to achieve universal coverage by 2014, it aims to install over 900 shared sanitation facilities in 317 new settlements across its municipal area. Past experience and evidence of disappointing usage rates and service levels in South Africa is provided by, *inter alia*, Bond, (1999) and Ngwane *et al*., (2002), suggesting that the construction of new facilities is merely a first step towards realising the broader ambitions of development. Understanding the reasons for non-use or inappropriate use provides a basis for both remedial interventions and improved scheme design. In this study we respond to this problem by exploring and assessing user experience and perceptions of three Community Ablution Blocks (CABs) in informal settlements around Durban. The investigation rests on the perspectives developed by Linstone *et al.* (1981) as well as on the theoretical framework provided by work on Receptivity. The latter of these two conceptual frameworks suggests that the potential success of an intervention can be assessed by investigating users' willingness and (crucially for this study) their ability to "absorb, accept and utilise innovation options" (Jeffrey and Seaton, 2004: 281-282). The main premise behind the Receptivity model is the benefit to be gained from understanding people's responses to a technology in terms of perceptions, attitudes and agendas for change which are relevant to them. The Receptivity framework allows researchers to explore technology users' perceptions of problems related to water and sanitation and their ability to scan for new knowledge (*Awareness*); their understanding of the potentiality of knowledge exploitation and its association with needs and capabilities (*Association*); the process of learning to gain the knowledge and skills necessary to adopt a technology (*Acquisition*); and their ability to internalise it in their routines, organising maintenance and managing risk (*Application*).

The importance of Receptivity to the conduct of this research rests on its focus on feedback from CAB users by directing attention to those aspects of their experiences that influence acceptance of the facilities and thus their sustained use. The analysis of the research findings identifies potential challenges in technology implementation and suggests solutions, based on users' involvement, that increase a sense of ownership and acceptance of the technology. The timing of this investigation is opportune to provide an agenda for change, as Durban local government is expanding its provision of shared sanitation to the city's informal settlements.

4.2 Urban sanitation in South Africa

As a middle-income developing country, South Africa suffers unequal income distribution, with 34% of its population living below the poverty line (UN, 2005). This discrepancy is primarily reflected in the provision of basic services, such as water and sanitation, which are inadequate in informal settlements, characterised by high density of inhabitants, a largely transient population and poor health conditions.

South Africa has committed to achieve universal water and sanitation access by the year 2014. The efforts to expand coverage began after the apartheid era (1948-1994) through a more democratic redistribution of essential services according to principles of equity and dignity (Eales, 2008). With recognition of water scarcity and unequal resource distribution in the country, the Water Service Act of 1997 and National Water Act of 1998 established the right of all citizens to free water and basic sanitation as part of a strategy to fight poverty, whilst the new South African Constitution of 1996 transferred to local governments the responsibility for WATSAN service provision.

Besides reinstating the controversial debate on the nature of water as a public good, the principle of free water and sanitation bears important implications for WATSAN provision. Service-delivery is thereby driven by supply-side approaches to achieve high coverage rates, a strategy which is often to the detriment of user engagement (Kihato and Schmidt, 2002). Although demand-driven and community-based approaches to water and sanitation interventions are recognised by South African WATSAN policies

(DWAF, 1994), enthusiasm for participation does not often materialise in practice (Friedman, 2006). As reported in previous research on service delivery, users' agendas are not always transferred in consultative process where feedbacks are inputted into project design (Friedman, 2006). Typically, service providers' mandates for WATSAN provision focus on providing access within tight deadlines, often operating in an environment which offers insufficient human and financial resources (Eales, 2010). This approach to tackling service delivery is typical of most municipalities, despite differences in available resources and overall performances.

In Durban, eThekwini Metro is the authority responsible for providing WATSAN services to 3.5 million people. The challenges faced by eThekwini in providing universal access to improved water and sanitation are enormous, ranging from increasing water scarcity and water stress (DWAF, 2004) to constant circulatory migration to the municipality which fuels demand for low cost accommodation and services. The worst scenarios faced by eThekwini lie in the urban areas, where an estimated one million people of African/Black ethnicity live in densely populated settlements (1,437 people/ km^2) under conditions of informal land tenure. Migration to informal settlements is driven by the need to find shelter in the proximity of job opportunities in the city (Marx and Charlton, 2003).

eThekwini's strategy to meet the national goal of universal access entails the transformation of the city's informal settlements either through relocation of their residents to new houses or on- site upgrading by means of basic services and infrastructures provision. To this purpose, community sanitation systems were chosen as the most appropriate solutions to swiftly serve disadvantaged communities. A CAB comprises a shared sanitation facility connected to a local sewer where the effluent is channelled. The units are characterised by separate areas for male and female users, each one with toilets or urinals, hand washbasins and showers. Provision is usually made for a storeroom and a washstand. Installation costs are incurred by the municipality, whilst users are expected take over management responsibilities. In most areas a caretaker is appointed by users to clean the toilets and liaise with the municipality on maintenance requirements. The caretaker may work on a voluntary basis or receive some compensation through a pay per use scheme. Awareness campaigns and training are conducted by the municipality through environmental health practitioners, responsible for training in the various areas in the informal settlements (Gounden, 2010). The training scheme developed by eThekwini municipality, conducted once the facilities are operational, involves the organisations of workshops in the areas of CABs installation. The training activities focus on education and hygiene aspects, maintenance of the facilities by not littering the toilets, water conservation report of leaks and illegal connection. Furthermore, special attention is paid to instruct the facility caretakers on aspects of operation and maintenance as well as management of the facilities (i.e. ensuring cleanliness, availability of toilet papers and soap).

Our assessment of CABs in Durban is explored by formulating six research questions, (presented in Table 4-1), to investigate aspects of users' experience in a context of supply-driven free basic services. The responses to the research questions suggest a novel agenda and new solutions for the implementation of CABs in Durban.

Table 4-1 Research questions

	Research questions
Q 1	What role does training play in users' ability to maintain the CAB?
Q 2	Is there a relationship between training received and users' satisfaction with the CAB?
Q 3	Is payment for maintenance and use of the CAB associated with user satisfaction?
Q 4	Is there a relationship between payment for using the CAB and caretaker's availability?
Q 5	Is there a relationship between payment for the CAB and cleanliness of the facility?
Q 6	How does experience of use influence perceptions of the systems?

Furthermore, from the first five research questions an equal number of related hypotheses were developed. The rationale for developing the research hypotheses was driven by a critical analysis of existing contributions illustrating the benefits of Demand Responsive and other forms of participatory approaches to WATSAN technology implementation (Katz and Sara, 1997; Breslin, 2004; Satterthwaite, 2005) as well as the related criticism of the supply-driven form of technology transfer. As discussed above, eThekwini municipality largely exhibits a supply-driven approach to WATSAN technology implementation, characterised by free service provision, scarce community participation and inputs into system design and implementation. Advocates of participatory approaches of WATSAN technology transfer have proven that users' involvement in project planning and implementation, their contribution (in kind and in cash) for system implementation, use and maintenance, can largely impact on the output of the interventions made (Narayan, 1995; Burra *et al.*, 2003; Roma and Jeffrey, 2010). Success of WATSAN interventions is typically measured in terms of users' satisfaction and acceptance of the systems transferred, long-term system performance and users' willingness to maintain the technology. Drawing on this body of literature, this study adopts indicators of user involvement, (i.e. users' participation into training and financial contribution to system) which are assumed to play a significant role on users' satisfaction as well as on performance and maintenance of the implemented facilities. Results from the Chi square tests are presented in Table 4-4 and employed to corroborate or disproof the existing literature and to provide suggestions for change.

4.3 Methodology

Data generation to respond to these research questions was effected via verbally administered semi-structured interviews. Three CABs were selected on the basis of their operational age. Specifically, the first two units (Case Studies A- Clermont and B-Amaoti) had already been in use, respectively, for two years and four months; and a third one (Case study C-Clermont) had just been completed at the time of investigation and recipients had not yet used it. Within the case study area served by each technology users were randomly selected through transect walks, generating a total of 136 valid responses. The questionnaire was specifically developed for this investigation and contained a demographic component (summarised in Table 4-2), questions concerning use of the CAB, its maintenance, as well as perceived benefits, challenges and acceptance.

Table 4-2 Descriptive statistics of the sample

Sample characteristics	Case Study A	Case Study B	Case Study C*
Estimated households	153	360	500
Number of household surveyed	29	57	50
Proportion of female respondents (%)	76	67	68
Ethnicity (%)			
Zulu	97	19	28
Xhosa		65	72
Mpondo		9	
Others	3	7	
Household characteristics			
Mean household size	6	4	4
Average number of children per household	3	1.5	2
Proportion of household members who are in employment (%)	55	37	40
Household average monthly expenditure on food (ZAR)	703	603	660

***** Predicted users

Responses from Case Study A and Case Study B were employed to answer the first five research questions. Questionnaire responses were coded and processed using the Statistical Package for the Social Sciences (SPSS) V.17 software. A Chi square test was used to measure the existence of associations between those nominal variables that constitute five hypotheses developed from the research questions. Furthermore, to answer the final research question, experiences of use, elicited from Case Studies A and B, were compared with anticipated experiences from Case Study C.

In addition, physical inspections of the facilities were undertaken to check their operational condition. The purpose of these inspections was to validate the results of users' interviews. To obtain an unbiased picture of their condition, CABs were inspected without notifying the attending caretaker.

Three sets of results are presented in the following paragraphs: (i) a descriptive assessment of users' experience with the technology; (ii) tests of statistically significant associations to evaluate the hypotheses derived from research questions; (iii) a comparison of experienced and anticipated benefits of CAB use.

4.4 Results and Analysis

4.4.1 Users' experiences of shared sanitation

Users' experiences of the facilities in Case Study A and B are reported in Table 4-3.

Table 4-3 Frequencies of Case Study A and B

	Case Study A	Case Study B
Use		
Proportion of users (%)	93	56
Daily average use of facility	2.5 times	1 time
Proportion of respondents who received training (%)	22	40
Proportion of respondents who identified problems (%)	81.5	22
Nature of problem:		
Lack of safety at night	22	8
Unclean and unpleasant environment	29	na*
Malfunctioning of facility	16	na
Lack of privacy	11.5	na
Unable to afford	na	52
Distance from dwelling	8	28
Maintenance		
Proportion of respondents able to identify individual responsible for maintenance of the facilities (%)	4	72
Attitude in case of breakage:		
Inform the caretaker	11	25
Unaware of actions to take	41	62.5
Use alternative means	33	15.5
Users reporting availability of soap in the facility (%)	44	12.5
Acceptance		
Proportion of satisfied users (%)	43	53
Proportion suggesting improvements (%)	70	31
Nature of suggested improvement:		
Regular cleaning and maintenance	46	23
Improvement of personal safety	20	15
Introduce payment systems	11	na
Improvement of privacy	11	8
Free too use	na	31
Benefits identified, compared to previous sanitation means (%):		
Comfortableness	56	47
Cleaner and healthier environment	33	53
Advice on CAB trusted most (%):		
Caretaker and municipality	41	44
Myself, neighbours or family members	59	56

*na= no response given for the entry

Inspection of the unit in Case Study A identified broken washing units and pipes. The block was unclean and malodorous and soap was not available to users. A facility caretaker was appointed by the community and worked on a voluntarily basis. The CAB was free to use for the community, with only a small contribution to be paid on a voluntary basis for maintenance. Conversely, the second CAB (Case Study B), was clean and in good working condition. A caretaker was available *in loco* day and night and a pay per use scheme in place. Each user paid an amount ranging from 50 cents to 1 SA Rand to use the facility.

4.4.2 Hypotheses testing

The aggregated data from Case Studies A and B were employed to test a set of hypotheses generated from the first five research questions. Table 4-4 reports the null hypotheses and the results of the Chi square tests.

Table 4-4 Chi square test results

Null Hypothesis	Decision rule	Results	Conclusions
H_o = there is no association between training received by users and satisfaction with CABs	df=2 and α=0.05 Decision rule: Reject H_o if χ^2 >5.991.	χ^2 = 10.363>5.991 The null hypothesis can be rejected	Those respondents who received training are more satisfied with the CAB than those respondents who have not received training.
H_o = there is no association between training received and users' awareness of what to do in case of breakdown	df=3 and α=0.05 Decision rule: Reject H_o if χ^2 >7.814.	χ^2 =11.133>7.814 The null hypothesis can be rejected.	Users who receive training on CAB use are better prepared to respond constructively to system breakdown.
H_o = there is no association between payment for using the systems and users' satisfaction with it	df= 1 and α=0.05 Decision rule: Reject H_o if χ^2 >3.84.	χ^2 = 0.493< 3.84 The null hypothesis cannot be rejected.	Users paying for the CAB are not necessarily more likely to be satisfied with it.
H_o = there is no association between payment for use and caretaker availability	df= 1 and α=0.05 Decision rule: Reject H_o if χ^2 >3.84	χ^2 = 41.98 >3.84 The null hypothesis can be rejected.	Where users pay for CAB services, caretaker availability is more frequent.
H_o = there is no association between payment for using the systems and material found in the toilets	df= 1 and α=0.05 Decision rule: Reject H_o if χ^2 >3.84	χ^2 = 31.22 >3.84 The null hypothesis can be rejected.	Where users pay for CAB services, CAB cleanliness is improved.

4.4.3 Comparison of user perceptions pre and post facility use

The final research question, presented in Table 4-1, explores how experience of use may affect opinions of the systems. To this purpose, perceptions from potential users' of a newly installed unit (Case Study C) were investigated. Descriptive statistics are reported in Table 4-5.

Table 4-5 Case Study C results

	Case Study C*
Proportion of respondents who received training (%)	26
Predicted willingness to pay (%)	84
Predicted benefits associated with facility (%)	
Health and cleanliness	57
Easy access to water and sanitation	26
Predicted attitude in case of problems (%)	
Inform the caretaker or municipality	75
Use alternative means	8
Unsure of my behaviour	18
Advice on CAB trusted most (%)	
Municipality or caretaker	53
Myself neighbours or family members	47

* Predicted perceptions given by potential users

In order to assess the extent to which system use may have influenced users' perceptions of the systems, results from Case Studies A and B were compared with the findings from Case Study C. Figure 4-1 illustrates a comparison between anticipated and experienced aspects of CAB use.

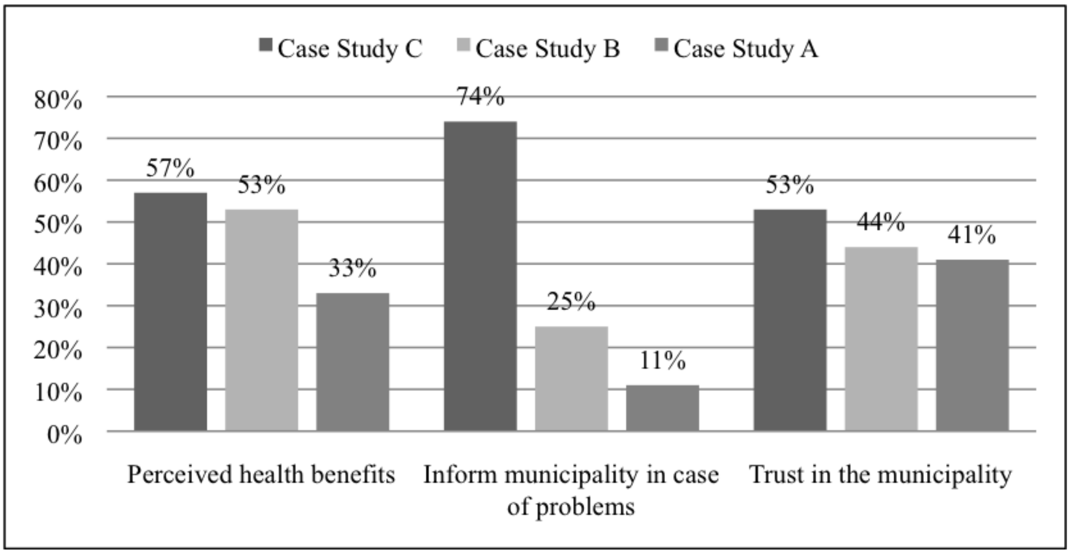

Figure 4-1Comparison between experienced and anticipated use

A little over half of the respondents in Case Studies C and B reported an actual or anticipated improvement in their health from using the facilities, whereas a only a minority in Case study A perceived health benefits derived from using CABs. The noteworthy difference between Case Study A, where respondents have been using CABS for two years and Case Study C where respondents have not yet used the technology, suggests that the experience of use may have decreased the appreciation of the benefits derived from using improved sanitation. A further variation is reported in respondents' anticipated and actual behaviour in case of problems with the facilities. Whilst 74% of potential CAB users anticipated that they would report problems to the municipality, actual CAB users' willingness to address the municipality significantly decreased with experience of use (25% and 11%). Finally, recipients' trust in those individuals or institutions which might provide advice on the CAB facility was recorded by asking respondents to indicate whose advice concerning the CAB facility was most trusted. In Case Study A, 41% of respondents indicated that they would trust eThekwini municipality, with a small majority (55%) found to trust only themselves or their neighbours' opinions about CABs. Results from Case Study B reflect findings from Case Study A in that a small majority of users (56%) only trusted themselves or their neighbours for advice related to the CABs and only 44% trusted the municipality. In comparison, trust in the municipality among potential users' was slightly higher, (53%); this result being further corroborated by their predicted intentions to inform the municipality in case of problems with the technology. These findings provide some evidence that experience of using CABs may influence their perception of the benefits related to the facilities, as well as their attitude towards and trust in service providers. Admittedly, further investigation of pre and post implementation perceptions would be required for Case Study C.

4.5 Discussion

This study highlights some of the factors which facilitate or impede implementation and acceptance of CABs in the eThekwini municipal area. In common with previous post-implementation evaluations, the investigation ascertains the importance of "non technical" aspects as a key influence on the process of WATSAN implementation and acceptance. Statistical results demonstrate that users' acceptance of CABs can be undermined by lack of cleanliness, (as in Case Study A), or lack of affordability, (as in Case Study B). These findings confirm and strengthen conclusions from previous studies discussed in the introductory section. The majority of users surveyed were aware of the problems related to CABs and suggested potential improvements to the existing design or operation of the schemes. Respondents with experience of CAB use from Case Studies A and B report an improvement in personal safety and privacy, as well as the introduction of regular cleaning and maintenance procedures. Similar findings have been highlighted by other studies (Duncker *et al*., 2006; Diallo *et al*. 2007), where convenience of use, cleanliness and privacy emerged from the investigation of acceptance of household latrines and UD toilets respectively.

The results of the Chi Square tests (Table 4-4) underline the importance of training in increasing users' awareness of maintenance as well as their satisfaction with the systems. Furthermore, even if, as our findings suggest, pay-per-use schemes positively influence caretaker presence and, consequently, facility cleanliness and tidiness, they do not appear to be correlated with users' satisfaction with the CAB. Although characterised by different payment schemes, neither of the CABs in Case Studies A and B met with significant levels of satisfaction. The affordability of sanitation systems is a controversial issue, particularly within a context of free service provision where WATSAN services are perceived as a symbol of human dignity and legal right (Eales, 2008). Our results, however, suggest that users' financial contributions to CAB operation would provide an important incentive to caretaker availability, thus enhancing security and cleanliness; both desirable improvements suggested by users. Respondents' participation in training activities represents a further positive influence on user satisfaction with CAB facilities. Training proved to be correlated with respondents' satisfaction with both facilities and proactive attitudes towards problem solving. This may relate to the role played by users' consultations and engagement in enhancing their responsibility for and acceptance of the service provided. Evidence of this argument is provided by other studies on communal sanitation in India, where toilet facilities designed, built and managed by the communities which use them attracted a high degree of acceptance from users (Burra *et al.*, 2003).

Our findings on experienced and anticipated aspects of CAB use (Figure 4-1) deserve particular attention since they corroborate the results of the Chi square test (Table 4-4). Although Case Studies A and B present substantive differences in context and design/operational detail, respondents in both cases exhibit low levels of trust in the municipality's capacity to provide maintenance for the units. Furthermore, a comparison of perceptions of trust shows a discrepancy between the responses from actual and potential CAB users. Where respondents have not yet used the technology, trust in the municipality is higher when compared to those that were already using a CAB. This discrepancy may perhaps be explained by users' disillusion with service providers when problems are not adequately addressed. Thus, experience of use may have negatively affected levels of trust and subsequently a seeming indifference towards the quality and integrity of the facility. This finding is also supported by respondents' lack of attention to problems and reporting them to the municipality (Figure 4-1). In line with other studies on communal sanitation in Southern Africa (Mukheli *et al.*, 2002), this investigation shows that after a period of use, communal facilities may be perceived as mere "open resources" for which users do not feel accountable. This may relate to the fact that eThekwini's sole responsibility for the provision of sanitation systems constitutes a poor incentive to participatory approaches that would enhance users' sense of ownership.

4.6 Conclusions and recommendations

An understanding of non-technical issues is fundamental to the acceptance and sustained use of the implemented systems. The social, cultural economic and behavioural aspects influencing system use should be investigated not only at the planning stage but also at the early post-implementation phase, when interventions to mitigate problems are still possible. This study shows that low satisfaction levels for CABs represent a challenge to the systems' sustained use, and thus the overall success of the interventions.

Although presenting one of the most dynamic and progressive WATSAN management plans in South Africa, eThekwini's forthcoming WATSAN interventions would require significant efforts to achieve universal water and sanitation coverage, thus maximizing the progress towards MDG Target 10. As discussed in previous studies (Stalker Prokopy, 2005), the outcome of WATSAN projects could be significantly improved through users' involvement in decision-making. Participatory approaches should be promoted from the planning stage of interventions through inclusion of recipients in the decision-making processes. Furthermore, regular training of CAB users should be provided to counter the problem of frequent migrations in informal settlements. Awareness campaigns on the importance of health benefits gained from using improves sanitation facilities should also be conducted by using various channels, such as the development of CABs Health Clubs (Waterkeyn and Cairncross, 2005). Community-based financial contribution plans could be created by linking them to micro-finance activities related to the sanitation facilities, such as locally managed shops, health centres and recreational spaces. With users' input into project design, CABs could be transformed into central areas of the settlements where social activities occur. In the post-implementation stage, mechanisms for monitoring CAB performance should be in place. Users' motivation and responsibility could be kept high through the use of post-implementation awards for the best performing facility, as successfully implemented in East Asia (Evans and Trémolet, 2010).

Participatory implementation of CABs is a challenging endeavour in a context of supply-driven services, which requires mutual engagement from both providers and recipients. This entails recognition that recipients constitute an essential resource, providing inputs to the design and management of the facilities through appropriate participation platforms (Friedman, 2006). To achieve this goal, building capacities within eThekwini municipality is fundamental. Capacity building would not only provide the necessary knowledge management skills, but also generate willingness to adopt demand-driven interventions. Finally, development of novel strategies that take into account associated delays in service supply and software costs in the delivery would be required. Ultimately, this mutual effort could translate into considerable gains for all parties, expressed in terms of users' acceptance and thus sustained use of the facilities.

CHAPTER 5: DEVELOPMENT OF A TOOL TO ASSESS WATSAN TECHNOLOGIES IN DEVELOPING COUNTRIES

5 DEVELOPMENT OF A TOOL TO ASSESS WATSAN TECHNOLOGIES IN DEVELOPING COUNTRIES

This chapter discusses the new developments in the research, which were driven by the results of the fieldwork investigation conducted in South Africa (presented in Chapter 4). The insights gained from the Case Study analysis prompted an expansion of the research scope to develop a tool for evaluation of WATSAN technologies in early post-implementation phase. Section 5.1 reviews the conclusions of the South African fieldwork and argues the case for an assessment of WATSAN technologies that focuses on all stakeholders involved in the process of transfer and implementation. Section 5.2 presents a review of the literature on approaches to technology assessment in developing countries, which justifies the need to develop a tool focusing on users' experiences of WATSAN technologies in developing countries. The following Section 5.3 discusses the theoretical background that informed the development of a tool, called RECAP, for assessing WATSAN technologies in developing countries. Section, 5.4, provides a description of, and a set of guidelines to conduct, a RECAP assessment, (a more detailed guidebook is provided in Appendix II). The chapter concludes, in Section 5.5, by outlining revised research objectives and questions, which will be tested in fieldwork investigations presented in subsequent chapters.

5.1 Is there a need for novel approaches to investigate WATSAN technologies in developing countries?

Critical reflections on the outcomes of the first exploratory case study prompted an important change in the research focus and method adopted. The legacy of past WATSAN interventions, discussed in Chapter 2, coupled with more recent scholarly evidence (Mackintosh and Colvin, 2002; Rodgers *et al*., 2007) proved that misuse and lack of acceptance of WATSAN technologies remains a crucial and unsolved problem in technology implementation and sustained use in developing countries. These reflections substantiated the need to focus on the challenges to acceptance and sustained technology use that may emerge in the post-implementation stage.

Findings from the data analysis of users' experiences with Community Ablution Blocks (CABs) in Durban further corroborated the evidence of post-implementation challenges discussed in the literature. The investigation showed that sustained use of CABs was undermined by lack of user safety, no shared sense of ownership and responsibility between users and providers and poor management in the post-implementation stage. Reflections over the nature of these problems enable to characterise the post-implementation challenge as a discrepancy between the intended performance of the systems and users' experiences in the post-implementation stage. To further investigate the gap between technology performance and experience, a purely technology-recipient focus was to be abandoned to involve a broader spectrum of stakeholders playing a role in technology implementation. Critical analysis of CS-I findings, in fact, suggested that other stakeholders (such as the local government and NGOs) involved in the process of CAB implementation might play an important role in ensuring the systems longevity and sustained use. Thus, a re-conceptualisation of the problem as a discrepancy between intended technological performance and experiences prompted change of the method used. Whilst the Receptivity framework had been conceptualised and employed in the exploratory CS-I to investigate recipients' ability to absorb and adopt technologies, the researcher faced the choice of whether to apply Receptivity to investigate technology performance or to slightly modify the method use to adapted to the new assumptions emerged from the CS-I. An attempt to investigate the Receptivity categories of awareness, association, acquisition and application in an informal interview with a member of the municipality clearly illustrated the difficulty to operationalise the components to gather meaningful information about technology performance. Not only some of the Receptivity categories (i.e. awareness and acquisition of implemented CABs) lost their explanatory power and meaning when applied to provider in a post-implementation stage, but also it emerged that a framework characterised by a rigid structure of categories could prevent further issues to emerge from the investigation. A further factor that led to a slight modification of the method adopted related to the deployment of the Receptivity framework in the field. The significant and meaning of the aforementioned categories to the questionnaire adopted in CS-I was not always easily understood by field workers and translators, thus requiring the presence of the researcher for replication in further studies.

The above-mentioned aspects revealed to be potential limitations to developing an appropriate instrument to routinely evaluate WATSAN technologies in the post-implementation stage. Thus, upon a critical consideration of the obstacles encountered in adopting the Receptivity categories to explore the performance-experience gap, and a consultation with Cranfield University peers, an important change in the method was adopted. The concept of Receptivity was employed in its broader meaning and to the extent that it allowed the investigation of users' ability to adopt the technologies. A broader use of the concept of Receptivity enabled respondents to shape the agenda of evaluation, without imposing assessment categories on their judgements. Furthermore, the adoption of more general categories and concepts which are easily understood and adopted by those executing the evaluation in the field, improves the applicability and usability of the RECAP tool to evaluate WATSAN technologies

Finally, another finding from CS-I, which greatly influenced the development of a RECAP tool, relates to the nature of challenges and problems that emerge in post-implementation. These are often related to non-technical aspects of the technologies, such as lack of operation and management, scarce ability (or willingness) to afford to pay for the systems and low trust in the services offered by the municipality (see Table 4-1). Thus, CS-I suggest the importance of establishing mechanisms to routinely evaluate CABs from a broader perspective involving not only technical aspects but also stakeholders' perceptions of non-technical attributes. The discrepancy between intended technological performance and experiences prompted the investigation of its origin and causes, through an assessment that compares and contrasts providers' views with recipients' perceptions. The analytical process leading to RECAP development is summarised in Figure 5-1.

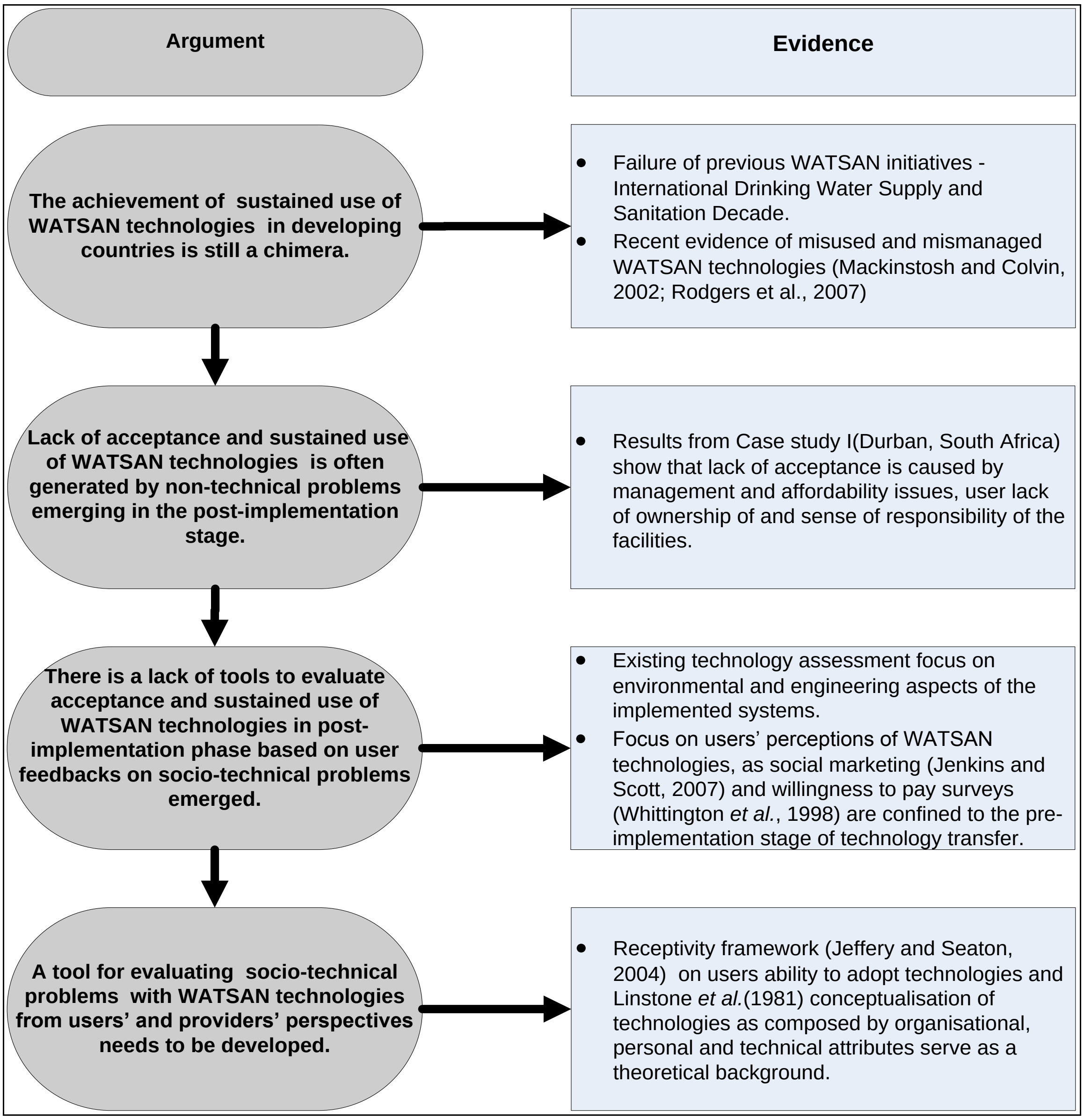

Figure 5-1 Drivers for new research development

5.2 Existing approaches to technology assessment

An analysis of existing approaches and methods to technology assessment is fundamental to explore gaps in the literature that may inform the development of a novel diagnostic tool to evaluate WATSAN technologies in developing countries. A review of the methods and practices adopted for technology assessment reveals the existence of a plethora of tools generated for application in the industrialised world.

Henriksen (1997) and Tran (2007), for instance, provide a comprehensive overview of procedures adopted to assess industrial technologies and organised them in a set of categories, outlined below.

- *Economic analysis* involves the investigation and assessment of the financial costs and benefits associated with developing a technology or acquiring a new process. Some established methods for economic analysis include cost/benefit analysis, cost/effective analysis and Net Present Value (NPV).
- *Decision analysis* provides elements for decision-making by comparing attributes of a pool of alternatives with respect to a defined set of criteria. Typical methods used in decision analysis are: multi-criteria decision making, group decision support systems or Analytic Hierarchy Process (AHP*)*.
- *System engineering/systems analysis* is defined as the process to assess the whole technological system with respect to multiple indicators. An increasingly adopted method is Life Cycle Assessment (LCA), which entails the evaluation of a product process technology performance during its life cycle, from extraction to its final disposal (Azapagic, 1999).
- *Technological forecasting* attempts to postulate and predict information about a technology performance or trends by using probabilistic and mathematical models of some variable that characterise the technology. Established methods of technology forecasting are Delphi technique and S-curve analysis.
- *Information monitoring* involves the collection and processing of information that increase the competitiveness of a technology and its supplier in the market. Examples of this type of technology assessment are given by electronic databases, patent searching.
- *Technical performance assessment* aims at determining the overall performance of a technology after its implementation, through evaluation of operational aspects, ergonomic, cost effectiveness. Quantitative statistics and trial use evaluations are examples of methods adopted to perform this type of assessment.
- *Risk Assessment* entails the evaluation of possible side effects that may generate loss in suppliers' revenue. Risk can emerge from faults in the products, lack of adjustment to market forces, as well as environmental, health and safety side effect.

Methods for risk assessment are simulations, modelling studies and probabilistic evaluations.

- *Market analysis* involves studies of the market requirement and demand for a technology as well as the cost-benefits implications for suppliers to meet the market specifications. Surveys or market push/pull analysis are typically employed in this assessment.
- *Externalities/impact analysis* entails the evaluation of short and long terms effects of the technology to the environment, the society, which can ultimately turn into real costs for suppliers. An example of this evaluation is Environmental Impact Assessment (EIA), a set of predefined procedures and steps, adopted in project planning phase, to evaluate the effects of a project, activity or technology on the environment and the proposed measures to mitigate them.

In developing countries, frameworks for the assessment of WATSAN technologies typically draw on existing methodologies, which have been conceptualised and applied in industrialised countries. The focus for the evaluation typically rests on system/engineering analysis, assessment of technology performance and environmental and health impacts. A more recent trend has involved linking technology assessment with the investigation of technology sustainability, its evaluation being measured through *ad hoc* indicators (Dunmade, 2002; Vishnudas *et al.*, 2008). Drawing on Henriksen's (1997) and Tran's (2007) categorisation of technology assessment, Table 5-1 shows how recent evaluation studies of WATSAN technologies in developing countries can be clustered using the assessment categories discussed above.

Table 5-1 Examples of Technology Assessment in developing countries

TA Category	Reference with application to WATSAN sector in developing countries	
Economic Analysis	Von Münch and Mayumbelo (2007)	A methodology for financial analysis is developed to compare the costs of excreta management options in Zambia.
Decision Analysis	Ramanujam and Saaty (1981)	The Analytic Hierarchy Process (AHP) is presented as a potential technique for evaluating technologies on the basis of economic, social and political criteria.
System analysis	Balkema *et al.* (2002)	A system analysis is developed for assessing the sustainability of urban wastewater treatment systems based on multiple indicators: functional, economic, environmental and socio-cultural.
Technical Performance Assessment	Harvey and Drouin (2006)	Comparison of locally produced rope-pumps with conventional hand pump in Ghana. Assessment was conducted through sanitary surveys, water quality tests and technical performance assessment.
Risk Assessment	Howard (2003)	Hazard Analysis and Critical Control Point (HACCP) is applied to water a safety plan for identifying the risk of water contamination and adopting appropriate monitoring and control measures.
Market Analysis	Louis *et al.* (2007)	A model for analysing demand in relation to supply for municipal sanitation services in the Philippines is introduced. The model provides guidance for planning future technology and capacity development.
Externalities/impact Analysis	Jones and Silva (2009)	Life Cycle Assessment is employed to evaluate the sustainability of arsenic treatment options in Bangladesh

The examples and methods for evaluating WATSAN technologies outlined in Table 5-1 are primarily based on mathematical, environmental, economic and statistical modelling and exhibit an inherently *technocentric* bias. Increasingly, scholars (e.g. Hoos, 1979; Palm and Hansson, 2006) have contended that dominant paradigms of technology assessment, although presenting multi-criteria agendas for evaluation, still pursue the identification of problems, where social aspects and users' perceptions are largely under investigated. Similarly, Goulet (1994) argues the importance to shift from assessments conducted by small groups of scientists and technocrats to more participatory processes that include the technology recipients and the suppliers.

Against this background, novel perspectives for technology assessment have emerged in the industrialised world. Participatory forms of technology assessment were developed to measure the impacts of the technology on society and to incorporate the voice of the public. The overall ambition of participatory technology assessment is to reduce the negative impacts on humans derived from adopting and acquiring new technologies (Schott and Rip, 1996). The Constructive Technology assessment approach shares a similar ambition, by providing a set of strategies and tools to feed back an assessment of a technology into the design and construction process, through better articulation of users' demand and acceptability (Schott and Rip, 1996). Drawing on people-oriented forms of technology assessment, recent contributions have sought to widen the scope of technology evaluations. Social Impact Assessment (SIA) constitutes an excellent attempt to consider human and social aspects in the assessment of technologies. The International Association for Impact Assessment (IAIA) defines SIA as "the process of analysing, monitoring and managing intended and unintended social consequences, both positive and negative, of planned interventions" (IAIA, 2003:2). Typically, SIA accompanies an assessment of the environmental impacts of projects, although their use is still uncommon (Palm and Hansson, 2006).

This same study by Palm and Hansson (2006) discusses the importance of investigating the ethical issues emerging from the development of new technologies. An ethical technology assessment is conceived as a participatory dialogue across nine criteria involving all relevant stakeholders: spread of information; distribution of power and control structures; effects on social relations and contacts; respect of privacy; sustainability; human reproduction, respect of gender and minorities; international relations and impacts on human values. The authors apply the checklist to examples drawn from innovations in the information and communication, health and reproductive sectors. A similar attempt to focus on the social aspects of technology is provided by Assefa and Frostell (2007), who develop a framework for the social sustainability of energy technology assessment based on three indicators: public knowledge of the technologies; public perceptions of the technology, its physical and social implications and public concerns over risks and danger related to the technologies.

This thesis argues that despite these recent contributions and a more general shift of focus towards the human dimensions of technology use, we remain uninformed about end-users experiences of WATSAN technologies, particularly in the immediate post-implementation phase. Although, as discussed in Chapter 2, the importance of focusing on recipients has been highlighted by advocates of the Appropriate Technology movement, of participatory approaches and by members of international organisations, the majority of studies are confined to the pre-implementation phase of technology transfer. A related criticism of technology assessment approaches employed in developing countries is that they are still inherently related to practices in the industrialised world. Châtel, (1979) and Goonatilake, (1994) both argue that the political, legal, socio-cultural characteristics pertaining to developing countries may hinder opportunities to undertake appropriate technological assessment and they advance the need for generating adaptive approaches that can be adopted in the context of developing countries.

This knowledge gap, coupled with the opportunities that rapid post-implementation evaluations provide to remedial interventions prompted the development of a novel tool to assess WATSAN technologies. The novelty of this tool (named RECAP) rests on several aspects. Firstly, a RECAP assessment is multidimensional: it incorporates and evaluates perceptions of socio-cultural, economic, environmental, ergonomic and hygienic attributes of the technology. This multiple perspective is coupled with a participatory approach, based on feedback from end users of the technology, which supports diagnosis of problems that are often disregarded by engineering assessments. Secondly, distancing from technology-focused approaches, the RECAP tool gives voice to both recipients and providers of transferred technologies. Thirdly, the RECAP assessments are conducted in the post-implementation phase of WATSAN technology development, enabling the evaluation of emerged problems and assessing the experiences forecasted in the planning phase. Finally, the tool's straightforward conceptualisation and ease of use allow application to a variety of WATSAN technologies in different contexts, by evaluators from the developed and developing world.

5.3 The theoretical background to the RECAP tool

Although useful to evaluate performance of WATSAN technologies, the approaches illustrated in Section 5.2 do not capture the socio-technical problems that may undermine users acceptance and sustained use. Perhaps one of the most authoritative efforts to model the processes that shape technology adoption by focusing on the boundaries within which it occurs is *Diffusion of Innovations* by Rogers (1962). Since its conceptualisation, Rogers' diffusion model has been applied and adapted in several fields of research, such as rural sociology, education, public health and management, to cite a few (Rogers, 2004). Diffusion is defined as "the process in which an innovation is communicated through certain channels over time among members of societal systems" (Rogers, 2003: p.5). According to Rogers' model, four core elements can be identified in every diffusion process, from adoption of water technologies in small rural villages to the spread of Internet technology in the industrialised world (Rogers, 2003). These are *i)* the innovation itself, which can be an idea, a practice and (more importantly for this research) a technology, characterised by hardware and software; *ii)* communication channels by which messages embedded in innovations are transferred among individuals; *iii)* time, whose role in the process of diffusion is related three factors: the decision-making process accompanying individuals from first knowledge of an innovation to its adoption or rejection; the earliness or lateness with which innovation adoption occurs, and the rate of adoption of an innovation in the system. Finally, a fourth core element characterising innovation process refers to *iv)* the social system, namely "interrelated units that are engaged in problem solving to accomplish common goals" (Rogers, 2003: p.23).

Recipients of innovations are exposed to a decision-making process characterised by five stages: knowledge, persuasion, decision, implementation and confirmation. Whilst an in depth discussion of the components of Rogers' model is outside the scope of this thesis, for the purpose of this Section it is necessary to highlight the focus on human and societal dimensions governing the diffusion process. Rogers conceptualises a two-way interaction between the transfer of innovations and the society where this occurs. The diffusion of innovations brings about a transformation in the society where it takes place, by altering the functional and structure of the social system. However, theory's most striking feature relates to the influence exerted by social structures on the process of diffusion itself. This crucial element has been influencing subsequent developments of recipient-focus frameworks and approaches to investigate technology transfer, which will be later discussed. On the basis of Rogers' model, people's decisions to adopt an innovation depend on the norms and behavioural patterns which dominates in a society; thus, for instance, the attempt to introduce boiling water in a village in Peru may have failed due to the existing cultural traditions associating hot water with illness (Rogers, 2003). Similarly, in his model of diffusion, individuals' choice of adoption can be influenced by opinion leaders, individuals exerting negative or positive influence over people's behaviour and decision making process towards adoption; agents of change and aides, who also affect by different means and degrees recipients' opinions of innovations.

Furthermore, the diffusion model goes beyond the focus on the role of societal structure, by explaining the importance of human dimensions and subjective evaluations in shaping of innovation adoption and its rate. Individual perceptions of innovation attributes drive the diffusion process and can be used to predict its rate of adoption. These are:

- Relative advantage: perceptions of members of a social system that of the introduced innovation is better than the existing idea that it substitutes.
- Compatibility, perceptions of consistency between the innovation and existing needs, traditions, behaviour and values of adopters.
- Complexity, perception of relative ease to use and adopt an innovation.
- Trialability, the ability to try the innovation on a limited basis.
- Operability, the degree to which results of an innovation are exposed to and seen by to other members of the society.

The investigation of recipients' perceptions of the above-presented attributes is paramount to understand the adoption process, its speed and success. Particularly, Rogers postulates the existence of positive relations between potential adopters' perceptions of relative advantage, compatibility, trialability and operability with the pace at which an innovation is internalised by them; whilst a negative relation exists between perceptions of complexity and adoption rate. The identification of subjective perceptions of innovation attributes, closely positions Rogers' work to the acceptability research, which aims at investigating perceptions of innovation attributes and to guide research and development of the product.

The importance of investigating attribute perceptions of potential adopters' of technology is reflected in this thesis and in aim to develop a post-implementation evaluation tool based on users' feedback and stakeholders' perceptions of technologies. Furthermore, the development of the RECAP tool draws its theoretical premises from a particular set of contributions in the technology evaluation field, which have been critical of *technocentric* approaches. Contributions from Linstone *et al.* (1981) and Seaton and Cordey-Hayes (1993) identify the failure of technological innovations with a lack of understanding of recipients' ability to incorporate the changes implied by technology adoption. The main deficiencies of these approaches are summarised below (Seaton and Cordey-Hayes, 1993):

- Failure to address the peculiar needs of the receiving entity. A *technocentric* approach focuses primarily on transfer and delivery without understanding the recipients' environment, the context and its requirements.
- Inability to tackle the social and individual components involved in the process of transfer, focusing merely on its technical and economic attributes.
- Erroneous assumption that receiving entity, irrespectively from size or type, conceives of technological change as a priority, carefully articulating their technical needs and/or problems.

By applying these reflections to the WATSAN sector, some important propositions that influenced the development of the RECAP tool are made. These are the following:

1. The transfer and implementation of WATSAN technologies cannot be separated from their context and recipients. Hence, the experience of the technology users becomes a fundamental aspect of the process of assessment of the technology. The development of this first proposition stems from evidence of failures of past blue print and *technocentric* solutions to water and sanitation problems in developing countries (discussed in Section 2.3) and the benefits of recipient's involvement in

the process of technology transfer implementation and evaluation as advocates by proponents of Demand Driven Approaches (Narayan, 1993; 1995; Katz and Sara, 1997). The importance of stakeholders' involvement in all stages of process of technology transfer leads to use of the concept of Receptivity as part of the RECAP tool, as people oriented process of technology evaluation (discussed in Section 5.3.1).

2. Multiple dimensions are embedded in a WATSAN technology. These include not only engineering aspects but also other aspects such as institutional, socio-cultural and hygienic attributes. Experience of past WATSAN interventions has largely proved that failure to generate successfully accepted and adopted WATSAN technologies depends not only on the technical soundness of the systems implemented but also on social-cultural (Rainey and Harding, 2005) or economic attributes of the technologies (Burra *et al.*, 2003; Diallo *et al.*, 2007). Drawing on the past experience Linstone *et al.*'s (1981) investigation of the phenomena of technological change and assessment based on multiple perspectives (personal, organisational and technical), this proposition informs the development of an Attribute Perception (AP) model (described in Section 5.3.2).

3. User experiences of WATSAN technologies in the post-implementation stage must be evaluated to investigate challenges to the systems acceptance and sustained use that emerge in the pre-implementation stage. The emergence and characterisation of challenges to the longevity of implemented WATSAN systems have been exhaustively discussed in the literature (Carter et al. 1999; Harvey and Reed, 2007; Ademiluyi and Odugbesan, 2008). These challenges appear to be characterised by a discrepancy between users'/communities' intentions and willingness to use the technology in the pre-implementation stage and lack of equivalent behaviour in the post-implementation stage (Yaccob, 1990). Thus, this proposition requires the deployment of the RECAP tool in the post-implementation stage of technology transfer, when sufficient time is available to diagnose problems and challenges that may undermine the success of WATSAN interventions.

Thus, the two theoretical models, Receptivity (Jeffrey and Seaton, 2004) and Attribute Perception (AP) were adopted to inform the design of the RECAP tool. Furthermore, the application of the RECAP tool in the field is guided by a gap analysis approach, which allows the investigation of the discrepancy between intended performance and experience of the technologies.

5.3.1 The Receptivity model

Technocentric models of technology adoption have been subject to strong criticism based on the argument that a physical characterisation of a technology is not sufficient to diagnose problems, justify failures and explain the process of technological change. Important limitations of such models have been identified, perhaps the most significant of which has been the lack of focus on the human aspects (Linstone *et al.,* 1981). The early approaches to innovation tended to ignore the role of individuals in the process of technology transfer and implementation, focusing merely on the equipment.

Responding to these limitations, new research has sought to re-conceptualise the process of technology transfer building upon a new definition of technology, which emphasizes social context, human perceptions and learning and includes not only the material output of scientific discoveries but also the skills, knowledge, and experience of those involved in the process (Gilbert and Cordey-Hayes, 1996; Seaton, 1997). The Accessibility, Mobility and Receptivity (AMR) framework developed by Seaton and Cordey-Hayes (1993) focused on the implications of technology uptake from the receiving organisation's and individuals' point of view, marking an important step towards a revised, more social, model of technology transfer and adoption based on the concept of Receptivity. The first study to explicitly emphasise the role of Receptivity was conducted by Trott *et al.* (1995), who reconfigured Seaton and Cordey-Hayes' (1993) AMR framework to build a model for assessing the process of inward technology transfer. Although the AMR approach identified the conditions necessary for successful technology transfer where Receptivity constituted its main component, Trott *et al.* (1995) focused on Receptivity in order to unpack the internal processes taking place within the receiving unit. He postulated a four-component model of technology transfer, also known as the "4As model" based on the components of awareness, association, assimilation and application and applied it to the case study of inward technology transfer to ICI chemical industry in the United Kingdom. The significance of the 4As model rests on its focus on the recipient's own internal activities, which are deemed to improve their ability to effectively acquire new technology. Scanning and networking activities, in fact, are fundamental to increase the flow of technological information and the knowledge base within the organisation, thereby improving its receptivity. This enrichment of the Receptivity component into the 4As model constituted an important step towards the development of a technology transfer model, which explicitly incorporates knowledge as a determining factor of successful adoption. These intellectual efforts led to the conceptualisation of a Receptivity model (Jeffrey and Seaton, 2004) to analyse stakeholders' adoption of water innovation options in industrialised countries. Receptivity is defined as: *the willingness (or disposition) but also the ability (or capability) in different constituencies (individual, communities, organisations and agencies) to absorb, accept and utilize innovation option.* (Jeffrey and Seaton, 2004: pp.281-2). The main premise which rests behind the idea of Receptivity is the inability to understand the responses and behaviours of people, communities, organisations and businesses to a technology or a policy without also understanding the perceptions, attitudes and agendas for change which are relevant to them (Seaton, 2002). The model is characterised by four components, outlined in Table 5-2.

Table 5-2 Receptivity components

Receptivity Components	Description
Awareness	Perception by stakeholders of some problems related to water and sanitation and their ability to search and scan for new knowledge.
Association	Understanding of the potentiality of knowledge exploitation and of its association with needs and capabilities.
Acquisition	Involves a process of learning to gain the knowledge and skills necessary to incorporate a technology.
Application	Capability to receive long-term benefits from technologies implemented. This implies the ability of internalising the innovation in the recipients' routine, organising maintenance and managing risk.

Source: Jeffrey and Seaton, 2004

Several studies have employed the concept of Receptivity to investigate recipients' perceptions and adoptive capacity of technologies in the developed world. Table 5-3 presents an inventory of the most relevant contributions.

The importance of Receptivity to the conduction of this research rests on its focus on end users of WATSAN technologies and services. In the first case study presented in

Chapter 4, the Receptivity model proved to be useful to frame the investigation and unveil users' experience of non-technical aspects and constraints to use the community sanitation centres. Users' perceptions on use, maintenance and acceptance of the systems, provided a useful lessons for providers to tackle the problems identified and to suggest appropriate solutions.

Table 5-3 Use of Receptivity in the literature

Receptivity application	References
Large industrial company exploitation of innovation opportunities.	Trott *et al.* (1995)
Financial sector organisational learning in response to technology change.	Gilbert and Cordey-Hayes (1996)
Developing a measure of innovative effort as a means of assessing the ability of an organisation to evolve in knowledge and technical dimensions.	Seaton and Al-Ghailani, (1997)
Examining the role of partnering arrangements between technology suppliers and customers as a means of facilitating innovation through knowledge transfer.	Beecham and Cordey-Hayes (1998)
Transfer of cleaner production (CP) solution to manufacturing industries in the United Kingdom	Vickers and Cordey-Hayes (1999)
Sustainable water management practice in Argolid Valley, Greece	Jeffrey and Seaton (2004)
Understanding the role of user perceptions to using rain and grey water technologies and alternative water sources.	Jeffrey and Jefferson (2003); Clarke and Brown (2006)
Developing a methodology for transferring research concepts into industry practice.	Cook *et al.* (2006)
Understanding problems in environmental modelling technology design from the perspective of recipient needs.	McIntosh *et al.* (2007)

As a component of the RECAP tool, Receptivity is employed to provide a qualitative risk assessment of innovation options by asking policy-makers and technology designers to analyse recipients' points of view. Furthermore, its focus on the social, cultural and psychological components of WATSAN technology transfer helps identify some of the challenges and needs faced by the involved stakeholders, fostering project design as well as resource allocation. Finally, Receptivity is utilised for its ability to diagnose the experience and acceptance of water and sanitation solutions and analyse the reasons why a potential innovation failed to achieve expected goals. Whilst the developing country context presents no obvious threats to the coherence or legitimacy of the Receptivity model, the case study presented in Chapter 4, suggests that a number of specific features of WATSAN technologies are influential in the adoption and use process. These are discussed in the following sub-paragraph.

5.3.2 The Attribute Perception model

As described in the analysis of CS-I, users' experiences of the technologies revealed that their perceptions of non-technical aspects related to the system affected use and acceptance. The importance of user perceptions of technologies as multi-attribute systems justifies the development of a framework for analysis of the multifaceted attributes of an innovation. Throughout this research use is made of the notion of *attributes*, namely those properties of a technology (in use and in the context of the user), which recipients consider relevant and describe in their own terms and values. The problem for "providers" is that while they have only one agenda, recipients are embedded in their own world with multiple agendas, which influence the perception of attributes relevance and importance.

The formulation of an Attribute Perception (AP) framework draws on Linstone *et al.*'s (1981) conceptualisation of technology as a multi-perspective entity: not only the technical element of the process (as the previous approaches did), but also the *organisational* and *personal* attributes have to be considered. By *organisational* perspective, it is meant the focus on the socio-cultural organisation in which the technological system is embedded. Furthermore, the perceptions and beliefs of technology recipients- the so-called *personal* perspective- should be taken into account. Drawing on Linstone *et al.* (1981), the premise at the basis of the AP analysis is the idea that innovation does not merely comprise material components but it is a complex combination of attributes, which constitute important determinants of the system.

Among relevant attempts to unpack the concept of technology, a comprehensive recognition characterises a technological system as composed not only by hardware, tools, equipment, but also by a knowledge component described by terms such as software, social technology and know-how. According to Ramanathan (1994) a technology is not only *Technoware*, object-embodied technology, but also *Humanware*- experience, skills and knowledge; *Infoware*- process and procedures and institution-embodied technology *(Orgaware)*. Similar insights can be drawn from the literature on technology acceptance applied to information systems. The Technology Acceptance Model (TAM) developed by Davis (1989) represents an important attempt to investigate non-technical aspects of technology acceptance. This largely depends on users' perceptions about technology ease of use and usefulness, which are influenced by other external variables. Recipients' perceptions and attitudes affect their behavioural intentions to use the system, which in turn determines its actual adoption. Similarly, in an attempt to integrate the most relevant literature on technology acceptance modelling, Venkatesh *et al.* (2003) formulated the Unified Theory of Acceptance and Use of Technology (UTAUT), which stresses the importance of expectations of performance, effort and social influence as fundamental determinants in use. Other aspects such as age and experience do also play a mediating role in impacting on technology use.

The technology acceptance literature provides useful guidance for developing an Attribute Perception (AP) framework, which entails the analysis of a transferable innovation option and its attributes as conceived of by providers and users. A screening of the relevant literature on WATSAN technology transfer identified a non-exhaustive pool of attributes employed as benchmark for the assessment of the technologies, Table 5-4.

Table 5-4 Significant attributes of technologies elicited from the literature

Technology Attributes	Definition	References
Design	The external physical characteristics of a technology, its form.	Cromwell (1992); Kalker *et al.* (1999); Bewket (2007);
Space	The spatial and geographical requirements/constraints imposed by a technology.	Cromwell (1992); Kalker *et al*. (1999); Rijal (1999); Oliveira *et al.* (2006); Bewket (2007)
Economic	The costs related to technology use and maintenance.	Cromwell (1992); Kalker *et al.* (1999); Karani (2001); Graff *et al.* (2006); Rijal (1999); Friedler *et al*. (2006); Bewket (2007);
Environment	The environmental benefits associated with the employment of the technology.	Rijal (1999); Karani (2001); Graff *et al.* (2006); Friedler *et al.* (2006); Oliveira *et al.* (2006); Bewket (2007);
Health and Hygiene	The contribution provided by the technology to benefit human health.	Rijal (1999); Rainey and Harding, 2005; Graff *et al.* (2006);Altherr *et al.* (2008)
Society and culture	Socio-cultural aspects of technologies, including the influence of gender, religion and culture.	Cromwell (1992); Kalker *et al.* (1999); Graff *et al.* (2006); Rijal (1999); Bewket (2007); Rainey and Harding, (2005); Friedler *et al.* (2006); Meierhofer and Landolt (2009);
Function	Technology's capability to perform its design functions.	Graff et al. (2006); Oliveira et al. (2006); Bewket (2007);
Institutional/legal	The institutional and legal aspects related to the use, implementation and longevity of the technology.	Downs, (2001); Dunmade (2002); Meierhofer and Landolt (2009);

The strength of the AP framework as an influential component of RECAP rests on its ability to explore stakeholders' views and perceptions of a technology, with relation to its multiple components. In so doing, RECAP expands its scope and focus beyond technical, environmental and economic attributes, typically adopted in technology assessments, allowing for the stakeholders involved to give prominence to those attributes relevant to them.

5.3.3 The Gap analysis approach

The underlying assumption of RECAP development is that the process of WATSAN transfer and adoption is concerned with users' capacity to adopt and their experience of the multi-faceted aspects of the systems. This leads to some suggestion on how to face the problem and consequently how to best exploit the potential of the foundational theories adopted.

The methodological perspective that informs RECAP development stems from the Service Quality literature, which relates the quality problem to a gap between its suppliers and consumers (Krepapa *et al.,* 2003). Service quality can be defined as the measure by which a service complies with customers' expectations. (Lewis and Booms, 1983). One of the most influential developments in the literature is the gap analysis approach conceptualised by Parasuraman *et al.* (1985), who define quality as dependent on the discrepancy between customers' expectation of a service and their perceptions of the actual service delivered. This is in turn influenced by other discrepancies between consumers and providers related to design, communication, management and delivery of services. The divergence between the two should be solved by providers through a better understanding of customers' requirements and an attempt to meet them; as well as through investigation of users' satisfaction with the services offered and adoption of appropriate actions to improve them (Yang, 2003). The smaller the value gap between consumers and providers, the greater is client satisfaction and a firm competitiveness in the market. Table 5-5 outlines of the most relevant studies using gap analysis to investigate service quality.

Table 5-5 Gap analysis studies

Reference	Identified Gaps	Case Study	Outputs
Grönroos (1984)	Gap between buyer and seller with regard to service technical and functional quality.	Service firms in Sweden	Managers should understand customers' perceptions of technical and functional quality.
Parasuraman *et al.* (1985)	Gap 1: Managers' perceptions of customers' expectations- customers' actual expectations. Gap 2: Managers' perceptions of customers' expectations-service quality specification; Gap 3: Service quality specification- actual service delivery. Gap 4: Actual service delivery- external communication about service	Retail banking; credit card services; security brokering; product repair and maintenance	Service quality depends on the nature and magnitude of a gap between what service customers expect to receive and what they actually receive
Brown and Swartz (1989)	Gap 1: Client expectations-experiences Gap 2: Client expectation professional perception of client expectations Gap 3: Client experiences- professional perceptions of client experiences	Medical service area, in particular professional patient relationship.	Professionals' behaviour should be conformed to clients expectations and clients educated to generate expectations consistent with the service delivered.
Headley and Choi (1992)	Customers' perceptions of quality of a service and providers' ideas of what customers want.	Study of service quality of a fitness centre.	Critical areas of the service requiring intervention from the management are identified.
Steinman *et al.* (2000)	Investigate "the us versus them" gap between providers and consumers in order to improve market orientation (customer satisfaction through continuous need assessment).	Service quality of Japanese and American business to business relationship.	There is a market orientation gap as suppliers evaluate their own market orientation as being higher than customers' one.
Krepapa *et al.* 2003	The gap between customers and providers perceptions of market orientation has a unique effect on the satisfaction response over and above any direct effect that customer perceptions of providers market orientation may have on satisfaction.	Corporate banking	Inconsistencies between providers and customers' perceptions of market orientation impact on customers' satisfaction.
Yang, 2003	Gap between customers and providers in terms of perceptions of the service outcome and of the process of service delivery.	Home appliance manufacturer	Analysis of customers' requirements and satisfaction can help identify which quality attributes need improvement.

The underpinning principle of gap analysis, as employed in this research, is the possibility to evaluate quality of a service through a customer/user-centred approach (Headley and Choi, 1992). Its methodology fulfils the main premise for RECAP development: it is concerned with users and focuses on the process of delivery of a service, a technology or policy. Adapting Headley and Choi's (1992) diagram on quality improvement to the transfer of WATSAN technologies in developing countries, a process of user engagement to increase acceptance and sustainability of the technology is depicted in Figure 5-2.

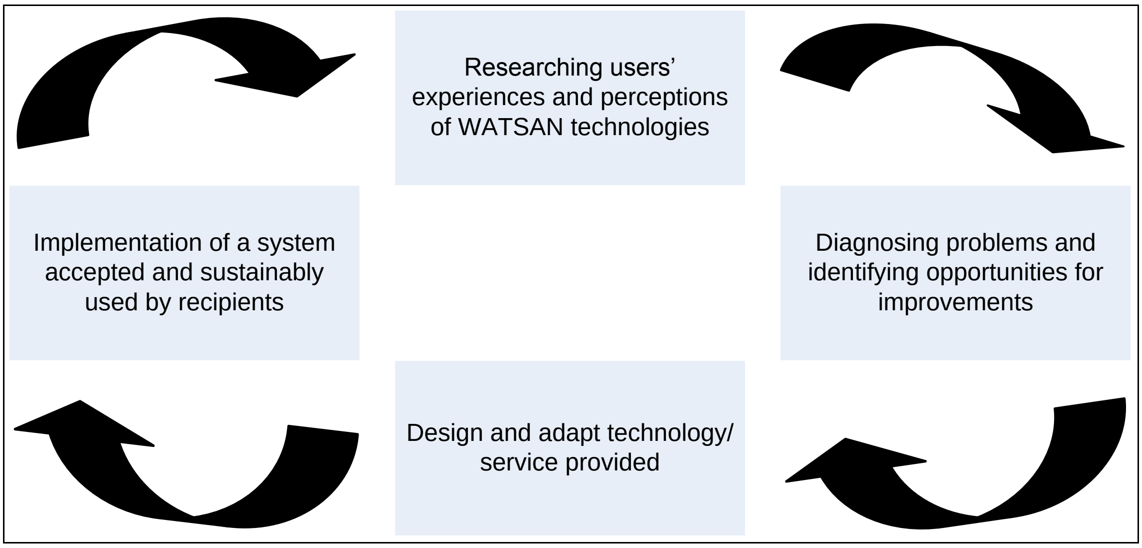

Figure 5-2 User involvement in the process of WATSAN technology implementation

The process illustrated in the diagram highlights the importance of exploiting users' knowledge to improve the process of technology transfer, as well as interdependency between users' feedback and the sustainability of the technologies implemented by providers.

The strengths of gap analysis, highlighted by its advocates (Headley and Choi, 1992), rest in the flexibility of focus, being applicable to most context and service types, its ease of implementation, and clarity of results. A gap analysis is therefore selected as useful conceptual device to guide the analysis: it provides an objective overview of the magnitude and type of discrepancies between the stakeholders involved in the process of technology delivery. Its straightforward approach allows for comparing and contrasting receptivity and perceptions of attributes of WATSAN technologies of two groups of participants, located at the two extremities of the process of transfer. The first concerns providers of WATSAN technologies. These include technology design companies, multinational corporations, as well as international organisations and governments. The second group of actors comprises technology recipients. These may be users of technologies in private places (such as households), as well as in public areas, such as community sanitation centres. Finally, gap analysis can guide the investigation of the discrepancies between the intended attributes perceived by technology providers and the experienced attributes identified by recipients. These are defined as follows:

- Intended attributes, as conceived by its providers. These are the attributes of a WATSAN technology as conceived of by its providers.

- Experienced attributes, as interpreted by its recipients. These attributes provide a picture of technological device after the transfer process has taken place.

Figure 5-3 summarizes the various models and components of the RECAP tool.

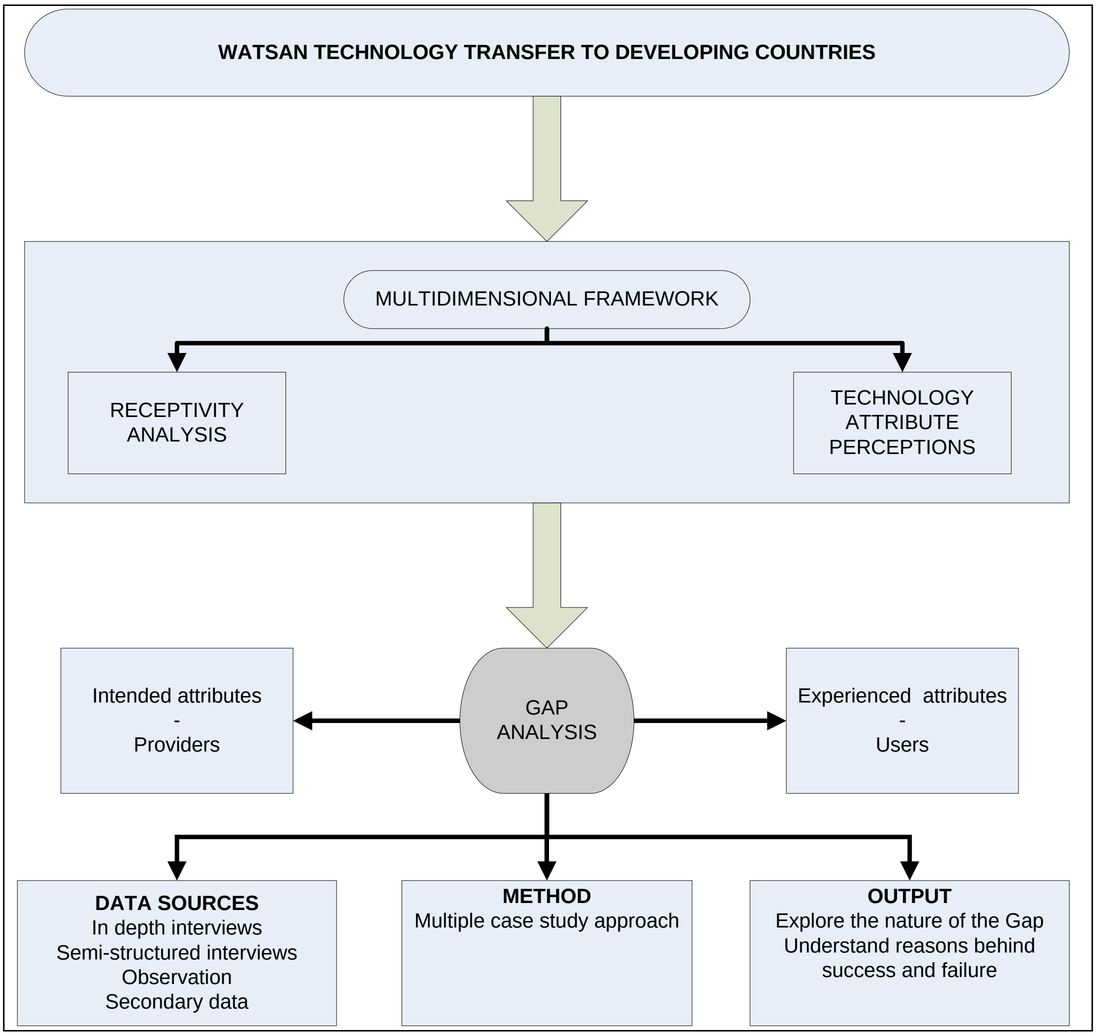

Figure 5-3 The multidimensional structure of the RECAP tool

5.4 The RECAP tool and its use

The agendas provided by Receptivity and Attribute Perception (AP) are translated into RECAP, a tool for the appraisal of WATSAN technologies in the post-implementation phase. A RECAP assessment of a WATSAN technology evaluates technology performance and experience within a framework of expectations about technology deliverables. If appropriately managed, a RECAP assessment can provide evaluators with feedback from recipients to support the framing of future interventions to enhance recipients' acceptance and use of the technology. Furthermore, the assessment is conceived of as a circular process: information gathered from users can help to build an understanding of the issues and problems involved and initiate a learning process for providers. Figure 5-4 illustrates the various steps of a RECAP assessment.

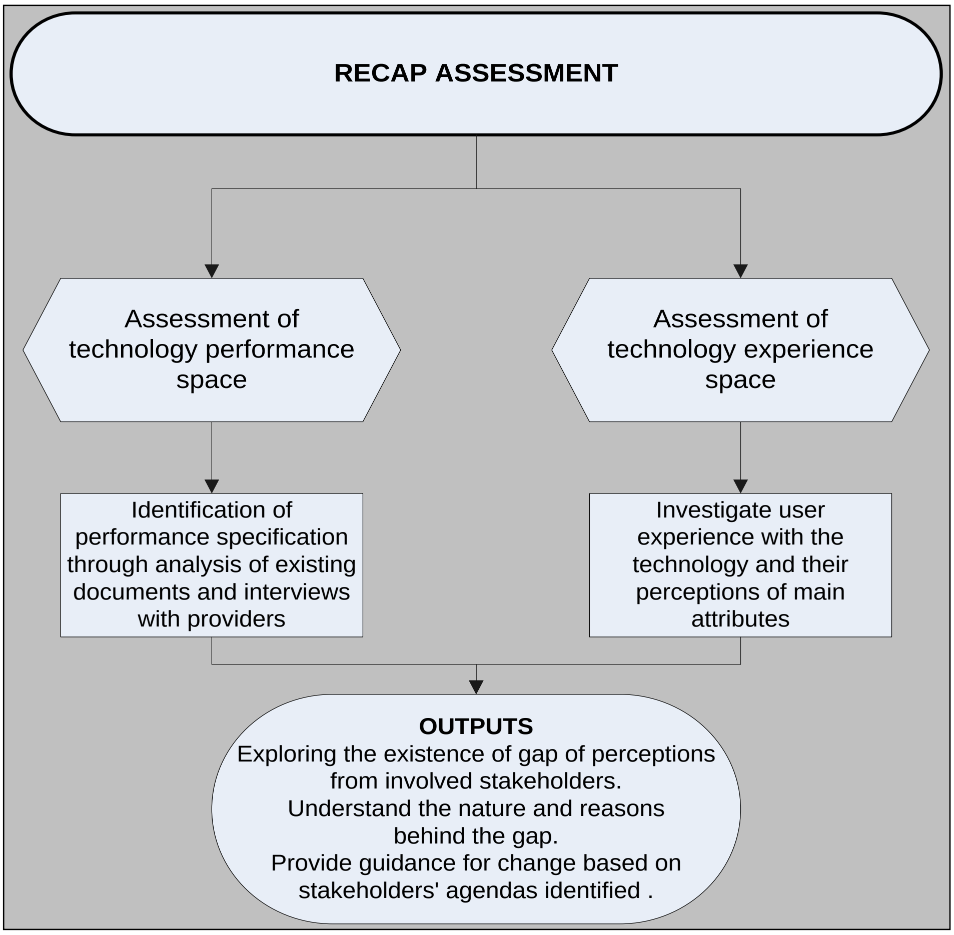

Figure 5-4 The RECAP assessment

A RECAP assessment is composed of two phases, which can occur simultaneously or in sequence. These are the assessments of (i) technology performance space and (ii) user experience space. As discussed in Section 5.2, the assessment of performance and experience spaces are often presented in the literature as parallel activities that never appear as part of an integrated evaluation of a WATSAN technology. In this respect, RECAP provides a novel approach, since it entails a comparison between the performance and benefits that a technology is supposed to deliver and what is actually experienced by respondents.

Technology *performance space* refers to the actual functioning of the technology measured on the basis of environmental, engineering and health and economic/financial attributes. The assessment of *performance space* involves an evaluation of the technology performance and its intended benefits. This assessment is normally undertaken through reference to existing documentation on the technology specification, scoping studies, scheme planning documents and interviews with providers. The objective of the assessment of technology performance space is to investigate and evaluate the technology functionality with respect to the technology attributes (environmental, health and hygiene, economic, etc.) deemed important by them.

Technology *experience space* is conceived of as recipients' understanding of the technology, their capability to use and maintain it and their impressions of its utility and functioning. The *experience space* is assessed by investigating recipients' experience with the technology and the determinants of their actions. As discussed in Section 5.3.1, users', receptivity and acceptance of WATSAN systems is affected by their ability to absorb, use and internalise technologies. This allows the researcher to focus the investigation on two dimensions: ability and motivation. Ability refers to human capability to adopt the technology and their experience with using it. It investigates the existence of restrictions to use and tries to evaluate experience with the technology. Motivation is defined as a recipient's willingness to adopt and use a technology, which in turn is influenced by two aspects. The first relates to recipients' opinions towards the technology and its usefulness. Values and opinions towards the technology are assessed by asking respondents' to identify advantages and disadvantages of related to the use of a technology. The second aspect refers to recipients' perceptions of the opinion that influential people, (i.e. family members, neighbours, technology providers, and community leaders) may have regard to the technology.

5.4.1 The value and benefits of RECAP

The RECAP tool is designed to be used by a variety of stakeholders:

- Field personnel working in the WATSAN sector, members of grassroots organisations.
- Academics, researchers and technology trainers and educators.
- Customer satisfaction groups.

RECAP can identify the causes of the gap between what the technology is supposed to achieve (performance space) and what it actually achieves (experience), often manifested through recipients' lack of use of the technology. Such identification can generate a better understanding of the match between objectives and outcomes and support design of remedial interventions at a stage of technology deployment where change is still possible.

Compared to other impact assessment and evaluation tools RECAP presents some advantages. Firstly, it can be adopted both in the piloting phase of a technology and in the post-implementation phase. Secondly, differently from the other evaluation procedures, RECAP captures the points of view and experiences of technology recipients, letting them shape the adoption agenda. Finally, RECAP does not focus on a single indicator, rather it encompasses a holistic approach by investigating and evaluating all attributes related to a technology.

5.4.2 Timing of a RECAP assessment

Based on the Overseas Development Agency's (ODA) guidelines (2003), the time span for performing an evaluation of project implementation and results can be subdivided into three stages, each of them corresponding to a phase of the project/intervention life-cycle. A RECAP assessment can be performed in all these stages, although its optimal use is in the post-implementation stage when problems diagnosed can lead to timely solutions adopted by providers.

- *Ex ante evaluation* is usually conducted at the initial planning phase of technology implementation. It involves feasibility studies, collection of information and data, which may facilitate decision-making. By adopting RECAP in the planning stage recipients' needs can be identified and compared with providers' agendas for technology transfer.
- *Mid term evaluation* occurs in the very early stages of implementation and has the purpose of providing information for improvement through assessment on the basis of a series of indicators, such as relevance, efficiency and effectiveness. (ODA, 2003). In the technology life-cycle this stage corresponds to the technology piloting test. The use of RECAP in the early stage of implementation enables to swiftly

identify emerging problems and to propose appropriate interventions based on the analysis of recipients' experience and opinions.

- *Ex post evaluation* is conducted after a certain period a technology has been introduced a process has been started or a project implemented. The main activity involved in ex post evaluation is to gather and analyse information to provide recommendation for further actions. The adoption a RECAP assessment at this stage results useful to identify reasons for failures and initiate a learning process for providers and recipients alike to be adopted in future actions.

5.5 Revised thesis research questions

To satisfy the new ambition of this thesis, the preliminary research questions were refined to reflect the conceptualisation and hypotheses generated towards the development of the RECAP tool. The revised research questions and objectives of this thesis are illustrated in Table 5-7.

Table 5-6 Thesis revised research questions and objectives

	Research Questions	Research Objectives
RRQ1	What is the nature and extent of variation between the designed, anticipated, and experienced attributes of WATSAN technologies in developing countries?	• To explore discrepancies emerging between intended performance and experience of WATSAN technologies in the post-implementation stage. • To investigate the nature of the identified discrepancies between providers and users of WATSAN technologies in developing countries.
RRQ2	What can early post- implementation evaluation tell us about the failings of WATSAN technology interventions in developing countries?	• To understand the processes and dynamics affecting WATSAN technology acceptance, use and sustained use in developing countries.
RRQ3	How can early post- implementation evaluation be used to improve the impact of WATSAN technology interventions in developing countries?	• To develop a valid, reliable and replicable approach to diagnose challenges to technology acceptance and sustained use.

The following chapters present the application of a RECAP assessment to evaluate WATSAN technologies in the post-implementation stage. Chapter 6 presents and discuss the results of the deployment of a RECAP assessment to community managed decentralised wastewater treatment systems (DEWATS) in Java and Bali (CS-II). The chapter is presented as paper entitled “Using a diagnostic tool to evaluate the experience of urban community sanitation: A case study from Indonesia” which has been submitted for consideration to the academic journal World Development. Chapter 7 illustrates the RECAP post-implementation assessment of two alternative water treatment technologies (SODIS and AQUATAB) in Flores Island, Indonesia (CS-III). The chapter is presented as manuscript, entitled “Evaluating users’ experience of alternative methods for treating drinking water: A field study in Flores Island, Indonesia”, submitted to the academic *Journal of Water, Sanitation and Hygiene for Development.*

Both chapters illustrate the application of a RECAP assessment by answering the revised research questions presented in Table 5-7. An in depth discussion of usefulness, validity and reliability of the RECAP toll will be provided in Chapter 8.

CHAPTER 6: USING A DIAGNOSTIC TOOL TO EVALUATE THE EXPERIENCE OF URBAN COMMUNITY SANITATION: A CASE STUDY FROM INDONESIA

6 USING A DIAGNOSTIC TOOL TO EVALUATE THE EXPERIENCE OF URBAN COMMUNITY SANITATION: A CASE STUDY FROM INDONESIA

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Abstract

Improving access to water and sanitation does not necessarily guarantee longevity of those systems transferred. Lessons from past interventions suggest that success depends on acceptance of the technology from the recipients and sustained use after donor assistance ends. A qualitative evaluation of urban community sanitation systems in Indonesia is conducted by use of a diagnostic tool focusing on technology performance and experience. By means of surveys and interviews, the perceptions of involved stakeholders (local government, NGO and users) are evaluated. Conclusions suggest bridging the gap between governments and users in relation to maintenance and monitoring would improve the quality and longevity of interventions.

Keywords: Southeast Asia, Indonesia, urban community sanitation, post implementation, evaluation.

6.1 Introduction

Since 2000 the world's governments have embarked on a concerted effort to eradicate poverty in the form of the Millennium Development Goals (MDGs). Target 10 of the MDGs commits to "*halve by 2015 the proportion of people without sustainable access to safe drinking water and sanitation*" (UN, 2000). The attainment of universal water and sanitation (WATSAN) coverage indisputably contributes to human development (UNDP, 2006). Progress towards Target 10 would enhance the performance of other MDGs, by reducing child morbidity and mortality (Goals 4 and 5), promoting school attendance (Goal 2), increasing employment rates, agricultural productivity, and improving gender equality (Goal 3) (Fewtrell *et al.,* 2005; Hutton and Bartram, 2008).

With five years left to the MDGs deadline, it is timely to assess the progress made and identify potential challenges to the longevity of the technologies implemented. Although progress towards Target 10 has been made, particularly in the water supply sector, the likelihood of meeting the sanitation target is remote. Data from the United Nations (UN, 2009) suggest that 884 million people still require access to improved water sources, 1.4 billion will have to acquire improved forms of sanitation for Target 10 to be met.

Furthermore, the benefits from access to water and sanitation facilities may become meaningless if the sustained use of the introduced systems is not secured. In this context, the sustainability of a technology is partially (though importantly) its capacity for long-term continuance, as well as users' ability to use and benefit from it for a substantial period after external assistance has come to an end (Parkin, 2000; Abrams, 2000). It is in the conceptualisation of sustainability that challenges to its accomplishment are the greatest. The attainment of universal sanitation coverage does not automatically translate into appropriate use or longevity of the implemented technologies (Dunmade, 2002). Technology implementation represents only the beginning of a complex process of adoption, which entails sound and reliable performance as well as users' acceptance.

Lessons from past initiatives, such as the International Drinking Water Supply and Sanitation Decade (IDWSSD), suggest that the success of WATSAN interventions largely depends on the ability to ensure that the technologies implemented are used after donor assistance has ended. Post mortem evaluations of the IDWSSD attribute scarce success to operational aspects of technologies in post-implementation, reporting that most of the systems introduced were neither used by recipients nor fully operational, and quickly fell into disrepair after installation (Mu *et al.*, 1990; Warner and Laugeri, 1991). Evidence of unused and un-sustained WATSAN systems is also provided in more recent assessments (Rodgers *et al.,* 2007). In a study of WATSAN technologies in Nigeria, Ademiluyi and Odugbesan (2008) identify recurrent problems occurring in the post-implementation phase. Among the prevalent issues reported were: lack of users' desirability of the systems and loss of motivation for using it; change of the existing economic conditions, under which O&M costs became unaffordable; migration of skilled personnel; and inability to generate long-term unassisted ownership schemes. To counter these problems, public participation and demand responsive approaches have been implemented in WATSAN projects to provide further ingredients for success. The assumption that involvement of end-users in the planning and implementation stage as well as their willingness to pay and maintain the systems can enhance the effectiveness of implemented projects has been demonstrated by several scholars (Katz and Sara, 1997; Stalker Prokopy, 2005).

Ensuring acceptance and sustained use of WATSAN systems drives the focus of attention to end-users, their preferences and ability to provide feedback. To date, there have been few attempts to evaluate WATSAN systems that give users an opportunity to frame the agenda for change, by eliciting the feedback necessary to diagnose adoption problems. Typically, post-implementation evaluations of technologies in developing countries are characterized by technical and environmental investigations (Harvey and Drouin, 2006; Latteman and Höpner, 2008), or self-evaluation conducted by technology providers. Although useful, these types of assessment are primarily based on mathematical, environmental and economic methods. Thus, they are still inherently focused on the technology and its pertaining aspects. Academic research (Hoos, 1979; Palm and Hansson, 2006) has contended that, by pursuing the identification of technical problems, dominant paradigms of technology assessment largely under-investigate social aspects and users' perceptions of the technologies.

The concept of feedback drives another fundamental issue in WATSAN technology adoption: that of accountability. Successful adoption is typically determined by the accomplishment of essential tasks, such as daily operation of the system, administrative duties and maintenance that are often disregarded due to the difficulty of allocating responsibilities (Abrams, 2000; Harvey and Reed, 2007). Infrastructures will eventually age, technologies may need repair, users may lose interest, and local trained people may move location or job (Carter *et al*., 1999). The allocation of responsibilities can be a difficult endeavour undermining the success of the implementation. This is because the process of technology transfer and adoption presents multifaceted targets and involves multiple stakeholders (donors, local implementers, local and national authorities, beneficiaries) in a context of lack of coordination and enforcement.

This contribution presents an evaluation of a particular approach to community sanitation system, called SANIMAS, which implemented Decentralized Wastewater Treatment Systems (DEWATS) in poor urban areas of central Java and Bali, Indonesia. The aim of the study is to compare the intended performance and benefits of DEWATS technologies with early post implementation user experience. The timing of such an evaluation is significant as sufficient opportunity is still available to diagnose potential challenges and develop sound solutions. The article contributes to the continuing discourse on MDG achievement by exploring those aspects that may compromise sustained and beneficial use of sanitation technologies.

6.2 Urban sanitation provision in Indonesia

Indonesia shares with other developing countries a record of limited success in water and sanitation interventions. Under the Suharto regime (1967-1998) the WATSAN sector was driven by highly centralized top-down approaches, which aimed at achieving increased coverage rather than sustained use. Central government agencies were responsible for planning and financing activities, whilst local bodies were assigned responsibilities for system operation and maintenance (Colin *et al.,* 2009). The centralized process of service delivery not only excluded the poor from the development agenda, but also offered scarce accountability for performance checking (ADB, 2004).

Typically, priority was given to the improvement of water supply rather than sanitation interventions. Most centrally driven interventions entailed the construction of communal bathing-washing and toilet facilities called MCK (*Mandi Cuci Kakus).* Nowadays, most of these facilities are in disuse and in disrepair, as neither training nor users' sense of ownership were developed as part of the implementation programs. A more recent evaluation of the status of WATSAN projects in rural communities of Indonesia reports that less than four years from project completion 40% of the water supply and sanitation systems introduced were abandoned. Poor construction and lack of designers' understanding of the socio-cultural context of the communities were the main reasons cited for failure (ADB, 2004).

The consequences of ineffective government WATSAN strategies are reflected in the sanitation crisis that the country now faces. Only 1% of the population is served by the sewerage network, being the worst record among Southeast Asian countries (BAPPENAS, 2007). Around 60% of households in urban areas have toilets connected to poorly designed septic tanks (located less than 10 meters from a water supply source), which are rarely emptied and allow seepage into groundwater sources, causing high levels of surface and groundwater contamination. The rest of the population relies on unhealthy sanitation practices such as open defecation (18% in urban areas) or on simplified toilets with no connection to wastewater treatment, such as "helicopter" latrines, built over and discharging directly into watercourses (BAPPENAS, 2007). In this scenario, outbreaks of diarrhoea and typhoid fever are not uncommon, contributing to infant mortality rates of 35 per 1000 live births, the highest in Southeast Asia (UNDP, 2005).

As signatory country of the Millennium Declaration, Indonesia has formulated a strategy to achieve a 72.5% access to improved sanitation facilities, eradicate the practice of open defecation in all cities and decrease river faecal contamination by 60% by 2015. The government efforts to meet the MDGs are to be viewed against a background of institutional decentralisation, which has taken place in the country since 2001. As part of this process, financial autonomy and responsibility have been transferred to local governments for water and sanitation provision.

The SANIMAS program was introduced as a pilot case study in 2003 and subsequently scaled-up to become an integral part of the national strategy to meet MDG Target 10. This commitment is established in the national policy, *Development of community-based water supply and environmental services* (Government of Indonesia, 2003), which formalizes Community Driven Development (CDD) as a means to increase the success of sanitation investments in the country. Empowerment of WATSAN users is facilitated by their involvement in project planning, financing and implementation to increase their ownership of the facilities. The SANIMAS approach to implement DEWATS includes a comprehensive “hardware and software” package to implement sanitation solutions in the forms of communal simplified sewerages systems or community centers connected to a decentralized wastewater treatment plant.

6.3 Methodology

The qualitative evaluation adopted in this study employs a diagnostic tool, called RECAP, designed by the authors to assess WATSAN technologies by comparing their intended and experienced performance. The tool is informed by two conceptual framework exploring human-technology dynamics: of Receptivity (Jeffrey and Seaton, 2004) and Linstone *et al.* (1981) conceptualisation of technology as multi-attribute entity, leading to the investigation of stakeholders’ perceptions of technology attributes. Receptivity is defined as: *the willingness (or disposition) but also the ability (or capability) in different constituencies (individual, communities, organisations and agencies) to absorb, accept and utilize innovation option.* (Jeffrey and Seaton, 2004: pp.281-2). The main premise that rests behind the Receptivity model is the need to understand the responses and behaviours of people and communities to a technology in terms of the perceptions, attitudes and agendas for change that are relevant to them. Meanwhile, in this investigation use is made of the notion of *attributes*, namely those properties of a technology (e.g social, economic, functional), which stakeholders consider relevant and describe in their own terms and values. The strength of a framework for Attribute Perceptions as an influential component of RECAP tool rests on its ability to explore stakeholders’ views and perceptions of a technology, in relation to its multiple components. In so doing, the focus of this investigation extends beyond technical or environmental attributes, for stakeholders to give prominence to those technology attributes relevant to them.

The methodological perspective that is adopted within a RECAP study is the gap analysis approach, stemming from the Service Quality literature, which relates the service quality problem to a gap between its suppliers and consumers (Krepapa *et al.*, 2003). Quality can be defined as the measure by which a service complies with customers' expectations (Lewis and Booms, 1983). The underpinning principle of gap analysis, as employed in this study, is the possibility to evaluate quality of a service through a user-centred approach (Headley and Choi, 1992). Its methodology fulfils the main premise for RECAP development: it is concerned with users and focuses on the process of delivery of a service, a technology or policy. Figure 6-1 illustrates the structure of the RECAP assessment and its application.

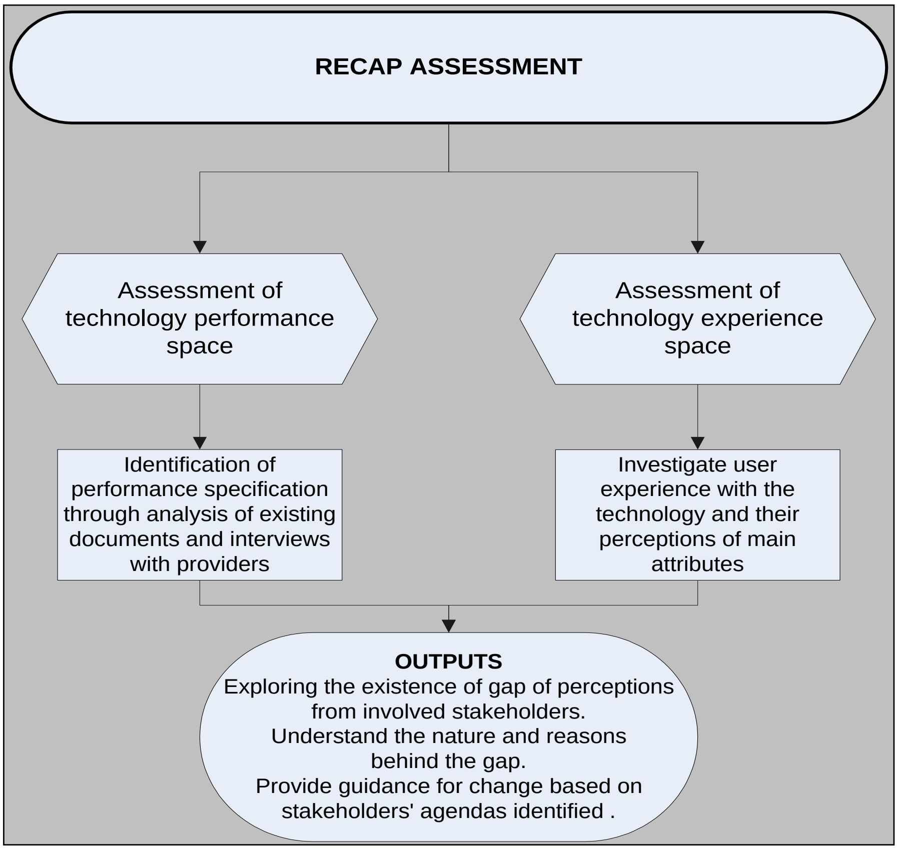

Figure 6-1 The Recap Assessment

The RECAP tool is an enquiry vehicle designed to expose discrepancies between intended and experienced attributes of a WATSAN intervention. Outputs from a RECAP analysis allow identification of challenges, which may undermine the longevity of interventions.

This cross-sectional study investigates the two dimensions of DEWATS performance, through a multi-method approach. Intended attributes are elicited via analysis of internal documents and interviews with stakeholders involved in the implementation of community sanitation in central Java and Bali, providers (local government and the implementing NGO, Borda). Furthermore, experience attributes of the technology are analyzed by means of interviews and users.

In depth interviews with providers were conducted, after selection through purposive sampling to ensure compliance with their informative role. Seven respondents, with senior or executive roles, were selected among local government departments (Solid Waste Management Agency, Environmental Service Agency and Department of Public Works) and the NGO. A questionnaire was developed specifically for this investigation and consisted of open questions concerning technology implementation, maintenance and monitoring, longevity, as well as providers' perceptions of benefits, challenges and users' acceptance of the systems. Table 6-1 illustrates the characteristics of the sample employed to elicit the performance of DEWATS systems.

Table 6-1 Technology performance. Sample characteristics

Technology providers Sample size n=7		
Sector	**Sector/Area**	**Position**
NGO	Management	CBS programme coordinator
	Technology/engineering	Head of technical section
LG	Department of Public Work	Head of Department
	Sanitation Task force	Executive
	Environmental Service Agency	Head of Department
	Department of Planning and Development	Head of Department
	Solid Waste Management Agency	Senior officer

To investigate the experience of communal systems, random sampling was undertaken. A sampling cluster was defined as communities served by DEWATS technology. A total of 13 communities were selected using a list of technologies implemented between 2003 and 2008 in Bali and Java. Of these, 9 communities were provided with communal sanitation centers (CSC), toilet blocks linked to DEWATS plant managed by users; whilst 4 communities were provided with simplified sewerage systems (SSS) connected to a local DEWATS plant managed by the community. Within each community respondents were randomly selected in the course of a transect walk. Informed consent was obtained from each participant, and interviews were administered by village leaders and field facilitators to ensure respondent comfort during the interviewing process. A sample of 122 valid interviews was obtained. The questionnaire was specifically developed for this investigation and contained a demographic part (summarized in Table 6-2), questions concerning use, maintenance and monitoring and longevity of the technology, as well as information concerning perceptions of benefits and challenges and acceptance. Questions were translated into Indonesian and pre-tested for validity.

Table 6-2 Technology experience. Sample characteristics

Technology users Sample size n=122	
Total estimated households	N=1211
Household characteristics	
Range household size	1-10
Mean household size	4.0
Religious belief	
Muslim (%)	81
Hindu (%)	19
Age group	
Mean age respondent (years)	34.5

6.4 Results

6.4.1 DEWATS intended performance

SANIMAS (*Sanitasi oleh Masyakarat*) means Sanitation by Communities, an approach aiming to implement DEWATS technologies in densely populated communities in urban informal settlements in Indonesian cities, by providing economically affordable, institutionally feasible and socially acceptable systems in the context of Community Driven Development. The designed performance of the DEWATS technologies is presented in Table 6-3.

Table 6-3 Technology performance

Technology Attributes	
Design	Simplified Sewerage Systems (SSS) that connects to DEWATS plants, managed by the community. Community Sanitation Centres (CSCs) that include water supply, toilets, bathrooms, laundry areas, connected to a DEWATS plant managed by the community.
Environmental	Low cost and low energy consumption system. Water treatment facilities produce effluent, which complies with environmental standards (112/2003): pH 6-9; BOD_5 100 mg/l; TSS 100 mg/l and Oil/grease 10 mg/l. Reuse of environmental waste through biogas production.
Health and Hygienic	Health and hygiene education allows for development of community awareness of good sanitation practices.
Financial	Multiple financing schemes involving local government, NGOs and communities contribution in kind and in cash. A Community Contribution Plan is developed: selected community provides a contribution “in-kind” (in the form of labour force and materials) and “in cash” (obtained from users fees collection) equal to 2-5% of the total investment costs. Cost-recovery principle: NGO provides assistance until costs are recovered through tariffs agreed by users.
User acceptance	Community selection is performed by means of Rapid Participatory Assessment (RPA), to identify existing WATSAN conditions, understand recipients’ needs and willingness to pay for the technology. Community empowerment through informed choice between proposed technologies. Development of Community Based Organisations (CBOs) to manage the systems.
Knowledge management	Training for construction and O&M of the systems; financial training for collection of users’ fees and managerial training for the CBS organisation.

Source: BORDA, (2008).

In addition, interviews with providers were transcribed and inputted into Nvivo 8. A first deductive coding structure was employed to sort responses on the basis of the interview structure (acceptance, benefits, challenges, implementation, longevity, management and monitoring) whilst a second coding cluster was identified in the interview responses by eliciting relevant attributes on the basis of the technology attributes identified. A matrix-coding query was preformed to analyse co-occurrence between the two clusters of codes. The query was performed to identify patterns within the text and links between them, whilst gaining access to the text for further analysis.

Figure 6-2 presents the results of the analysis of co-occurrence between cluster sub-codes, their link and its strength.

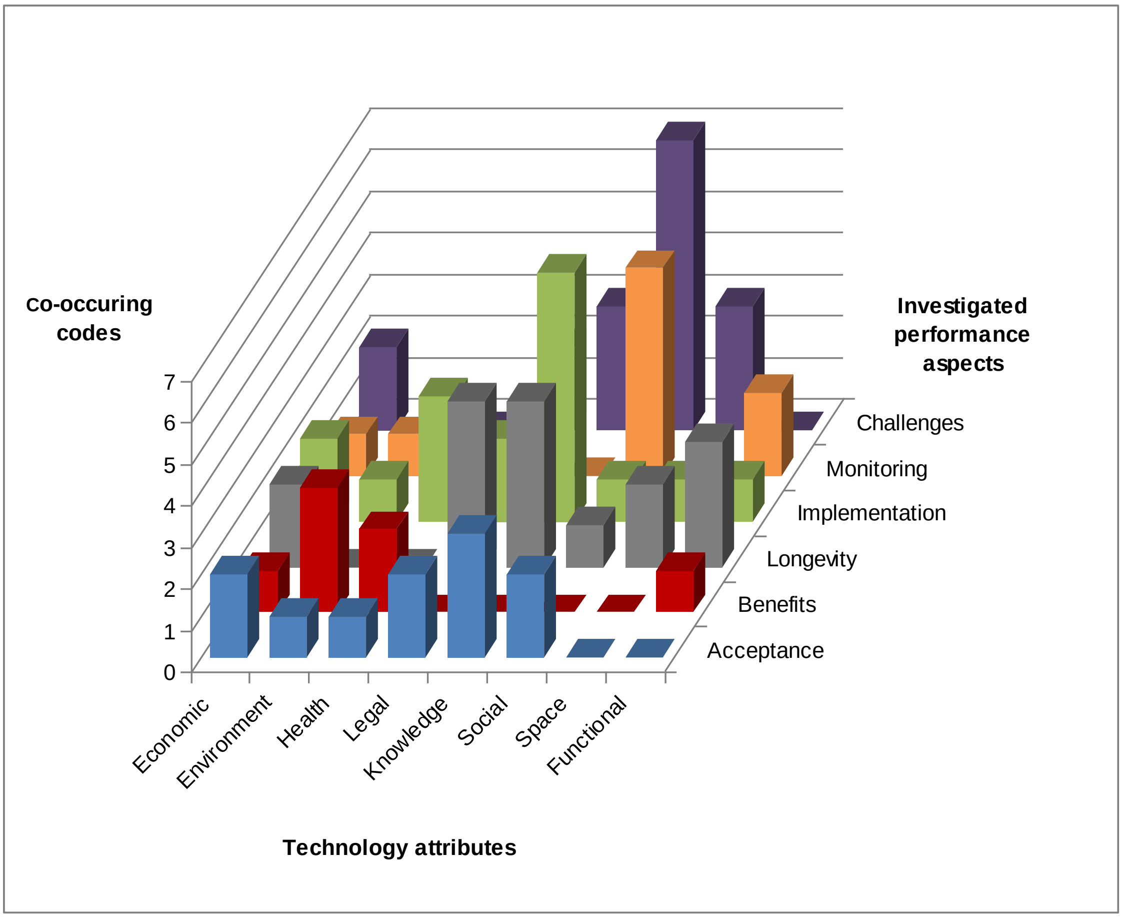

Figure 6-2 Coding co-occurrence

Figure 6-2 illustrates the main aspects emerged from the interviews with technology SANIMAS/DEWATS providers. Issues of technology acceptance focused around knowledge management aspects. Providers show a great understanding of the importance of knowledge and educational aspects in the implementation of the technologies; health and hygiene educational campaigns were conducted with the help of local media or through direct interaction with poor communities. According to most respondents, the conduct of education, training and awareness campaigns is the primary influence on positive user attitudes towards the systems.

Health and environmental benefits were identified as the most important improvement brought by the systems. However, no monitoring strategies to assess health or environmental impacts were employed by local government at the time of fieldwork. Issues related to challenges encountered in implementing the technologies involved primarily social attributes of the technologies: all but two respondents agreed that cultural and behavioural aspects are the most impelling. The importance of changing and adapting social behaviour to new sanitation practices was stressed by most respondents, particularly members of the NGO.

When aspects of management and maintenance were addressed, poor knowledge and lack of operational strategies was reported. Maintenance and monitoring is performed by the NGO for one year following technology introduction. Thereafter users are expected to provide for monitoring and management of the systems. Users responsibility for maintenance of the DEWATS plants is justified by reference to the processes of community driven development and community empowerment, which constitute the underpinning principles of the SANIMAS approach.

Finally, institutional and knowledge management considerations were reported as central to the sustained use and longevity of the systems. While local government members stressed the importance of increasing users awareness' and education of water and sanitation aspects, other interviewees referred to the ability of the local government to support communities and their Community Based Organizations (CBOs) to provide system maintenance.

6.4.2 Users' experience of DEWATS

Descriptive statistics was generated from the survey of DEWATS users by inputting coded questionnaire responses into the SPSS 17 (Statistical Software for the Social Sciences) package. A summary of the results obtained is provided in Table 6-4.

Table 6-4 Frequencies on user experience with the technologies

User experience of DEWATS technology	CSC n=83	SSS n=39
Implementation/Use		
Households using DEWATS	78%	100%
Households using biogas digester for cooking purposes, where available	69%	na
Users considering DEWATS affordable	61%	77%
Households participating in training activities	58%	41%
Maintenance and Monitoring		
Users agreeing on presence of operator for maintenance	95%	100%
Users feeling responsible for technology maintenance	91.5%	79.5%
Users feeling included in technology management	73.5%	90%
Trust for maintenance and use		
Community Based Organisation	23.5%	55%
DEWATS operator	27%	24%
Myself and household	37%	5%
Community	6%	16%
Benefits/Challenges		
Users perceiving technology benefits to health	83%	87%
Users who experienced problems with technology	67.5%	56%
Users reporting proactive attitude in case of problems (i.e. report to caretaker or to CBO)	60%	82%
Technology acceptance		
Users perceiving technology fulfils their needs	75%	95%
Users perceiving technology respects own traditions	94%	100%
Users satisfied with technology	65%	69%
Nature of dissatisfaction:		
Technical (poor water supply systems, clogged pipes)	29%	75%
Health and hygienic (problems with cleanliness and smell)	39%	na
Management (poor management of in cleanliness and fee payment)	21%	17%
Social (antisocial behaviour, lack of community awareness of how to use DEWATS)	7%	8%
Technology longevity		
Suggested changes to technology	43%	31%
*Nature of suggested changes: **		
Technical (Improvement of system maintenance, expert help to fix structural problems)	50%	58%
Social (recreational activities, increase community awareness and responsibility for the technology)	14%	17%
Health and hygiene (improve cleanliness, smell)	14%	na
Management (improve collection fee systems, engage all users to contribute to systems)	22%	25%
Users willing to increase contribution for technology	64%	49%

*Multiple responses set

In the investigated sample the reported household use of the DEWATS systems is very high also for communal systems. Where a biogas digester was available, the degree of usage by investigated households was high at 69%. Informal discussions with village leaders reveal that for some household, lack of use of biogas digester may be explained by cultural reasons and unwillingness to come in contact with human waste. Overall, the high degree of acceptance reflected in respondents' awareness and understanding of a range of aspects: their perceptions of health benefits related to using improved sanitation (respectively at 83% and 87%), proactive attitudes in reporting problems, high level of satisfaction for both CSC and SSS users, as well as willingness to contribute economically to improvement of DEWATS management. Among the changes suggested by users are improvements that aim at integrating DEWATS technologies and systems in the life of communities, such as building a gathering place over the facilities to organize meetings, in case of CSC, or improving community awareness of appropriate use and management of DEWATS, in case of SSS. Users' proactive attitude in reporting problems of the communal technologies may be generated by the sense of ownership infused by SANIMAS participatory program for DEWATS construction and implementation. Although responsibility for reporting problems with the technology is higher (82%) where SSS systems are implemented, a high percentage (60%) of people exhibiting positive attitudes towards problems is measured also for users of CSC.

The experienced problems reported by users were distinctly heterogeneous among communities, as illustrated in Figure 6-3. Technical problems with DEWATS represent the highest cause of concern in five of the 13 communities. Difficulties with the technologies relate to poor or intermittent water supply, polluted water, clogged wastewater pipes and poor maintenance. Independently of whether the system is SSS or CSC, the presence of technical problems and users' inability to fix them represents a challenge to appropriate systems use in most of the communities investigated. Consequently, respondents' suggested changes to increase system longevity relate to technical aspects of the communal systems. Users' suggested improvement relate to better strategies for DEWATS maintenance and assistance for repairing broken parts. Hygiene related problems are identified in both CSC and SSS types of DEWATS systems. Lack of cleanliness constitutes a problem at the facilities in CSC and smell and odour caused by malfunctioning of DEWATS represents a problem in communities with SSS.

As expected, social and managerial aspects of DEWATS systems represent a major problem in community sanitation centres (i.e. communities 3 and 4), where anti-social behaviour and queuing at facilities are disincentives for people to use. Other types of problems affects communities at a lower level and in Community 2, featuring SSS with a DEWATS plant, no problems with the facilities were identified.

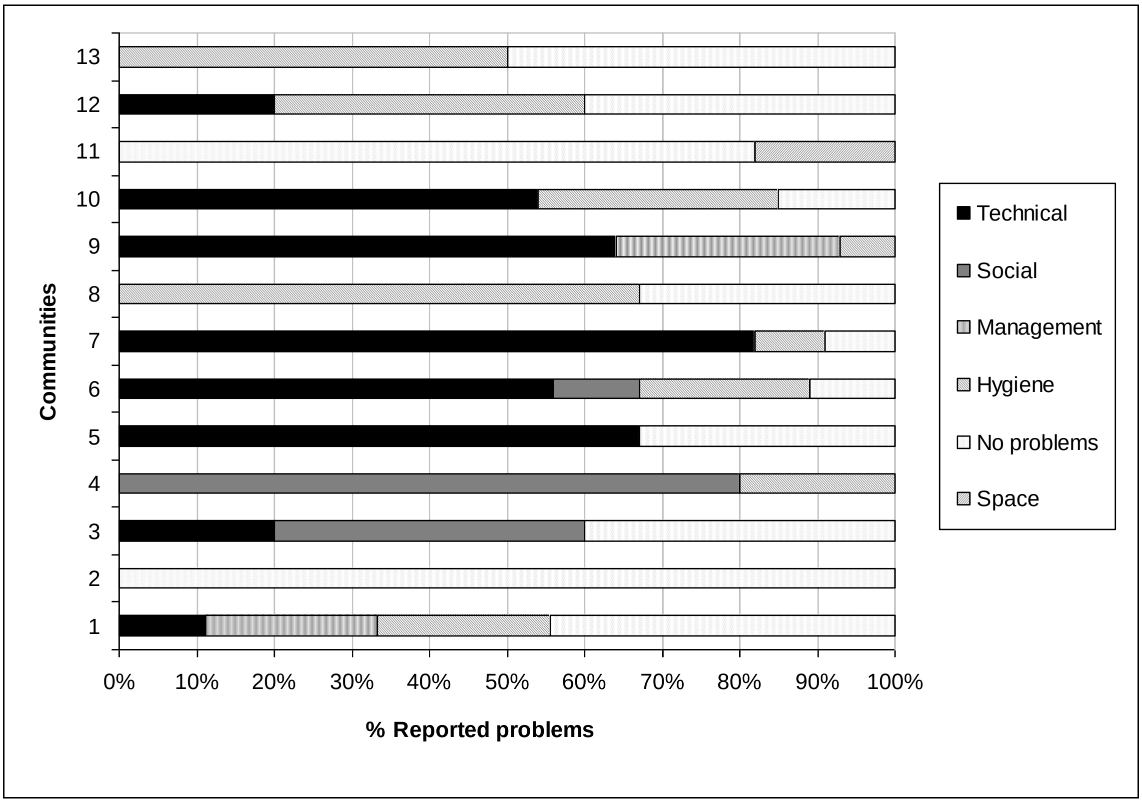

Figure 6-3 Experienced problems by communities

6.5 Discussion

This study investigated the intended performance and experience of DEWATS by means of interviews with key stakeholders and users. The analysis of results shows that SANIMAS is a financially, socially and environmentally effective program, well suited to improving progress towards the attainment of MDG Target 10. The high degree of community acceptance of DEWATS, generated by the use of participatory approaches in the planning and implementation stages, is equally rooted in the country's tradition of community development programs and well-established village committees. Compared to other community-managed approaches implemented in developing countries (Harvey and Reed, 2007), SANIMAS participatory program proves to be successful to DEWATS implementation. The balance between technical soundness and knowledge management, coupled with the country's tradition of community activism contribute to high level of ownership for the implemented technologies. Conversely, experiences from community-managed sanitation in other regions (i.e. Southern Africa) report a low sense of ownership, due to the adoption of top-down and blue print implementation schemes which do not infuse on users any sense of ownership or responsibility for the technologies and the facilities, which are reputed to be mere "open access resources" (Mukheli *et al.*, 2002).

Notwithstanding the positive engagement of communities, two main discrepancies between technology intended performance and users experience were identified. A first challenge relates to a lack of mechanisms to monitor and assess problems within communities. As illustrated in Figure 6-3, each community presents a specific set of problems perceived as challenges to sustained system use. A number of communities are preoccupied with challenges posed by technical problems with DEWATS. Furthermore, in community sanitation centres, management and organizational problems are reported as crucial aspects for technology acceptance and use. These relate to scarce responsibilities for cleanliness of the facilities, where a communal block exists collection of tariffs for use. As discussed in the analysis of providers' interviews, there lacks an institutional agenda for monitoring and gathering information related to health, environmental, technical and social aspects of the communities. The relevance of the above-discussed problems in respondents' agendas for system use testifies the need to establish regular mechanisms to monitor the technologies in the post implementation stage through feedbacks from users. In a comprehensive study of community managed water technologies in Latin America, Lockwood (2002) identified similar challenges to technology sustained use and argues for the necessity of establishing institutional monitoring mechanisms to improve the systems sustainability.

A further gap to system's longevity was identified in the loose accountability for technology long-term maintenance. Admittedly, this discrepancy is linked to the previously identified need of monitoring mechanisms. Responses from providers reveal a lack of accountability for system maintenance. While maintenance is provided by the implementing agency up to one year after implementation, this study shows how potential challenges may emerge thereafter, due to low capacities or lack of institutional agendas for DEWATS maintenance. Local governments exhibit reliance on communities' and their organizations' ability to manage and maintain the DEWATS technologies, however, experience suggests that technical faults, inevitably occurring after a period of use, constitute significant problems for the communities that undermine their satisfaction.

Within Indonesian government a lack of organized strategies, coupled with shortage of trained and skilled staff, undermine the ability to sustain successful and accepted sanitation (Robinson, 2008), in a legal environment featuring no specific regulations to allocate responsibilities and enforce practices for maintenance and monitoring. The lack of institutional agendas for systems' maintenance corroborates the argument increasingly maintained by scholars (Yacoob, 1990; Lockwood, 2002). This warns of a limitation of community (and demand) driven approaches, which may lead to a process of disenfranchisement by local governments from playing a supportive role to WATSAN technology users. Admittedly, incentives to improve performance of the systems might best be sourced from the communities; notwithstanding institutional mechanisms should be created to link incentives to support systems. Depending on the local cases, responsibilities should be allocated with a balanced combination of capacities and resources between local governments and communities.

Although communities share a sense of inclusiveness in DEWATS management and show a willingness to meet the costs for maintaining them, their capacities should be appropriately channelled and managed by local established power structures. Each community presents unique problems, which must be addressed and evaluated through routinely conducted procedures. Unsolved technical issues, such as clogged pipes, emphasize the need for routinely organized schemes for maintenance and monitoring. Similarly, where social problems represent a barrier to use CSC, such as in Community 4, institutional support for tailored interventions is required.

6.6 Conclusions

The discrepancy in views on the responsibility for technology maintenance and monitoring also needs to be bridged if the beneficial use of DEWATS technologies is to be sustained. Greater sustainability could be gained by generating small-scale operation and maintenance organizations operating on city basis, either by involving the private sector or by setting up teams of skilled community-based facilitators (Ismawati, 2010). Furthermore, an institutional enforcement scheme should be provided to guarantee continuous assessment of services delivered by CBOs and enable training and support for the communities.

If significant and long-lasting progress towards the achievement of MDG Target 10 is to be made, increasing the number and scope of WATSAN interventions is necessary but not in itself sufficient. The longevity of interventions is ensured by improving stakeholders' motivation to invest in protecting technology effectiveness. More importantly, a shift of focus towards technology users becomes an imperative to guarantee long-lasting use of the technology. To conclude, the adoption of a RECAP assessment to evaluate the SANIMAS program in Indonesia proved to be a useful exercise for identifying and diagnosing potential challenges to the sustained use of the systems. The assessment allowed for identification of the causes of the gap between performance and experience that generate a better understanding of the match between objectives and outcomes and support design of remedial interventions at a stage of technology deployment where change is still possible.

CHAPTER 7: EVALUATING USER EXPERIENCE OF ALTERNATIVE METHODS FOR TREATING DRINKING WATER: A FIELD STUDY IN FLORES ISLAND, INDONESIA

7 EVALUATING USERS'EXPERIENCE OF ALTERNATIVE METHODS FOR TREATING DRINKING WATER: A FIELD STUDY IN FLORES ISLAND INDONESIA

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Abstract

Scientific evidence and epidemiological studies have exhaustively proven that point-of-use water treatment methods can significantly improve the microbial quality of water and reduce the risk of diseases, thus contributing to meet Target 10 of Millennium Development Goal 7. Despite the ease of use and relatively low cost of such treatment methods, progress towards MDG Target 10 is patchy, showing disparities among developing regions. Experience shows the benefits derived from provision of water technologies depend on recipients' acceptance of the technology and its sustained use. To date, few contributions have specifically addressed the problem of user experience in the post-implementation phase of technology transfer, as required to diagnose and evaluate emerging challenges that may undermine the longevity of the systems introduced. In this study we argue that the post-implementation challenge primarily rests on emerging dynamics of WATSAN technology acceptance in the aftermath of its introduction. An evaluation of SODIS and AQUATAB technologies in Flores, Indonesia, was conducted by use of a novel diagnostic tool focusing on technology performance and user experience. By means of surveys and in depth interviews, the perceptions of involved stakeholders (users, village leaders, NGO, local government and health operators) were evaluated. Results prove that economic and functional factors were significant in using SODIS, whilst perceptions of economic and taste and odour components were important in the use of AQUATB. Conclusions relate to the development by local technology providers of a greater understanding of factors of use and non-use and act on these aspects by addressing them in appropriate interventions suggested.

Keywords: Indonesia, Flores Island, Solar disinfection technology, Chlorine disinfection technology, user acceptance.

7.1 Introduction

The incidence of waterborne and water-related diseases caused by drinking unimproved water sources has long been evidenced by epidemiological studies and experimental research (Prüss *et al.,* 2002; Fewtrell *et al.*, 2005). Every year approximately 1.8 million people are reported to die from preventable diseases, such as infectious diarrhoea, caused by lack or use of poor water and sanitation and scarce hygienic conditions. Children are the most affected by the burden caused by lack of adequate water supply (WHO, 2001). For decades international efforts have addressed the problems of inadequate drinking sources through transfer of appropriate technologies, with the first global-scale intervention, the International Drinking Water Supply and Sanitation Decade (IDWSSD), established in 1989. More recently, the United Nations have recognized with Target 10 of Millennium Development Goals, the urgent need to provide universal access to improved water supply. According to the most recent MDG progress report (WHO and UNICEF, 2010), efforts to achieve universal water access are on track, with an additional 884 million people to be served by 2015. Progress towards Target 10 would significantly improve the performance of other MDGs, such as Goal 4, which aims to reduce infant morbidity and mortality.

Scientific evidence and epidemiological studies have exhaustively proven that point of use treatment methods, coupled with appropriate hygiene practices and sanitation facilities can significantly improve the microbiological quality of water and reduce the risk of infectious diseases (Conroy *et al.*, 1996; Quick *et al.,* 2002; Sobsey *et al.,* 2003). Among the most appropriate technologies for point-of-use treatment, the World Health Organization (WHO, 2001) suggests chlorination combined with appropriate storage, UV disinfection with lamps, solar disinfection by means of heat and UV-A; and solar disinfection by heat alone, such as solar cookers. Of these, two treatment methods, SODIS solar disinfection, and AQUATAB chlorine tablets, are increasingly attracting attention as viable and suitable options for point-of-use water treatment (Mcguigan *et al.*, 1999; Murinda and Kraemer, 2008). In developing countries these technologies often coexist with and complement the use of more traditional methods of water treatment, such as water boiling (McLennan, 2000) or filtering with cloths (Thayeh *et al.*, 1996).

Despite the ease of use and relatively low costs of such water treatment systems and the dissemination and participatory activities supporting their implementation, progress towards MDG Target 10 is patchy, showing disparities among developing regions (WHO and UNICEF, 2010). Furthermore, although technology promotion, user training and participation are nowadays well-established components of water technology transfer, these are often of insufficient quality to guarantee that modified sanitation and hygiene behaviours are continued after implementation. Experience proves that success in meeting the MDGs depends primarily on recipient acceptance of and responsibility for the technology and its sustained use (Harvey and Reed, 2007; Giné and Pérez-Foguet, 2008). Defining the problem of water supply on the basis of system longevity and sustained use shifts the focus of analysis to technology users and the stakeholders involved in the post-implementation phase.

Typically, academic studies focusing on the human dimension of water and sanitation (WATSAN) technologies have explored predictors of the diffusion of water technologies, or identified users' willingness to pay for the systems. Moser and Mosler's study (2008) of motivators for SODIS adoption in Bolivia identified predictable patterns of diffusions in key figures, such as opinion leaders, as well as on social networks supporting the technology uptake. Heri and Mosler (2008) elicited factors affecting use and intended use of SODIS in affective belief towards the technology and availability of PET bottles, cost and taste considerations. Similarly, in a study conducted in Central America, Altherr *et al.* (2008) found that intention to use SODIS were related to its subjective norms (e.g. use by neighbours) and a positive attitude towards the technology. A further body of literature has explored users' willingness to pay for potential water supply interventions in developing countries (Whittington *et al.,* 1991; Whittington *et al.,* 1993; Whittington *et al*., 1998). Adopting Contingent Valuation Method (CVM) methods, the estimated willingness to pay was employed by these studies as an indication of future ability and motivation to maintain a system, provide insights as to its sustainability and suggest policy recommendations.

Although highly useful in identifying predictors which shape technology promotion and diffusion strategies, these contributions have primarily focused on the adoption aspects of technologies, confining their perspective to the pre-implementation phase of technology transfer. To date, few academic studies (Rainey and Harding, 2005) have addressed the problem of acceptability from the temporal perspective of post-implementation. Such a perspective enables diagnosis and evaluation of emerging challenges that may undermine the sustained use of the introduced systems. The high numbers of technologies abandoned or misused at the end of the IDWSS Decade was cited as criticism of the failure of the 10-year global effort to provide universal WATSAN access to developing countries (Warner and Laugeri, 1991). Regrettably, evidence of unused water supply systems is also provided in more recent contributions (Gutierrez, 1999; Mackintosh and Colvin, 2002), re-affirming the importance of diagnosing problems after implementation. Challenges that may infringe the sustained use of the systems have been widely discussed in the literature. Communities and households may have not been convinced (or sufficiently persuaded) on the necessity of using WATSAN systems introduced (Ademiluyi and Odugbesan, 2008); financial costs which users are expected to pay for technology upkeep may prove unaffordable or unacceptable (Harvey and Reed, 2007); benefits in terms of service quality may not be internalised by recipients; and lack of institutionalised monitoring and support may prevent quality assurance control (Ongley, 2001).

Lessons learnt from past initiatives in the water and sanitation sector suggest that "evolving and adaptive mechanisms" (Carter *et al.*, 1999:8) should be put in place to ensure recipients' long-term engagement with the introduced intervention. In this study we argue that the post-implementation challenge rests primarily on features of WATSAN technology acceptance, which emerge in the aftermath of its introduction, and are therefore difficult to anticipate and prepare for beforehand. Thus, timely problem identification would enable diagnosis of potential challenges to sustained use and support prompt adoption of appropriate solutions.

A novel approach to assess WATSAN technology performance and acceptance in the post-implementation phase was developed by the authors. This is based on a conceptual tool, called RECAP, which facilitates diagnosis of emerging problems by giving voice to both technology recipients and providers, allowing for analysis of the experiential and performance components of the systems. Employing the RECAP tool, this study aims to evaluate the discrepancy between the intended performance and user experiences of two alternative methods for drinking water treatment, SODIS and AQUATAB, introduced in three villages in Flores Island, Indonesia. By evaluating factors favouring or hindering the sustained use of these technologies, this investigation hopes to provide fresh perspectives on those aspects of technology adoption which might progress MDG Target 10.

7.2 The water supply sector in the East Nusa Tenggara province

Our study was undertaken in three villages of the Sikka regency, situated in the East Nusa Tenggara province in Flores Island, which lies east of Java in the Indonesian archipelago. East-Nusa Tenggara is one of the poorest provinces of Indonesia, with 28% of its inhabitants living under the national poverty line (ADB, 2006) and on economy based on subsistence agriculture (Barlow and Gondowarsito, 2009). Poverty is exacerbated by its remoteness from, and scarce communication with, the industrialized centres located on Java. The Sikka regency, as with most of East-Nusa Tenggara, has an arid climate with low yearly average rainfall. The combination of dry climate, unfertile land and remoteness makes poverty a chronic problem in the province. Table 7-1 illustrates the main characteristics of the three villages included in the investigation.

Table 7-1 Village characteristics

	Village A (Kolisia)	**Village B (Gunung Sari)**	**Village C (Watuliwung)**
Geographical area and location	15km from Maumere, Surrounded by other villages and by the Flores sea on the northern border.	Island 45 mile/s from inland.	3 km from Maumere. Located in a valley surrounded by woodland
Main occupation in households	Farmers: 81% Fishermen: 16% Tertiary sector employees: 3%	Farmers: 20% Fisherman: 80%	Farmers: 80% Private business owners: 4% Tertiary sector employees: 12%
Religious belief	Roman Catholic: 71% Muslim: 29%	Muslim: 100%	Roman Catholic: 100%

Source: Data provided by Dian Desa.

The chronic poverty level in the province reflects the lack of basic water and sanitation services and the high incidence of waterborne and water related diseases. The most recent national report shows that East Nusa Tenggara presents one the highest incidences of malaria, Acute Respiratory Infections (ARI), typhoid and diarrhoeal diseases, which mainly affect children between 5-14 of age (Del Rosso, 2009). Although the WHO (2010) reports Indonesian access to water at 80% and sanitation facilities 52% of the population, the areas investigated suffer from a serious lack of basic WATSAN systems. Prior to the introduction of SODIS and AQUATAB technologies, villages' main source of water supply was untreated water; whilst occasionally boiling water for preparing coffee.

The SODIS disinfection method exploits the synergetic effects of UV-A light and high temperature (45-65 ^{0}C) to destroy and or inactivate pathogens in contaminated water. The technology, designed by the Swiss Federal Institute for Aquatic Science and Technology (EAWAG), was disseminated by the local implementing Non-Governmental Organisation (NGO) (Dian Desa) in May 2007 in villages A and C and in 2004 in village B. To counter the problem of SODIS "seasonal use", with the technology primarily used in the dry season (April-September), in 2008 Dian Desa introduced an alternative technology for household treatment in the three villages. AQUATAB, designed by Medentech Ltd. are chlorine tablets, whose principal chemical constituent is NaDCC sodium dichloroisocyanurate, which can inactivate most pathogens present in water within 30 minutes.

7.3 Methodology

The development of the RECAP tool to assess WATSAN technologies rests on the Receptivity model conceptualised by Jeffrey and Seaton (2004) to analyse stakeholders' adoption of water innovation options in industrialised countries. Receptivity is defined as: *the willingness (or disposition) but also the ability (or capability) in different constituencies (individual, communities, organisations and agencies to absorb, accept and utilize innovation options.* (Jeffrey and Seaton, 2004: 281-2). The Receptivity framework allows researchers to explore technology users' perceptions of problems related to water and sanitation and their ability to scan for new knowledge (*Awareness*); their understanding of the potentiality of knowledge exploitation and its association with needs and capabilities (*Association*); the process of learning to gain the knowledge and skills necessary to adopt a technology (*Acquisition*); and their ability to internalise a new artefact into their routine, organising maintenance and managing risk (*Application*). Among its several applications, the Receptivity model has been employed to elicit the adoption agendas of customers of household water filters in the United Kingdom, generating an agenda for technology design and deployment. The focus on users' perceptions of technologies leads to investigating the multidimensional characterisation of technology systems through lenses of the stakeholders involved and exploring its *attributes*. These are properties of a technology, which recipients consider relevant and describe in their own terms and values. Our formulation of an Attribute Perception (AP) framework draws on Linstone's *et al.* (1981) study conceptualising a technology as a multi-perspective entity: not only the technical elements, but also *organisational* (the socio-cultural organisation in which the technological system is embedded) and *personal* (perceptions and beliefs of technology recipients) attributes should be considered. Drawing on Linstone *et al.* (1981), we argue that WATSAN technologies can be evaluated on the basis of a combination of attributes (i.e. economic, social, environmental, etc.) perceived by stakeholders, which constitute important determinants of the system and its acceptance and use.

The methodology adopted for RECAP assessment stems from the Service Quality literature, which relates the service quality problem to a gap between its suppliers and consumers (Krepapa *et al.,* 2003). The underpinning principle of gap analysis, employed in this research, is the possibility to evaluate quality of a service through a customer/user-centred approach. Its methodology fulfils the main premise for RECAP development: it is concerned with users and focuses on the process of delivery of a service, a technology or policy. The RECAP assessment (illustrated in Figure 7-1) aims to investigate the presence of a discrepancy between the performance and users' experience of water treatment methods and suggest appropriate solutions.

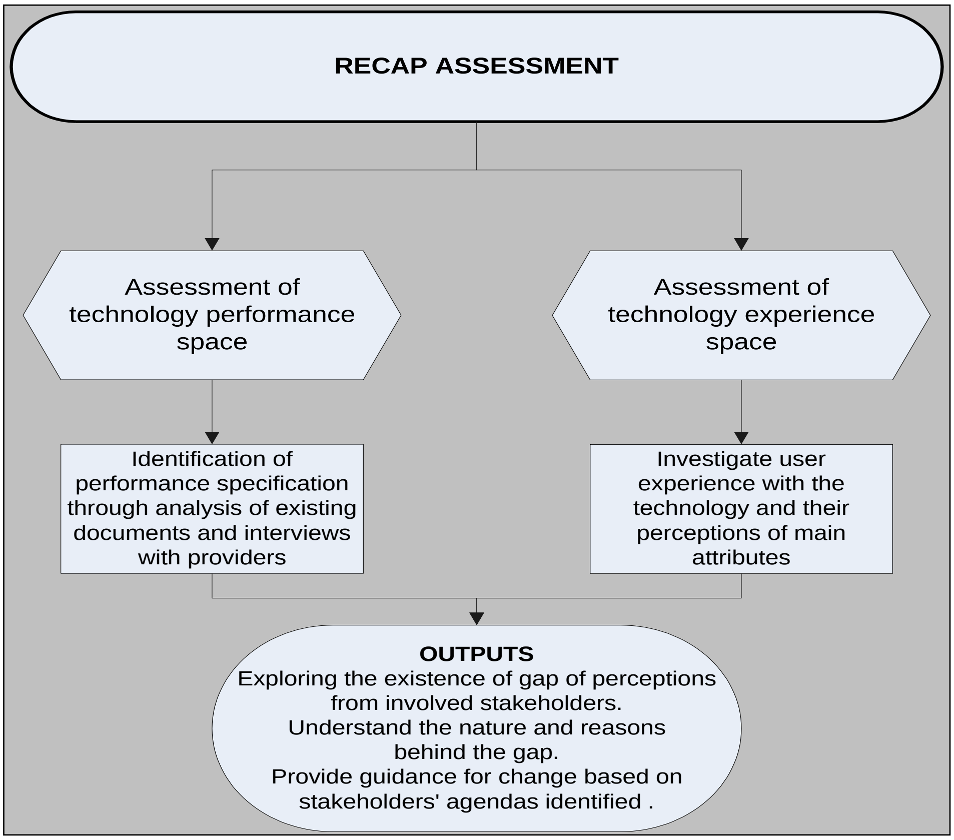


Figure 7-1 The RECAP assessment

Two data sets were generated in the investigation. The first was derived from a series of in-depth interviews with six providers involved in the implementation of SODIS and AQUATAB: the implementing NGO, village leaders, health clinics and local government. A second data set was collected in three villages where the treatment methods were introduced, by means of semi-structured interviews. Questionnaires, specifically developed for this study, contained a demographic part (summarised in Table 7-2), questions concerning users' knowledge of the technologies, patterns of use, perceived benefits and/or problems as well as their willingness to continue to use the systems. Questionnaires were translated into Indonesian and pre-tested for validation. Due to the recognised role played by women in supplying water (Arku, 2010), female members from households, randomly selected during transect walks in the villages, were invited to participate to the interviews. Questionnaires were administered by cadres, (field facilitators employed by the NGO to promote and diffuse technologies), to ensure comfort of respondents during the interviewing process.

Table 7-2 Sample characteristics

Villages	Kolisia (Village A)	Gunung Sari (Village B)	Watuliwung (Village C)
Estimated households	603	325	468
Number of households surveyed	100	98	100
Mean household size	4.9	5.04	4.8
Mean age of respondents (years)	40.7	35.1	41.3
Proportion of poor households*	65%	22%	73%
Proportion of female respondents	91%	97%	81%

* Poor households earn less than Rp.650, 000 per month and live in anyaman bambu (bamboo) dwellings.

Two sets of results are presented and discussed in this study: *i)* the intended performance of SODIS and AQUATAB in the three villages investigated through use of existing documentation and interviews with stakeholders involved in system provision and *ii)* users' experiences of the technologies and factors affecting the sustained use of SODIS and AQUATAB.

7.4 Results

7.4.1 Intended performance of SODIS and AQUATAB

SODIS and AQUATAB are simple water treatment methods, which aim to provide improved sources of water for poor households in developing countries. The designed performance of SODIS and AQUATAB is presented in Table 7-3.

Table 7-3 Technology performance

	SODIS	AQUATAB
Preparation procedure and time	- Plastic bottles, preferably of Polyethylene Terephthlate (PET) material are required. - Contaminated water filtered to reduce suspended solids (<30 NTU) and placed in clear plastic bottles of 1-2 liter volume. - Water is oxygenated through shaking in contact with air. - Bottles are exposed to full sunlight for a period of 6 hours (or longer if the sky is cloudy).	- Water filtered into a 20-litre appropriate container. - Immerse AQUATAB tablet for 30 minutes.
Benefits	- Simple preparation and easy to understand. - Relatively low-cost after bottle acquisition. - Minimal taste and smell in treated water. - Documented reduction of infectious diarrhoea in users. - Reported inactivation of viruses, protozoa and bacteria in water.	- Easy to prepare and practical disinfection method. - Safe to handle and transport. - Minimal chlorine taste is provided. - Relatively low cost. - Documented reduction of infectious diarrhoea. - Effective against cholera, typhoid, dysentery and other waterborne diseases.
Implementation strategy	- Village demonstration and training on preparation and use conducted by local the NGO. - Introduced in village B in 2004 and in villages A and C in 2007. - Cadres appointed to undertake promotional activities, sell bottles and monitor use in the villages. - Initially 10 PET bottles distributed for free in the villages. - At the beginning of the project 10 bottles were distributed for free to each household, thereafter a price of 1,000 Indonesian Rupiahs per bottle applied. Since December 2007, the price increased to 2,000 Rupiahs per bottle (2,500 Rupiahs in Gunung Sari due to additional transport costs).	- Village demonstration and training on preparation and use conducted by the local NGO. - Introduced in all villages in December 2007. - Cadres appointed to undertake promotional activities, sell tablets and monitor use in the villages. - Five AQUATAB tablets were distributed for trial to households. - Pricing system: tablets sold at 500 Indonesian Rupiahs each.

Source: Conroy *et al*. (1996); EWAG (2002); Molla *et al*. (2009).

Responses from in depth interviews with the local NGO, village leaders, village health clinics (Puskesmas) and local government were processed in Nvivo 8, a software for analysis of qualitative data. Deductive coding was employed to sort responses along aspects explored in the course of the interviews: benefits, challenges and strategies for acceptance and sustained use of SODIS and AQUATAB. A second coding cluster was inductively generated within interview responses, to identify providers' perceptions of technology attributes. The co-occurrence of the two clusters of coding was investigated by performing a matrix query that analyses frequency of responses co-occurring within the two clusters. The results of this analysis are presented in Figure 7-2.

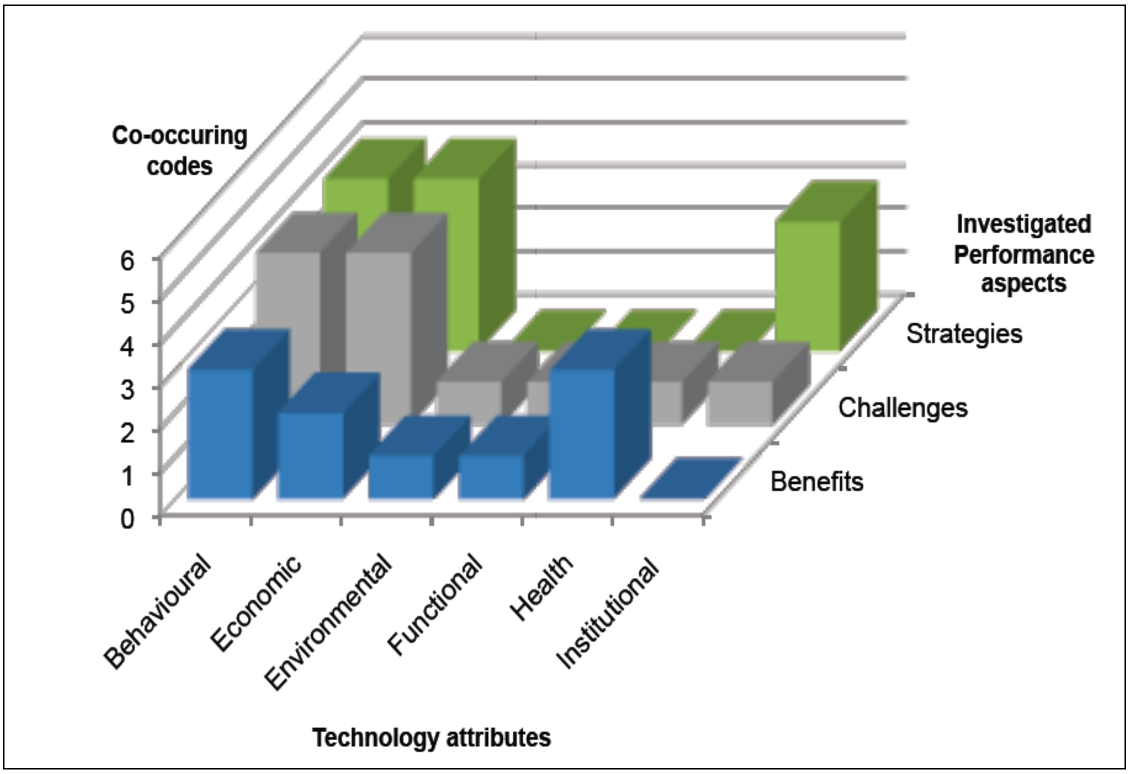


Figure 7-2 Intended performance of SODIS and AQUATAB

Interviewed stakeholders shared great awareness of the benefits and challenges related to the implementation and sustained use of SODIS and AQUATAB. The main benefits identified related to behavioural changes infused on those villagers who received training and promotion of SODIS and AQUATAB, as these activities generated new awareness of the importance of treating water. Strategies for SODIS and AQUATAB implementation relate to participatory activities and dissemination of information about use and benefits of the systems conducted as workshop organised by the local NGO during village meetings. Furthermore, practical training activities were conducted in each village by the local NGO, cadres and members of the Health clinics, who conduct practical demonstration on how to prepare and use SODIS and AQUATAB. The local government intervention in promoting education in the villages was mainly indirectly exerted. As reported by the Head of Environmental Health Department interviewed, the local government distributes information to village leaders in the form of brochures containing information about waterborne and water related diseases, as well as ARI generated from in-house fuel burning.

Other reported benefits related to the use of SODIS and AQUATAB are economic, since users can save money spent on buying water from vendors or for purchasing fuel and wood. Finally, health benefits derived from the use of the technologies were reported and measured as a reduction of diarrhoea incidence among users. However, results gathered from the records of health clinics suggest a different scenario. The percentage of diarrhoea cases in Village A (primarily using SODIS) is low, although outbreak episodes are still present. Conversely, in Village B (primarily using AQUATAB) the percentage of diarrhoea incidence was still high. Interestingly, in Village C, where the majority of users abandoned both of SODIS and AQUATAB, the percentage of diarrhoea cases is low (Figure 7-3). This may be related to the fact that despite not using SODIS or AQUATAB villagers largely boil water for drinking purposes.

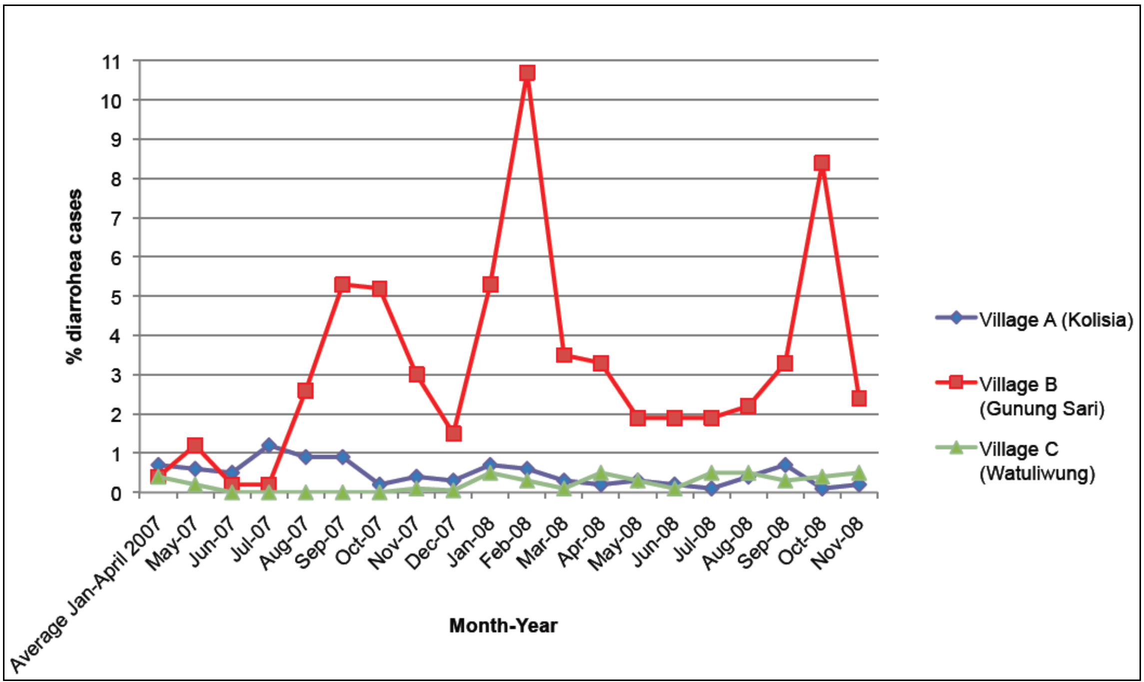


Figure 7-3 Percentage of on diarrhoea incidence provided by villages Health clinics

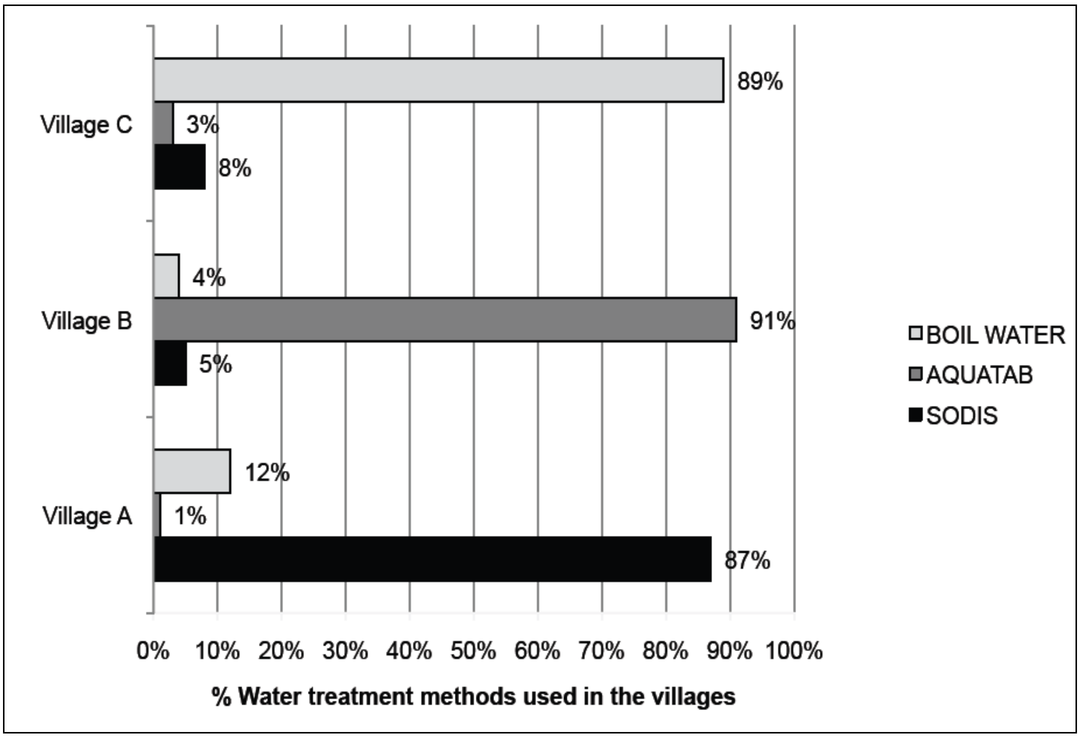
The percentage of diarrhoea cases for Village A (SODIS) and Village B (AQUATAB) reported in Figure 7-3 may be explained by several factors such as lack of user adherence to water treatment protocols or use of scratched and low quality SODIS bottles, consumption of food not adequately washed and poor hygienic practices. Furthermore an important aspect, which emerged from interviews with Heads of health clinics in villages A and B, is the lack of adequate monitoring and surveillance mechanisms in their structures. The role played by health clinics in the implementation and sustained use of SODIS and AQUATAB was minor, as poor resources and facilities prevented effective monitoring of the health gains linked to SODIS and AQUATAB use. Reported mechanisms to monitor diarrhoea were mere consultations with villagers. No records existed of causative agents of diarrhoea incidence, linkage with use of any water treatment or description of pre-existing medical conditions, such as malaria. Other monitoring mechanisms to assess the progress of SODIS and AQUATAB use are conducted by the local NGO, through cadres selling bottles and tablets in the villages.

Different types of challenges to implementation and sustained use of the two technologies were reported by interviewed stakeholders. In the case of SODIS these related to the pricing systems introduced by the local implementing agency for purchasing bottles; whilst for AQUATAB perceived challenges related to objections to taste of the treated water. Further perceived problems that may undermine the sustained use of the technologies related to a recognition that people in the villages were still reliant on free provision of water supply and sanitation.

Intervention strategies suggested by health operators, the local NGO and village leaders to facilitate sustained use of SODIS and AQUATAB are largely institutional in nature. A greater involvement from the local government was deemed necessary to provide continuous support to SODIS and AQUATAB users. Examples suggested were the establishment of financial schemes to provide micro-credits to villagers to purchase suitable SODIS bottles or an increase in educational activities and monitoring of villagers' health status. Furthermore, a greater involvement of local institutions was suggested to provide routine monitoring and surveillance mechanisms of water quality at household level. A further strategy, advanced by the local NGO, entails a higher responsibility and involvement of health clinics and local institutions in constant promotional and educational activities with users as well as discussion groups within villages on user awareness of problems and benefits related to the use of both SODIS and AQUATAB.

7.4.2 User experiences of SODIS and AQUATAB

At the time of investigation a distinctive pattern of use was present in the three villages, (illustrated in Figure 7-4). Although SODIS was introduced in all the villages investigated, its uptake was successful only in village A (Kolisia), with 87% of households using it regularly. In village B (Gunung Sari), AQUATAB tablets were the most used treatment method by households investigated (91%); whilst in village C (Watuliwung), neither of the methods transferred were used by households, who mainly used boiling water (89%).



***Multiple responses**

Figure 7-4 Pattern of technology use in the three villages

In Village A, 91% of households using SODIS was identified at the time of the investigation, whilst 9% stopped to use SODIS. The reasons for stopping SODIS were mainly of economic nature: once the free sample bottles donated by the local implementing agency broke, users, who were unable (or unwilling) to purchase PET bottles abandoned SODIS methods. Conversely a 91% continued to use SODIS as main water treatment method. Of these households appreciation of the taste (99%) and smell (100%) of SODIS-treated water was reported. SODIS was reported by 86% of users to provide enough water for household consumption and 93.5% of households showed strong confidence in the ability of SODIS to prevent diarrhoea. Among households using SODIS only a few members of the family, (8%), preferred other methods and believed that SODIS-treated water had caused them health problems, such as diarrhoea, stomach pain and diabetes. Interviewed respondents reported high trust in the local NGO and the cadres (90%), whilst trust in medical and health structures was reported by only 10%. Among current users, the reported willingness to continue to purchase bottles at the price of 2,000 Indonesian Rupiahs was high at 85%.

Conversely, the introduction of AQUATAB tablets in Village B generated a novel pattern as households began to replace AQUATAB to SODIS, with a 93% of users at the time of the investigation. The system was preferred by 73.5% of households, mainly for its lower cost (49%), and ease of preparation and use (37%) than other methods. A 7% of interviewed households did not use AQUATAB anymore, despite having received training. The preferred methods used in those households were boiling water and SODIS. The reasons why a 7% abandoned AQUATAB was mainly related to lack of appreciation of taste and odour of the treated water. Among those 93% of households who were using AQUATAB as main treatment method, 96% appreciated the taste of AQUATAB-treated water, whilst only 14% were satisfied with its smell. Only a few respondents reported to have experienced occasional problems with AQUATAB use, mainly related to lack of time to prepare the water, whilst none of the households reported cases of diarrhoea since using AQUATAB. In village B, willingness to continue to use AQUATAB was high at 99%. The reported level of trust in the NGO was high (77%); whilst 23% trusted medical and health structures. Households' patterns of use of SODIS and AQUATAB technologies in Village A and B, respectively, are illustrated in Table 7-4.

Table 7-4 Patterns of use of SODIS and AQUATAB

	Village A (Kolisia) (SODIS) % households		Village B (Gunung Sari) (AQUATAB) % households	
Household water supply source used	Hand dug well	71%	Hand dug well	100%
Water source more than 300 m from household		39%		86%
Household member responsible for preparation*	Female Male Children	71% 11% 18%	Female Male Children	79.5% 12.5% 8%
Reported container used for treatment	PET bottle 1.5L	100%	Gallon bottle 20L	57%
Reported filtering method used in household	Use of cloth to filter water	99%	Use of cloth to filter water	93%
Reported acquisition patterns in household	Purchase bottle	91%	Purchase tablets	77%
Reported treatment time in household	24h or 48 h if cloudy	79%	30 minutes	70%
Respondent knowledge of methods preparation	Very accurate	68%	Accurate	98%

*Multiple responses set

In Village C, both SODIS and AQUATAB were introduced in 2007. The investigation of households experience revealed that the percentage of SODIS users decreased from 89% to 8% at the time of investigation. This may be related to the approach adopted by the local implementing agency, who freely distributed PET bottles to village users to create an incentive for trying SODIS. After the trial bottles finished, users show reluctance to purchase PET bottles and used boiling water as main treatment methods. Similarly, the percentage of households who received free AQUATAB tablets (26%), following a communal demonstration, was reported to have decreased to 3% of users. Interviewed households reported that they preferred to boil water by using wood, readily available in the village surroundings. Despite having abandoned SODIS, households' perceptions of the health benefits derived from it were high at 79%. Of these, 53% of households believed SODIS to have a healing power, since water was perceived as capable of treating diseases like kidney infections and stomach pain. Meanwhile, 16.5% believed SODIS-treated water to be of good quality contained in bottles and thus preventing contamination and a 15% believed it to be of good quality for the technology capacity of for killing bacteria Conversely, 16% of respondents perceived SODIS as a causative agent of diseases such as flu, diarrhoea and kidney infection. Perceptions of benefits to health generated by AQUATAB water were reported only by 8% of interviewed households. Levels of trust in Village C were markedly different from those elicited in Villages A and B. In village C, trust on the local NGO was lower at 22%, whilst the majority of households (74%) reported to trust personnel from the health clinics.

Aggregated data from the three villages (n=298) were employed to explore a range of factors correlated to determining use of SODIS and AQUATAB, reported in Figures 7-5 and 7-6, respectively. The main reasons that influenced SODIS use related primarily to functional aspects (48%) and to a lower extent to economic reasons (37%). Compared to other treatment methods occasionally used in the village, such as boiling water, respondents preparing SODIS reported to have more time to conduct other activities and to save money used in wood. Conversely, reported reasons for not using SODIS were mainly economic (79%), such as the inability reported by households to afford PET bottles after their increase in price.

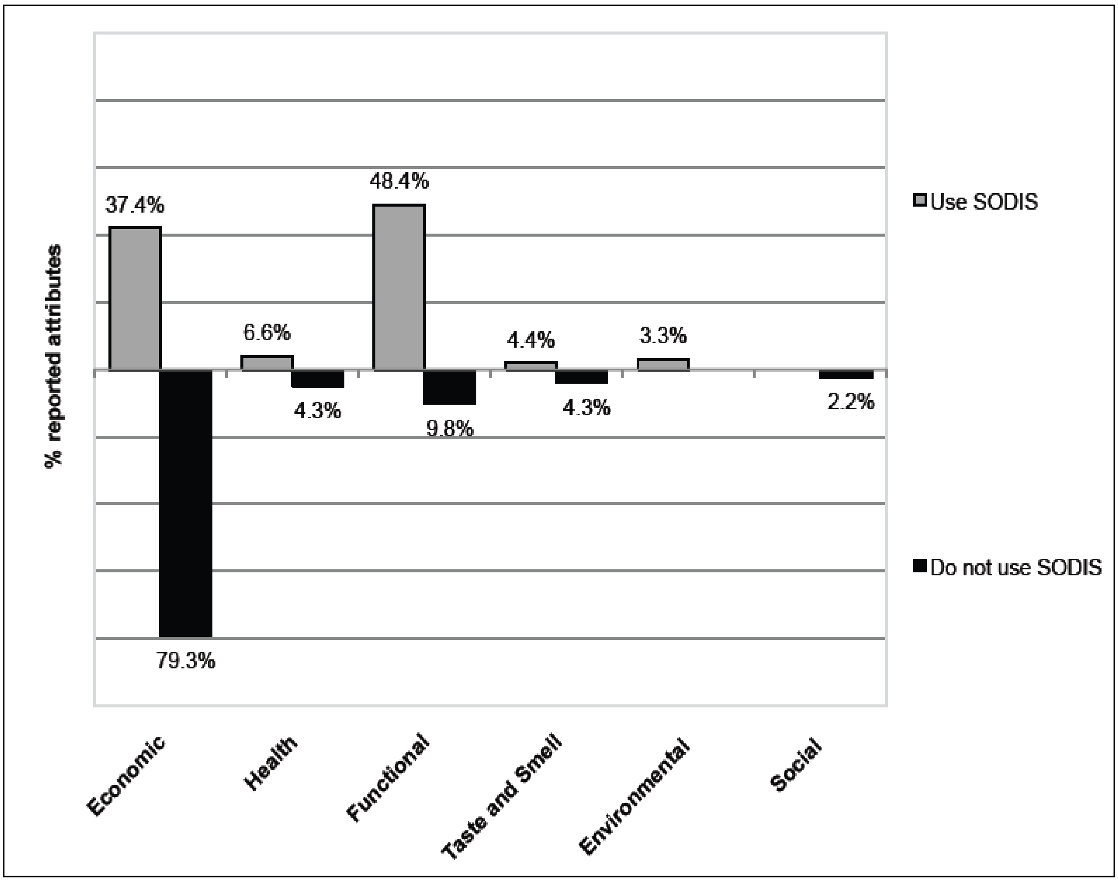


Figure 7-5 Attributes declared as influence of use and non-use of SODIS

Economic aspects were reported as the main reason for using and continuing to use AQUATAB (63%), since tablets were sold at lower price than PET bottles. Conversely, factors for not using AQUATAB related to users' perceptions of taste and odour aspects of the treated water (67.5%), which was not appreciated by users. This factor was coupled with a social attribute (19%), namely the decision not to use AQUATAB because friends or neighbours reported that AQUATAB-treated water tasted of medicine. Interestingly, in all villages perceptions of health benefits generated by the SODIS and AQUATAB constituted a relatively less significant factor for use than economic, functional and taste and odour aspects.

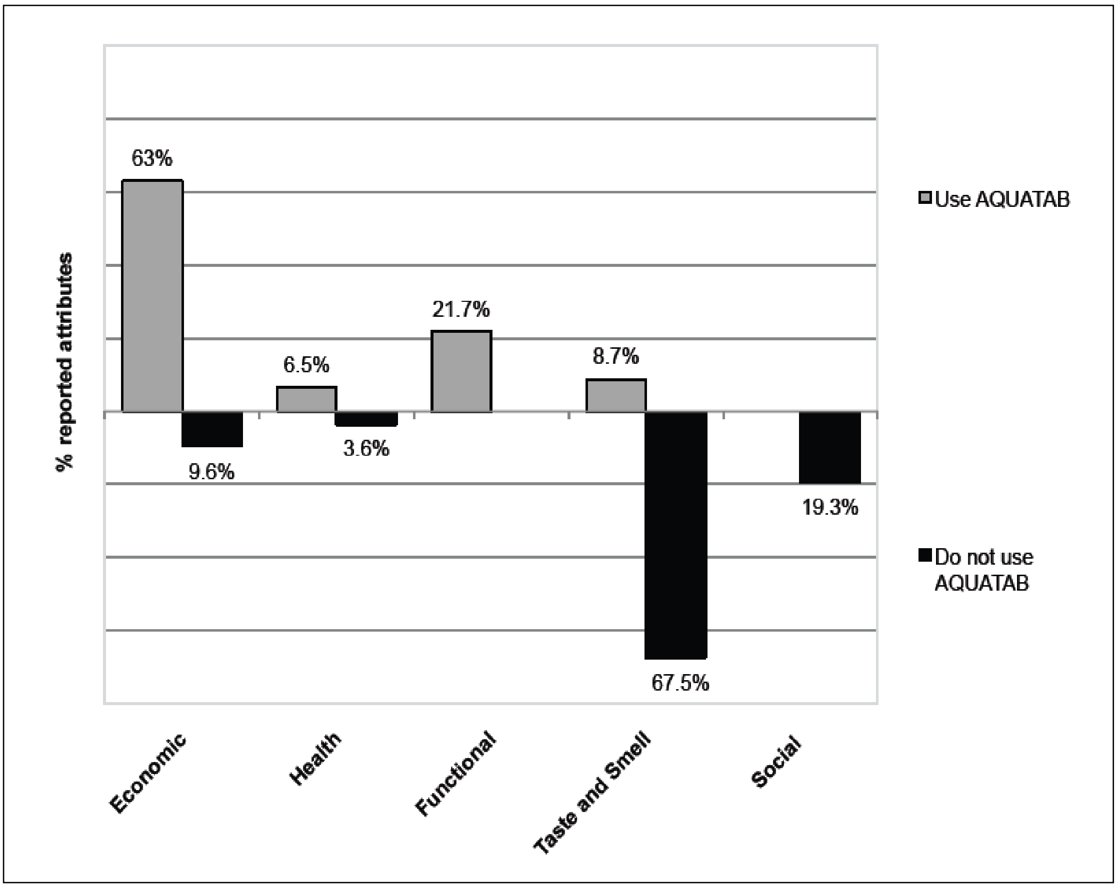


Figure 7-6 Attributes declared as influence for use and non- use of AQUATAB

7.5 Discussion

In this study the intended performance and experience of SODIS and AQUATAB were evaluated to diagnose potential challenges to sustained use of the systems. Our study corroborates the assumptions discussed in the introduction concerning the importance of routinely conducting post-implementation evaluations to tackle potential emerging challenges to sustained technology use. Results from investigation of user experiences highlight significant attributes influencing the use (and non-use) of SODIS and AQUATAB. With regard to SODIS, economic and functional attributes of the technology, such as affordability of PET bottles and ease of use of the technologies played important role. For AQUATAB, economic aspects were also the most commonly reported factor for using the technology. Conversely, taste and odour aspects were reported as reasons for ceasing to use the method. This is consistent with other studies where smell and taste have been identified as barriers to the use of chlorine-based water disinfectants (Lantagne and Clasen, 2009).

A significant aspect elicited in the analysis of patterns of use refers to respondents' perceptions of health risk. Although awareness of the advantages generated by treating water was reported, in none of the villages health risks considerations were cited as primary factors influencing technology use. This result is in accordance with findings from a previous study on SODIS (Heri and Mosler, 2008) were determinants for SODIS use were related to the economic advantages from using the systems. Furthermore, in all villages distorted perceptions of health benefits or problems of SODIS and AQUATAB were reported. In Village C, for instance, respondents believed SODIS to heal diseases, such as stomach pain or kidney infections. Similarly, those respondents refusing to use SODIS or AQUATAB reported to have experienced diseases (as flu and diabetes) resulting from technology use. Cultural factors may explain this result. In a society where animistic beliefs play an important role, water may be considered to have healing or alternative negative properties. Users' inability to prioritize the link between health benefits and technology use, as well as distorted perceptions of SODIS and AQUATAB-treated water, reveal the presence of a communication gap within villages. This may be determined by lack of appropriate messages that effectively communicate the nature of the methods and their benefits using language and agendas, which are relevant to and understood by recipients. The cause of this gap may be the allegedly low involvement of health operators in the promotion and discussion of SODIS and AQUATAB due to insufficient resources. Thus, the role of health operators is to be strengthened by greater involvement in the communication of and discussion with users of the technologies' public health benefits. A further discrepancy concerns the diarrhoea incidence reported from the health clinic in Village C and the lack of diarrhoea cases reported by AQUATAB users. This may be the result of inaccurate monitoring methods by village health clinics that appropriately link diarrhoea cases to use of the technologies.

Whilst a continuous educational support by health operators is deemed an essential step to guarantee sustained use of the technologies, a similar approach should be adopted by local institutions. A further gap identified, in fact, relates to the lack of post-implementation institutional support for SODIS and AQUATAB based on users' agenda for use, namely economic and functional aspects, and appropriate actions to tackle challenges. As reported in the discussion of providers' interviews, local government's activities to promote and disseminate SODIS and AQUATAB are confined to the pre-implementation stage and involve indirect liaising with village leaders. Awareness of those reasons for use and lack of use, which are relevant to recipients, would help shape new agendas for dissemination, education and interventions (Jeffrey and Seaton, 2004). The importance of framing intervention strategies so that they are well adapted to user agendas and target perceived barriers is further proved by the context-specific results obtained in this study. A discrepancy between stated reasons for using and abandoning SODIS and AQUATAB technologies within the three villages shows the need to develop singular strategies that address specific problems. This result further validates Carter *et al*. (1999) who discussed the necessity of developing evolving mechanisms to ensure technology longevity. Thus, local government's role could be promoted by its involvement in the provision of micro-finance credit to villages to acquire PET bottles and in the development of educational support to reinforce the messages provided by NGO and health operators.

7.6 Conclusions

Our analysis of the intended performance and user experience of two alternative point-of-use water treatment technologies supports the view that pre-implementation promotional strategies, training and dissemination alone are often insufficient to ensure sustained technology use. In the villages investigated an increase in the price of SODIS bottles coupled with the introduction of a less expensive alternative technology (AQUATAB) undermined patterns of sustained SODIS use. While issues of pricing for technology use is outside the scope of this study, we suggest that a combined use of SODIS and AQUATAB in the dry and wet season respectively, could secure constant provision of safe water supply to the three villages. To achieve this objective, interventions from the local government are desirable to adapt context-specific support strategies. Furthermore, continuous educational efforts should be promoted by those stakeholders that are trusted most within villages. Effective communication would enhance the achievement of improved public health as well as improve the sustained use of the transferred systems.

To conclude, the deployment of an early post-implementation evaluation tool (RECAP) has demonstrated the importance of continuous feedback from users and providers during post-implementation, in promoting sustained use of water technologies. Limitations to the RECAP tool and its application are primarily related to the need to involve a spectrum of stakeholders who can inform the debate over challenges to technology longevity. The tool in itself does not provide solutions, rather it suggests directions to frame agendas for change to achieve sustained technology use.

CHAPTER 8: DISCUSSION

8 DISCUSSION

This research has adopted a multiple case study approach to evaluate WATSAN technologies in developing countries through investigation of post-implementation challenges that may undermine and/or compromise sustained system use. The process of intellectual thinking driven by past and recent evidence of scarce success of WATSAN interventions, illustrated in Chapter 2, generated the rationale for developing an innovative approach to understanding the salient reasons at the root of the unsolved problem of effective impacts of implemented WATSAN technologies in developing countries.

This chapter begins by discussing the results from CS-I and synthesising the process leading to the development of the RECAP tool for evaluating WATSAN technologies. It then proceeds with a discussion of the main results obtained from the deployment of the RECAP diagnostic tool, presenting suggestions for change and an evaluation of the tool itself. Section 8.1 discusses the key findings of CS-I, (presented in Chapter 4), and the emerged rationale for developing the RECAP tool. Section 8.2 discusses the discrepancies identified through the analysis of WATSAN technology performance and experience in CS-II (DEWATS, presented in Chapter 6) and CS-III (SODIS and AQUATAB, presented in Chapter 7). Section 8.3 highlights remedial actions suggested by the analysis of results from the RECAP assessments. Finally, Section 8.4 examines the usefulness of the RECAP post-implementation evaluation tool, highlighting its strengths and weaknesses through a SWOT analysis.

8.1 The need for a novel approach to WATSAN technology implementation

Despite the current progress to meet of MDG Target 10 (WHO, 2010), discussed in Chapter 1, the backlog for achieving universal access to improved forms of water and sanitation is still extensive. Considerable efforts are still to be undertaken to keep pace with population growth, overcome regional discrepancies in progress rates and, most importantly, ensure effective impacts of the WATSAN systems transferred. In assessing progress to date, the academic community has increasingly been arguing that the strategies adopted to move towards MDG Target 10 largely prioritize the achievement of coverage rates to the detriment of a more concerted effort to ensure use and sustained use of the technologies implemented (Giné and Pérez-Foguet, 2008; Montgomery *et al.*, 2009).

The legacy of previous interventions in the WATSAN sector, discussed in Chapter 2, coupled with more recent scholarly evidence of misused and mismanaged WATSAN technologies in the post-implementation stage (Mackintosh and Colvin, 2002; Rodgers *et al.* 2007), have shown that the occurrence of problems in the aftermath of technology implementation may undermine their long-term use. These challenges have been described in terms of a lack of mechanisms to generate a sense of responsibility for the transferred systems, occurrence of problems determined by newly emerged conditions, lack of appropriate behavioural change in a context of poor managerial capabilities and isolation of technology users (Ongley, 2001; Harvey and Reed, 2007; Ademiluyi and Odugbesan, 2008).

Findings from the pilot CS-I, which investigated Community Ablution Blocks (CABs) in Durban (South Africa), largely corroborated the evidence from the academic literature. The post-implementation investigation of CABs showed that lack of established mechanisms for Operation and Management (O&M), coupled with a vacuum of responsibilities for technology and lack of a sense of ownership have negatively impacted on user acceptance and ultimately led to misuse of and indifference towards the implemented technologies. Despite user awareness of CAB problems and potential benefits, the inability (or unwillingness) to pay for the systems and lack of established mechanisms regulating payment were demonstrated to affect technology use. Comparison between users and intended recipients of CABs (provided in Chapter 4, Table 4-1) has shown that the experiences of use have undermined the trust in service providers and motivation to report problems with the facilities.

In accordance with findings highlighted in previous studies of community-based water supply and sanitation systems in Africa (Mukheli *et al.*, 2002; Harvey and Reed, 2007), the inability to generate a sense of responsibility in CAB users has led them to perceive the communal systems as mere “open resources”. The scarce success of CABs in CS-I should be read in a context where supply-driven approaches by the local municipality still dominated WATSAN service delivery (Eales, 2009). In a context of supply-driven strategies, providers' top-down approaches to technology delivery and implementation do not allow for creating an enabling environment for participatory approaches, involving and engaging technology users. As discussed in Chapter 2, target-driven strategies for WATSAN technology transfer have been criticised for leading to failure of the IDWSSD (Breslin, 2004) and have been gradually substituted with more participatory approaches to technology implementation. As highlighted by several scholars (Narayan, 1995; Stalker Prokopy, 2005), user engagement in participatory planning and implementation has proven to significantly increase the effectiveness of the impacts of the technology implemented. Results from CS-I (Chapter 4, Table 4-4) have also shown that the involvement of users in simple training activities generated higher satisfaction levels for the systems and a more proactive attitude to problem-solving.

An additional finding from CS-I, which influenced further research development, related to the nature of the problems which emerged in the post-implementation stage. Most of the causative factors compromising lack of acceptance and sustained use of the systems were of a non-technical nature. Recalling Linstone *et al.*'s (1981) argument (presented in Chapter 5), the results of CS-I drove the focus of attention to organisational and personal aspects of technology assessment, based on a multi-stakeholder perspective of the transferred WATSAN technologies and a greater awareness of socio-cultural dynamics. The new awareness of the importance of non-technical problems at the basis of misuse or lack of use of WATSAN technologies has prompted the development of an evaluation approach that allows stakeholders to shape their agenda for use and implementation, highlighting those technology attributes important to them.

Although in CS-I, investigation was primarily focused on users' experiences and perceptions of the technologies, the emerged assumption of lack of mutual engagement between users and local institutions has justified further investigation of reasons for scarce success towards the MDG Target 10. This recognition prompted the development of a novel multiple perspective approach, based on the RECAP tool, for technology evaluation going beyond *technocentric* assessment to compare and contrast providers' and users' perceptions of the technologies in the aftermath of their implementation. The RECAP tool, whose theoretical background, components and application have been broadly discussed in Chapter 5, was applied in CS-II and CS-III. The following section discusses the main results of the RECAP assessment applied to CS-II and CS-III.

8.2 Identified challenges in WATSAN technology sustained use

The deployment of the RECAP tool in CS-II and CS-III allowed the investigation of the intended performance and experience of WATSAN technologies through a mixture of data sources, such as interviews with technology providers and users, and official and unofficial documents. By comparing and contrasting providers and users' perceptions of the technologies and their agendas for implementation, challenges that ultimately may impact the effective use of the systems were identified. The research design adopted in this study and the focus on WATSAN technology stakeholders enabled construction of a real- life picture of the performance and experience of the technology as well as of the emerging challenges within each case study. The following sub-sections discuss the main results identified in each case study.

8.2.1 Post-implementation challenges with DEWATS in Java and Bali, Indonesia

In CS-II, the RECAP assessment was adopted to evaluate DEWATS technologies in Indonesia and explore the presence of challenges to their sustained use. Compared to the community-managed sanitation investigated in South Africa (CS-I), in this case study a different approach to implementation was adopted. The local implementing agency, Borda, has involved and engaged communities in a participatory planning and decision-making processes based on user willingness and ability to adopt (and pay for) the technologies; as well as health and educational training. Whether the SANIMAS programme proved to be a financially, socially and environmentally sound programme to implement highly accepted technologies by communities, challenges to sustained technology use were identified. These are discussed in the following sub-sections.

Lack of monitoring mechanisms to assess problems within communities using DEWATS

As reported in Chapter 6, each of investigated communities using DEWATS technologies experienced heterogeneous problems in the post-implementation stage (See Figure 6-3). The majority of communities were preoccupied with challenges to technology longevity posed by technical problems with the technologies and their lack of capacities and skills to solve them. In other communities, where sanitation centres were implemented, social and organisational aspects were reported as crucial to sustained system use. These related to lack of cohesion among user groups, which generate inability to organise payment by all community members, and episodes of anti-social behaviour at the facilities. The importance of these factors in users' agenda testifies the necessity of establishing routine monitoring mechanisms, which are capable of timely identify and address the specific issues in each community. As illustrated in Figure 6-2 providers' agenda for implementation did not encompass monitoring systems for the facilities. Particularly, the local government's role was primarily focused on the delivery of pre-implementation awareness campaigns to address health issues, and no arrangements for continuous assessment of the facilities' performance were in place. Furthermore, no specific national or local regulations existed that define performance indicators and which allocate responsibilities for monitoring the built systems.

In a comprehensive study of community-managed water technologies in Latin America, Lockwood (2002) identified similar problems caused by lack of institutionalised monitoring mechanisms. By reporting some examples of successful monitoring mechanisms in Nicaragua and Honduras, Lockwood (2002) stressed the essential role of monitoring and information gathering in ensuring technology sustainability. Monitoring mechanisms are essential to evaluate the effective system performance, as well as their organisational, health and environmental status, to create assessment benchmarks against which planning further activities. Furthermore, information gathered through monitoring activities may be fed back on a database to effectively record performances of the systems. Similar assertions were advanced by other scholars (i.e Ongley, 2001; Harvey and Reed, 2007), who linked the sustained use of WATSAN technologies with existence of institutional monitoring schemes.

Loose accountability for maintenance and management of DEWATS

A further challenge to DEWATS effectiveness was identified in the loose accountability for technology long-term management and maintenance. Admittedly, this discrepancy related with the previously identified need for monitoring mechanisms. The evaluation of user experiences with DEWATS revealed that although a sense of ownership for the technologies was shared among users, a lack of planned long-term assistance in solving the aforementioned technical problems or social issues (in the case of CSCs) could undermine the system longevity. As reported in Chapter 6, whether maintenance of DEWATS was provided by the local NGO up to one year after implementation, no clear role and responsibility for long-term management existed. The local government's agenda for DEWATS implementation did not encompass maintenance schemes and support for management the DEWATS technologies, rather it exhibited reliance on the communities and their organisations for managing and maintaining the systems.

The accountability challenge identified in CS-II (and partially explored in CS-I) relates to the poignant issue of managing common resources pool, where it is difficult to allocate responsibilities when a wide spectrum of stakeholders are involved. Recalling the demand-responsive approaches (DRAs) to WATSAN implementation emerged in 1990s, discussed in Chapter 2.4.1, scholars (Yacoob, 1990; Lockwood, 2004; Harvey and Reed, 2007) have warned against its possible limitations, which may lead to a process of disenfranchisement by local governments from playing a supportive role for WATSAN users. In the case of DEWATS, the local institutions have perceived their role merely as facilitation activity in the DEWATS pre-implementation stage. Similar misconceptions by local institutions of their role in WATSAN technology management and maintenance are reported in African cases studies (Harvey and Reed, 2007). Lockwood (2002; 2004) advocated the importance of providing constant support to communities by means of promoters, from local government or private sectors, namely figures that permanently assist users in undertaking the necessary interventions required.

8.2.2 Challenges undermining sustained use of SODIS and AQUATAB in Flores, Indonesia

In CS-III, point-of-use water treatment systems (SODIS and AQUATAB) at household level were investigated in Flores Island, Indonesia. Although different types of technologies were examined, the application of the RECAP tool allowed the identification of three main challenges to the SODIS and AQUATAB sustained use in the villages investigated. These are discussed in the following sub-sections.

Ineffective communication of health risks and benefits to users

Results from analysis of SODIS and AQUATAB technologies in Flores Island revealed that recipients' stated reasons for adopting the technologies were not driven by perceptions of health risks. This result was in accordance with other studies (Heri and Mosler, 2008), where determinants for SODIS use were identified as the comparative economic advantages to be gained from using the system. As seen in Figures 7-5 and 7-6 the main reasons for using and continuing to use SODIS and AQUATAB were of economic and functional nature, such as lower cost of the technologies compared with existing alternatives (buying wood to boil water or purchasing water from vendors) and ease of preparation and use. An additional result, which corroborated the assumption of low user understanding of the relationship between technology use and health was identified. This related to users' distorted perceptions of the health benefits and risks associated with SODIS and AQUATAB, with respondents reporting SODIS and AQUATAB to have caused them stomach pain or kidney infection; or others, considering SODIS capable of healing from diseases. The origins of these misperceptions may be of a cultural nature. In a society where animistic beliefs play a prevalent role, water may be considered to possess healing or alternatively negative properties. These results suggest the presence of a communication failure, which may be due to ineffective health messages transferred by providers to households. In CS-III the lack of resources and personnel available to village health clinics and the local government, whose educational role was confined to the pre-implementation stage may have contributed to decrease effectiveness of the message communicated. Lack of continuous and routinely conducted educational interventions with household groups may have contributed to the gradual emergence of misconceptions among users about the benefits of both technologies. Thus as advocated by other scholars (Rainey and Harding, 2005; Meierhofer and Landolt, 2009) discussion and promotional activities should be regularly undertaken, employing users' lay language and delivering messages fully understood and internalised by recipients.

Lack of appropriate health and water quality monitoring mechanisms

The identification of a further challenge to long-term adoption and use of SODIS and AQUATAB was prompted by the analysis of reported cases of diarrhoea incidence in the villages investigated (Figure 7-3). The high percentages of diarrhoea cases reported in all villages cast doubts on recipients' ability to prepare and use SODIS and AQUATAB, but also generated questions about the existing monitoring activities of diarrhoea incidence undertaken by village health clinics. Results from interviews with Head of health clinics in the two villages using SODIS and AQUATAB show that no established mechanisms for monitoring and reporting cases of diarrhoea incidence was present at the time of the investigation. Cases were recorded without appropriately evaluating the links between diarrhoea and the presence of other pathologies as well as the type of water treatment methods used by the affected patients. The establishment of appropriately designed public health records is paramount to evaluate the effectiveness of the implemented technologies and to explore patterns of use among villages. A stronger cooperation between local NGO, health clinics and local government agencies should be promoted to obtained reliable results recorded in a database that track the performance of the technologies and suggest strategies for planning new interventions.

Finally, a lack of routinely conducted monitoring to assess the water quality at household level was also identified. In accordance with the literature (Ongley, 2001; Rainey and Harding, 2005), failure to institutionalise adequate quality assurance control in water treatment systems is a common problem among point-of-use systems implemented in developing countries that must be tackled to ensure that the transferred technology bring the intended effect on users' health.

Poor facilitation role by local institutions of problems undermining use of technologies

The RECAP assessment in CS-III allowed the identification of reasons for use and sustained use of SODIS and AQUATAB. Among villages, respondents reported different priorities and agendas for use, which shaped their decision for continuing to use one method over another.

Analysis of the interviews with the Environmental Health Department in Maumere showed that despite local government's role in organising awareness and promotion campaigns in the pre-implementation stage, the authorities had only minor responsibilities in facilitating sustained use of SODIS and AQUATAB. Although aware of the main problems undermining the use of SODIS and AQUATAB within the villages, no strategies for facilitating sustained technology use were in place. This finding was supported by requests and suggestions advanced by the local implementing agency, health clinics and village leaders, for a stronger institutional role in facilitating the sustained use of both point-of-use technologies. A more proactive role from the local authorities was advocated in developing financial mechanisms, such as micro-credit schemes to support users in purchasing of PET bottles, and providing further funding and resources for health clinics to routinely conduct health awareness campaigns in the villages. This should be coupled with continuous educational activities to initiate behavioural change in users, by adopting agendas for use, which are relevant to them.

8.2.3 Common problems with context-specific solutions

Although based on the investigation of different technology types, Case Studies II and III shared a commonality in the nature of the indentified gaps and challenges. In both case studies, whether providers have shown great understanding of the problems at stake and a proactive attitude in implementing and involving users in the pre-implementation process, users were deemed to be the only responsible for managing the technologies and related emerged problems in the post-implementation stage. The results obtained, however, demonstrate users' isolation and lack of cooperation with other stakeholders in the aftermath of implementation may lead to incapacities and/or unwillingness to use the systems sustainably. Thus, corroborating the most recent literature (Harvey and Reed, 2007; Ademiluyi and Odugbesan, 2008; Montgomery *et al.*, 2009), these results showed that the acquisition of technology ownership (CS-II) or the adoption of promotional and training activities (CS-III) through demand driven approaches do not automatically guarantee infusing users with responsibilities and the abilities needed for adopting, maintaining and continuing to use the technologies.

A challenge to the effectiveness of demand-driven approaches to implement the technologies and based on principles of communities and users self help and cost recovery was identified. In the case of Indonesia, the lack of user support during the post-implementation stage may also be aggravated by the legacy of the decentralization process whereby local authorities have acquired newly devolved responsibilities, without an appropriate pool of resources, trained personnel and cross-departmental coordination. This study corroborates the recent literature arguing for the unrealistic goals of achieving technology users' self-sufficiency in the post-implementation stage (Schouten and Moriarty, 2003; Lockwood, 2004). Thus, to be effective WATSAN technology transfer processes must avail themselves of continuous support and assistance in the post-implementation stage (Lockwood, 2002; Harvey and Reed, 2007). This crucial finding by no means suggests a return to supply-driven approaches to WATSAN technology implementation; rather it advocates the development of novel collaborative strategies to increase cooperation between providers and users, to guarantee the latter routine support in the form of monitoring and management activities. Some of the most important strategies are discussed in the following section.

8.3 Suggested remedial actions

The literature and practice of WATSAN interventions have suggested a plethora of recommendations for improving the effectiveness of impacts of the WATSAN technologies in developing countries. Important steps have been made from condemning supply driven schemes to embrace demand driven approaches that entail a greater involvement of users in planning, decision-making, behavioural change and empowerment.

This study, however, has shown that demand driven approaches are necessary but not sufficient to prevent the emergence of challenges in the post-implementation stage. Under the umbrella of demand-driven approaches, technology providers should not be relieved from the burden of providing assistance and support to users in the post-implementation stage, rather stronger cooperation among all stakeholders should be promoted. The deployment of the RECAP assessments allowed the researcher to advance some remedial actions based on users and providers' feedback. Table 8-1 illustrates the suggested remedial actions and the actors involved in CS-II and CS-III.

To implement the remedial interventions reported in Table 8-1, considerable efforts should be made to increase the skills and capacities of all stakeholders involved. For local government, capacity building activities would typically involve training and education on technical aspects of the implemented technologies, but also building awareness of the importance of user feedback and support to the achievement of sustained system use. Capacity building would allow local institutions to strengthen the relationship among all stakeholders involved through the improvement of communication channels, as well as to improve cross-institutional cooperation and other types of partnership with local and non private enterprises to improve maintenance and monitoring of the systems (Richards, 2010). For users, routinely conducted education and training would in the long-term improve recipients' perceptions of a technology and influence the core ideas and beliefs at the basis of their acceptance and use of WATSAN technologies.

Education and capacity building activities should be accompanied by performance incentives, expedients and rewards to foster use and management of WATSAN technologies (Evans and Trémolet, 2010). The importance of financial and other type of marketing incentives at household and community levels in improving the sustainability of WATSAN technologies has increasingly been recognised by academic circles (Jenkins *et al.* 2010). On a similar basis, performance awards for local and district governments have been successfully implemented in India and Bangladesh for those authorities who reached the stated targets.

Finally, these interventions should take place in an appropriate legal and regulatory environment (Rotschild, 1999), where responsibilities for monitoring and maintenance of WATSAN technologies are spelt out and their compliance is enforced by law; and representation of users is recognised as essential steps to improve technology performance.

Table 8-1 Remedial actions identified

Sphere of intervention	Remedial actions CASE STUDY II DEWATS	CASE STUDY III SODIS and AQUATAB	Stakeholders involved
Monitoring	• Regular collection of information on the technology performance based also on feedback from users. • Monitoring of administrative and organisational issues within the communities (fee payment). • Monitoring of environmental and health and hygiene conditions.	• Provide monitoring schemes for water quality, which comply with regulatory standards. • Monitor pattern of use of technologies within villages. • Appropriately monitor diarrhoea incidence within villages.	Local government Private sector Health clinics and local government.
Technical and other types of assistance	• Generate small-scale O&M organisations operating on city basis, by involving the private sector or community-based facilitators. • Assistance with application and interpretation of developed regulatory standards.	• Provide financial assistance through public funding or micro-credit to villages. • Assistance with interpretation of developed regulations for water quality standards.	Local governments, member of NGO and private enterprises
Coordination and facilitation	• Facilitate communication between stakeholders involved. • Increase coordination among community based organisations (CBOs) to increase representation vis a vis local government and NGOs.	• Generate village water committee and organisations to represent households and gather informal feedbacks. • Facilitate public-private partnership between local institutions and private enterprises.	Key promoter from the local government and the communities. Implementing agencies
Training and education	• Routinely undertake training, hygiene promotion within communities. • Use formal educational channel to such as schools to deliver relevant messages for the technology.	• Focus training and educational activities on people responsible for preparing SODIS and AQUATAB (i.e. women). • Training of health operators and local governments in providing adequate messages to users. • Link training activities to messages that prioritize user agendas for adoption.	Implementing agency Local governments Donor agencies
Incentives	• Generate awards and prizes for communities based on the performance of technologies. • Development of performance awards for local governments, on which assessing donor's funding activities.	• Generate motivational inputs to sustainably use and maintain the technologies. Link technology to marketing options that foster willingness to adopt the technology (technology vouchers). • Generate village awards and prizes whose performance is measured on use and public health status.	Local government, NGO, National government, donor agencies,

8.4 The usefulness of the RECAP tool in post-implementation evaluation

The development of RECAP tool was prompted by the heuristic goal of exploring and understanding reasons at the base of the scarce success of WATSAN intervention in developing countries (discussed in Chapters 1 and 2). The discussion of results from CS-II and CS-III, provided in Section 8.3, has demonstrated that RECAP post-implementation diagnostic assessment can detect discrepancies between intended technology performance and user experiences, to generate a better understanding of the match between objective and outcomes and support design of remedial interventions at a stage of technology deployment where change is still possible.

As illustrated in this study, the optimal use of RECAP assessment is in early post-implementation stage, when diagnosed problems can still suggest timely solutions, which can be fed back to users and providers. Nonetheless, as discussed in Chapter 5, a RECAP assessment can provide useful results if performed in ex-ante evaluations, by comparing and contrasting recipients' and providers' needs; and ex-post assessment to initiate a process of learning based on identified reasons of success or failure. Secondly, a RECAP assessment exposes stakeholders' agendas for implementation and use of the technologies, to compare and contrast against their stated reasons and priorities. The tool uses the lay language of its units of investigations (i.e. users), thus exposing their problems and identifying potential solutions. Finally, RECAP does not focus on a single indicator, rather it encompasses a holistic approach investigating and evaluating all attributes related to the technologies. The clear and simple methods for gathering information enhance the use of the RECAP tool by several stakeholders, and increase its adaptability to evaluate different phenomena.

A comparison of the RECAP tool with existing approaches developed to improve WATSAN technology transfer interventions enables highlighting of some of its strengths and weaknesses. Firstly, one of the main strengths of the RECAP assessment rests on its multidimensional character and thus its departure from mere *technocentric* approaches to technology evaluation discussed in Section 5.2 (See Harvey and Drouin, 2006). In the RECAP assessment, the investigation of stakeholders' feedback by qualitative methods (i.e. in-depth interviews) provides the opportunity to scan for problems and generate feedback from multiple perspectives. Reported feedback of problems may be not only of technical nature, but also of social, economic, or cultural relevance. Thus, the RECAP tool allows a more comprehensive evaluation of WATSAN systems than engineering-focused frameworks, which still largely characterise the technology assessment sector (Palm and Hansson, 2006).

However, despite enabling a comprehensive approach to technology evaluation, a RECAP assessment may provide a less specific appraisal than those technology evaluation approaches based on single technological dimension, such as economic analysis or technical assessment (i.e. Von Münch and Maymbelo, 2008). Single-dimension assessments may provide more in-depth and focused appraisals of the systems investigated, whilst a RECAP evaluation has the potential to lead to a superficial investigation of the problems, it being based on stakeholders' knowledge of the technology's attributes and problems.

A second strength of a RECAP assessment relates to its use in the early post-implementation stage of WATSAN technology transfer. The focus on the post-implementation stage enables exploration of problems that may undermine sustained technology use and compromise the success of WATSAN interventions. Furthermore, the deployment of the RECAP tool in the post-implementation stage does not contradict previously conceptualised pre-implementation approaches (i.e. social marketing or CVM, discussed in Section 2.4), rather it complements them in the attempt to improve progress towards MDGs Target 10. For instance, the RECAP tool can be deployed to explore the determinants for behavioural change, by investigating the correspondence between recipients' intentions and willingness to pay and/or use a technology, typically measured with CVM methods (Whittington *et al.,* 1990; Altaf, 1994) and their actual behaviour in the post-implementation phase. Similarly, a post-implementation evaluation based on the RECAP tool can assess the efficacy of promotional WATSAN interventions advocated by the social marketing school (Jenkins and Curtis, 2005; Jenkins and Scott, 2007), by exploring variations of users' experiences and perceptions of the technology adopted.

8.4.1 Assessment of the RECAP tool

Having summarised the most important aspects of the RECAP tool, an appraisal of the tool itself is provided against the criteria of suitability, (i.e. the ability to adequately reflect the real meaning of the concept under consideration); reliability (i.e. the ability of a technique applied repeatedly to the same object yields the same result each time); and flexibility (adaptability and use in different context) (Babbie, 2001). Although a discussion of validity and reliability of this research was provided in Chapter 3.8, this section exclusively focuses on the RECAP tool, by assessing its value against the above-mentioned criteria. The RECAP tool evaluation was conducted through guidance provided by Department of Employment and Training from the State of Queensland, Australia (2004). These guidelines contain several types of information concerning the design of methods for evaluation as well as modes for conducting appraisal of assessment tools. A template provided by the Bremer Institute of TAFE of Queensland government of Australia was employed to undertake the RECAP assessment illustrated in Table 8-2.

The RECAP tool proved to be a suitable and robust instrument to adequately report and evaluate the phenomena under investigation. The tool allowed the assessment of real-life experiences of WATSAN technologies in the developing world and the evidence gathered directly by the researcher to be related to learning outcomes being assessed. Secondly, multiple sources of evidence were adopted by deploying the RECAP assessment to both water and sanitation as well as household and community-level technologies. Finally, the design, method and compliance with ethical requirements of the RECAP tool were validated by members of Cranfield University with expertise in the competencies being assessed, as well as by executers of the assessment in the field, with strong experience in the water and sanitation sector. To ensure the reliability of the RECAP tool, a booklet providing guidance on how to conduct a RECAP assessment (provided in Appendix II) was prepared and followed during investigation of CS-II and CS-III. Furthermore, the RECAP booklet provides a step-by-step guide on how to develop questionnaires and presents detailed checklists for choosing sampling and investigation methods, based on descriptions of advantages and disadvantages of the available techniques. This information, presented in a simple and clear manner, allows a consistent use of the tool by assessors from different backgrounds. Finally, the RECAP tool proved to be a highly flexible and adaptable instrument to diagnose problems with WATSAN technologies in the post-implementation stage, being applicable to different types of WATSAN technologies and adopted by a variety of fieldworkers.

Table 8-2 Suitability, reliability and flexibility of the RECAP tool

SUITABILITY	**Comments**
The assessment guided by the RECAP tool is based on realistic activities.	• The RECAP tool was tested in two case studies assessing WATSAN technologies implemented in developing countries. • The assessment was conducted to explore users and providers' agendas in order to answer the research questions guiding this study (Chapter 5-5)
More than one source of evidence is used as the basis for the assessment.	• The assessment was deployed in multiple case studies to investigate both water and sanitation technologies at community and household level.
Evidence is drawn from a variety of performances over time, where practical.	• Lack of time and resources prevented the possibility to conduct longitudinal assessments of the same case studies.
Agreement by the community on meanings and concepts of the RECAP tool is obtained.	• Methods and processes for RECAP assessment were peer-reviewed by academic staff at Cranfield University. • Evaluation of the applicability of the RECAP tool were undertaken with members of staff of the NGOs were the assessment was conducted.
RELIABILITY	**Comments**
Consistent instructions and procedures for undertaking the RECAP assessment are prepared for use by assessors.	• The RECAP assessment booklet (Appendix II) presents step-by-step guidelines for using RECAP tool in the field, providing instructions in a clear and understandable way.
Where units of analysis are to be assessed in different situations, the situations are generally comparable.	• The RECAP tool was designed to assess WATSAN technologies in a developing country context. Comparison between community sanitation and household-level water treatment technologies was proved to be possible.
FLEXIBILITY	**Comments**
The RECAP assessment can be adapted to meet the needs and backgrounds of all evaluators.	• The RECAP tool was designed for use by stakeholders from different backgrounds: field-personnel working in the WATSAN sector, NGO members; academic researchers; technology trainers and customer satisfaction groups.
The RECAP tool can be adapted to evaluation of several phenomena.	• The RECAP tool shows high flexibility in the appropriate methods for data collections, increasing its applicability to several phenomena under investigation.

Source: Adapted from Bremer Institute of Tafe, Queensland government of Australia.

To conclude, an overall evaluation of the RECAP design and application was conducted to highlight its strengths, weaknesses, opportunities and threats by means of a SWOT analysis. The SWOT analysis, whose development is credited to Albert Humphrey's research on long-term planning processes of companies (Morrison, 2008), is a useful management tool with numerous applications in the fields of strategic planning, problem-solving and product evaluation. Besides its extensive use in the business and organisational field (Houben *et al.*, 1999; Ling and Gui, 2009), SWOT analysis evaluations have been undertaken in the sectors of waste management (Srivastava *et al.*, 2005); natural resource planning (Terrados *et al.*, 2007); and knowledge management (Gill, 2009), among others. In this study a SWOT analysis was performed to evaluate the design and application of the RECAP tool and stimulate strategic thinking for further improvement. A SWOT analysis is characterised by four components:

- *Strengths* are positive tangible and intangible attributes, internal to an organization or pertaining to a product, which facilitate the achievement of the intended goals and/or purpose.

- *Weaknesses* are intrinsic characteristics of a product, project and organisation, which undermine the ability to achieve the intended goals and/or propose.

- *Opportunities* are external opportunities that may arise when changes occur in the external environment.

- *Threats* are external risk factors that may arise when changes occur in the external environment.

Drawing on the above provided description of SWOT analysis components, a set of questions was developed to identify and discuss the strengths, weakness, opportunities and threats of RECAP tool and its deployment. The questions adopted are illustrated in the worksheet presented in Table 8-3.

Table 8-3 SWOT analysis worksheet

Factors	Questions
Strengths	• What are the main advantages of the RECAP tool, its design and application? • What other forms of interventions could the RECAP tool assess?
Weaknesses	• What are the main disadvantages of the RECAP tool design and application? • How could the RECAP design and application be improved?
Opportunities	• What are the beneficial aspects derived from the application of the RECAP tool to WATSAN technologies? • What important trends are identified? • Does RECAP allows to identify and suggest changes related to improvements of WATSAN technology acceptance and sustained use?
Threats	• What obstacles the application of RECAP assessment may face? • Do stakeholders and assessors show interest in RECAP assessment?

The sources of information to answer the questions (outlined in Table 8-3) were collected throughout this research from several activities. These are the following:

- Researcher's first-hand experience of implementing the RECAP tool in CS-II and CS-III.

- Discussion with peers and supervisor throughout the process of RECAP conceptualization and design.

- Informal discussions with RECAP assessment executors in the field and conversation with local NGOs (Borda and DianDesa).

Based on this information, a SWOT analysis of the design and deployment of the RECAP tool is provided in Table 8-4.

Table 8-4 Swot analysis of the RECAP tool

	Internal factors		
Positive aspects	**STRENGTHS** • Entails a simple designed assessment can be conducted by several actors: field-personnel working in the WATSAN sector, NGO members; academic researchers; technology trainers and customer satisfaction groups. • Flexible tool applicable to both water and sanitation, and community and household technologies. • Potentially applicable, upon adaptation, to the assessment of interventions in other sectors.	**WEAKNESSES** • The availability of a broad spectrum of stakeholders is needed. • Requires a correct identification of appropriate time frame to timely provide solutions based on the identified agendas. • Suggests agendas for change but does not guarantee that these are transformed into interventions.	*Negative or potentially negative aspects*
	OPPORTUNITIES • If appropriately conducted RECAP assessment allows a timely identification of problems, which undermine sustained technology use. • Problem identification stimulates strategic thinking and design of remedial interventions. • Easily understood by assessors and NGOs in the field.	**THREATS** • Institutional members may show resistance to an evaluation of their competencies, skills and agendas.	
	External factors		

The main strength of the RECAP tool rests in its simple and straightforward design, which can be understood and applied by a variety of stakeholders and to several types of technologies. This research has demonstrated that a RECAP assessment can be successfully used to investigate both water treatment point of use and community-based sanitation systems. Furthermore, the simple and flexible design of the RECAP assessment can facilitate its deployment to diagnose other forms of interventions, where a comparison between its performance and the recipients' experience is possible. To this respect the identification of two groups of stakeholders (providers of a project, policy and intervention and its recipients) would be the essential requirement for deploying a RECAP assessment to other sectors. Thus, upon appropriate modification of its design (i.e. the elicitation methods), a RECAP assessment could potentially be deployed to diagnose policy implementation, educational, pricing and capacity-building interventions. A further strength of the RECAP tool rests in its multi-stakeholder approach that identifies discrepancies in the process of technology implementation. Although studies concerned with acceptance of WATSAN technologies exist in the literature (Mukehli *et al.,* 2002; Harvey and Reed, 2007), the RECAP tool provides an opportunity to investigate both users and providers, and by comparing and contrasting their agendas, the assessment allows the timely identification of challenges that may undermine the impacts of the implemented technologies. By focusing on users' feedback it also enables new awareness of users' priorities, which are fundamental to shaping the agenda for sustained technology use in context specific interventions. Finally, evidence from the deployment of the RECAP assessment in the field proved that the tool was easily understood by the fieldworkers who conducted the evaluation. The workshop conducted by the researcher to explain the purpose and structure of the RECAP assessment were easily understood by interpreters and field workers with different backgrounds and experiences. Similarly, the local NGOs showed appreciation for the RECAP assessment and recommended its deployment by external evaluators.

The identified weaknesses of the RECAP tool and its application include the need to involve a broad spectrum of stakeholders (ideally, local governments, technology designers, donors) who can inform the debate over challenges to technology longevity. This may constitute a limitation to performing a RECAP assessment, when scarce willingness to participate is shown by stakeholders. An additional weakness of the RECAP tool relates to the importance of conducting the assessment when the timing is still appropriate to apply the interventions identified. As discussed in Chapter 5, although a RECAP assessment may be deployed in ex-ante and ex-post evaluations, it produces its most effective results when problems are identified before technologies are abandoned or misused. A suggested approach to overcome this limitation consists of routinely conducting RECAP assessments to investigate the emergence of unforeseen problems, when is still possible to develop remedial interventions. Furthermore, incorporating a RECAP assessment in systematic project evaluation routines would significantly improve assessors' ability to swiftly identify problems by gathering a comprehensive picture of the project performance. Finally, an identified threat to using the RECAP tool is the potential resistance encountered by evaluators and caused by some groups of technology providers (i.e. the local authorities), who may feel challenged by an assessment of their skills and competencies relating to the implementation of a WATSAN technology.

CHAPTER 9: CONCLUSIONS

9 CONCLUSIONS

The scant and unsustainable progress achieved after decades of interventions in the WATSAN sector suggests that to effectively channel the financial and institutional efforts to meet the MDG Target 10, assessment of WATSAN technologies must go beyond the coverage goal and focus on aspects which might undermine or facilitate sustained use (Carter *et al.,* 1999; Montgomery *et al.,* 2009). This study has demonstrated that challenges to the achievement of sustained system use rest on features of WATSAN technologies which often emerge in the aftermath of their introduction and are therefore difficult to anticipate and tackle.

Recalling Easterly's (2006: 5) comparison between the "Searcher and the Planner's" approach to development which introduced Chapter 1, this research has shown that finding individual answers to individual problems by a process of trial and error is paramount to progress towards the MDG Target 10. Past experience taught that imposing blue-print solutions to WATSAN implementation does not drive to the sustained use of the systems, and, this study shows that routinely evaluating problems, assessing users feedbacks and discussing agendas for change may lead to propose interventions and improvements to WATSAN technology use. Thus, evolving mechanisms based on stakeholder feedback are necessary to explore and assess case-specific problems in the post-implementation stage, identify challenges and provide the necessary support. To this end, this study aimed to answer the following research questions presented in Table 9-1.

This final chapter begins by examining the key findings in the light of the research questions and objectives guiding this study (Section 9.1). The implications and practical recommendations, which arise from the study are highlighted in Sections 9.2 and 9.3, respectively. Finally, Section 9.4 highlights the limitations of this study.

Table 9-1 Research questions and objectives

	Research Questions	Research Objectives
RRQ1	What is the nature and extent of variation between the designed, anticipated, and experienced attributes of WATSAN technologies in developing countries?	• To explore discrepancies emerging between intended performance and experience of WATSAN technologies in the post-implementation stage. • To investigate the nature of the identified discrepancies between providers and users of WATSAN technologies in developing countries.
RRQ2	What can early post-implementation evaluation tell us about the failings of WATSAN technology interventions in developing countries?	• To understand the processes and dynamics affecting WATSAN technology acceptance, use and sustained use in developing countries.
RRQ3	How can early post-implementation evaluation be used to improve the impact of WATSAN technology interventions in developing countries?	• To develop a valid, reliable and replicable approach to diagnose challenges to technology acceptance and sustained use.

9.1 Key findings

Based on this study's findings three main lessons can be drawn for the current and unsolved theoretical debate of improving WATSAN interventions in developing countries.

Identified discrepancies between WATSAN technology intended performance and experience

The deployment of post-implementation diagnostic assessments based on the RECAP tool allowed the exploration and diagnosis of emerging challenges in the form of discrepancies between the intended performance and users' experience of WATSAN technologies. These challenges lie in the aftermath of technology implementation, and emerge irrespective of the degree of recipients' engagement achieved through participatory planning and decision-making processes. These discrepancies, which are typically of non-technical nature, relate to scarce identification and allocation of responsibilities among the stakeholders involved for the management of emerged problems and maintenance of the status quo. Furthermore, communication failures among stakeholders proved to be a crucial challenge to technology effectiveness as users' feedback and agenda for change are not exposed for discussion and evaluation. Although responsibilities to improve technologies performance are best sourced from users, institutional mechanisms should be created to allocate responsibilities with a balanced combination of capacities and resources from the local institutions and users.

Diagnosis of failures of past WATSAN interventions

The RECAP tool enables to explore some of the underlining causes of scarce success of WATSAN interventions. Past approaches to WATSAN technology transfer, based on supply-driven schemes and scarce participation from recipients, failed to generate successful solutions and long-term sustained technology use. Against this background demand driven approaches, emerged as a reaction to top-down strategies to WATSAN technology implementation, have demonstrated that involving and engaging users in planning, decision making and implementation activities can create ownership for the technologies transferred.

This study substantiates the alleged effectiveness of Demand Driven Approaches, simultaneously warning against the risk of their main limitation, which may lead to providers' disenfranchisement from their responsibility for WATSAN technology sustainability. In this sense demand driven approaches are not sufficient to guarantee the success of the WATSAN technologies transferred. User engagement and empowerment does not automatically translate into a responsibility for using and continuing to use the systems (Harvey and Reed, 2007). A greater effort must be undertaken by international donors, local governments and implementing agencies to support users in the post-implementation stage, through monitoring and evaluating their experience with the implemented systems. Furthermore, a greater cooperation based on information sharing, communication and user representation must be established in the post-implementation stage to ensure that challenges diagnosed are swiftly addressed and mitigated.

The value of early post-implementation evaluation in improving impacts of WATSAN technologies

An early post implementation assessment based on a RECAP tool may significantly improve impacts and long-term use of the technologies. By investigating stakeholders' agendas for use and implementation an early post-implementation assessment can diagnose potential problems that are difficult to forecast in the planning and pre-implementation stages of technology transfer. The adoption of providers and users' lay language to identify context specific problems and priorities enables to plan potential solutions, which are understood and requested by the stakeholders involved. This characteristic of RECAP assessment represents an important element of strength of the approach developed. Furthermore, the early identification and diagnosis of problems allow to design, discuss and adopt new solutions and interventions based on the priorities and urgencies identified. If appropriately managed, an early post-implementation assessment based on the RECAP tool can provide evaluators with feedback from both recipients and providers that not only support the framing of future interventions, but also enhance users' acceptance and adoption of the technologies.

9.2 Implications for future research

This study's findings highlight a number of topics for further investigation. This research has developed and tested a diagnostic tool for exploring and evaluating the nature of post-implementation challenges to WATSAN technologies. By utilising repeated assessments of WATSAN technologies, this study admittedly reported only snapshots of the evolving nature of the post-implementation challenges in the cases investigated. Thus, a first line of inquiry relates to further test the RECAP tool and its design, by deploying the assessment for a prolonged period of time. Furthermore, the application of RECAP in different settings, timeframes and by different stakeholders would further corroborate the validity, reliability and flexibility of the approach developed and the findings obtained. A related topic for investigation is the application of RECAP in cross-longitudinal studies in ex-ante, medium term and ex-post evaluations to compare and contrast nature and variations of the identified discrepancies and improvements made. This would allow investigators to track the implementation of the advanced suggestions for improvements and the implication on the technology effectiveness.

A second line of inquiry researchers are encouraged to build capacities of evaluators from development and local implementing agencies and other stakeholders groups to deploy RECAP assessments. This activity would require the researchers' in depth understanding of the mechanisms at the basis of RECAP assessment and ability to transfer knowledge and messages to other assessors. The incorporation of RECAP assessment into routinely conducted procedures of monitoring and evaluation would enable evaluators to diagnose challenges to the implemented WATSAN technologies at their onset.

The above-described lines of inquiry drive to a final implication for future research. This relates to the exploring existing mechanisms and formulating novel approaches to appropriately channel the gathered feedbacks from providers and users and frame them into empirical interventions that support the sustainability of the technologies investigated. Researchers are encouraged to consolidate existing or explore new strategies that foster dialogue and communication among all the stakeholders involved in the process of technology transfer and implementation.

9.3 Implications for the international development community

By highlighting the importance of early-post implementation assessment to diagnose problems with WATSAN technologies, this study's findings bring some practical implications for the international development community.

International donor agencies should strengthen strategies that prevent, identify or correct potential challenges to sustained technology use in the post-implementation stage. This may involve the establishment of constant and comparative evaluations, based on feedback from users and providers, as well independent forms of verification upon which developing funding options. The adoption of output-based funding schemes, to distribute resources to NGOs and governments on the basis of the achieved goals and other type of performance based incentives are fundamental to ensure a constant and sustained progress.

Furthermore, the international donor community should ensure that sufficient financial efforts are provided for building capacities of governments, local institutions and implementing agencies to develop database for gathering information and output of evaluations. This would facilitate the comparison among and within countries and would enable the planning future activities. Programmes that facilitate the development of partnerships between local governments, implementing agencies and private sector should be fostered to generate a diversified pool of skills and resources to provide monitoring and assistance to communities and households.

Finally, and more importantly, a greater awareness must arise among international donor communities, national and local governments and technology designers on the importance of giving “voice” to WATSAN technology users (Hirschmann, 1970). User feedback must be valued for being a fundamental instrument to improve the success and the effectiveness of the impacts of WATSAN implemented, as well as increasing accountability for interventions.

9.4 Study limitations

This study adopted a multiple case study approach to test the development of RECAP as a diagnostic tool. Thus, limitations related to case study research design must be taken into account when evaluating the findings of this research. Case study results are limited in their ability to develop generalisation applicable to all WATSAN sector interventions. In order to minimise the limitations of a case study approach, the RECAP tool was tested in the course of fieldwork investigations on two different types of WATSAN technologies (water versus sanitation and communal versus household level systems). Testing the RECAP tool on two different types of technologies allowed the strengthening of its validity, they would have been further improved if explored in other contexts and countries.

A second limitation to this research relates to the practical application of RECAP. Although the RECAP assessments were executed in the field by interviewers supervised by the researcher, time and resource constraints did not allow for RECAP to be independently tested and applied by other researchers and assessors in the field. The deployment of a RECAP assessment by other assessors would have allowed a peer-review of the tool’s features and usability, thereby identifying weaknesses in its application which may have not diagnosed by the developer. Thus, a third party application of the RECAP tool could have suggested further development of the approach and strengthened its validity, reliability and flexibility.

A final limitation to this study relates to the role of the researcher and the ability to understand reality and interpret findings which are embedded in a different culture and social context. The impossibility, due to time and resource constraints, of becoming immersed in the life of the investigated subjects for a prolonged period of time may have undermined the researcher's ability to fully capture relevant cultural meanings. To overcome the cultural barriers imposed to a research activity conducted in developing countries, all questionnaires were discussed with members of the implementing agencies and questions were translated by professional interpreters and crosschecked for validity by English-speaking members of the NGOs. Furthermore, responses from questionnaires were discussed with members of the implementing agencies to clarify meanings and messages.

9.5 Thesis contribution to knowledge

This thesis has illustrated and justified the importance of focusing on stakeholders' perceptions and experiences in the post-implementation stage of WATSAN interventions. Whilst the majority of approaches to WATSAN technology transfer (discussed in Chapter 2) have typically focused on planning and pre-implementation phase (i.e. social marketing and CVM methods), this study recognizes that sustained technology use rests on features of WATSAN technologies emerging in the post-implementation stage, which are difficult to anticipate and tackle. Through a post-implementation diagnosis of challenges related to technology use, this research has generated a greater awareness of the dynamics and problems, which may undermine system longevity in the aftermath of its implementation, when assistance has left. This finding marks a significant contribution to the intellectual efforts to improve WATSAN technology transfer in developing countries. Building upon the pioneering work of Carter *et al.* (1999) and this thesis has extended it by developing a flexible and replicable tool that allows the investigation of potential emerging challenges and the subsequent generation of corrective mechanisms.

Furthermore, by focusing on the feedback of stakeholders involved in the process of technology implementation, this study has brought to the attention of the academic community the important aspects of accountability and monitoring. Whilst few studies have warned against the effects of lack of accountability on the sustained use of implemented WATSAN technologies (Abrams, 2001; Harvey and Reed, 2007), no contributions have spelt out mechanisms capable of investigating and determining responsibilities for maintenance and management of WATSAN technologies. To this respect, this research has provided an element of novelty, by showing the importance of bridging the gap between providers and users of WATSAN technologies as a fundamental step for system longevity. Similarly, the recognition of the importance of monitoring mechanisms and the provision of a flexible and simple tool to identify aspects of technology use to be monitored represents a novel approach to tackle the post-implementation challenges discussed in the literature (Carter *et al*., 1999; Harvey and Reed, 2007; Ademiluyi and Odugbesan, 2008) and illustrated in Section 2.5.3.

Finally, the adoption of a gap analysis approach to investigate the discrepancies between intended performance and users' experiences introduces a novel perspective to evaluate WATSAN technologies. Firstly, it demonstrated the application of Service Quality approach to explore issue in the WATSAN sector, secondly shift the focus of attention to technology evaluations based on human dimensions of the systems. Whilst the majority of approaches of WATSAN technology assessment are still inherently focused on technical and engineering aspects of the systems (i.e. Harvey and Drouin, 2006), the deployment of the RECAP tool in CS-II and CS-III clearly illustrates the usefulness and importance on focusing on stakeholders' feedback and perceptions to identify emerging problems with the technology, thus marking a novel contribution to assess the success of interventions in the WATSAN sector in developing countries.

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APPENDIX I-CASE STUDY I

Community Ablution Blocks in Durban, South Africa

This Appendix presents the following information:

A. Questionnaires employed for Case Study I interviews with users and predicted users

B. Operational checklists of inspected facilities

C. Data analysis

D. Background documentation

A: Questionnaires

Questionnaire guidelines

1. A copy of these guidelines should be provided to each interviewer.
2. Interviewers should introduce themselves and anyone else with them. They should briefly describe their background and the purpose of the survey. Interviewers should provide their contact details for participants to gain further information.
3. Principals of ethical research are to be followed. Interviewer should read the "Statement on ethical research practice and data protection".
4. Respondents should be informed of the purpose of the interview: an information sheet, should be provided to the community and a copy of it should be left with community leader.
5. The interviewer must be able to answer YES to the following statements:

CHECKLIST	TICK IF YES
This survey is conducted with informed consent of respondent	
Confidentiality will be preserved (participant's identity is unknown)	
Participant is informed of the purpose of the interview	
Participants will be informed of outcomes, subject to requirements of confidence	
Data from the project will be securely stored and retained for at least 5 years	
Researcher's contact details are provided	

Questionnaire Instructions:

- The Interview must be conducted face-to-face with respondent.
- The interviewer should read the questions out and record them on the questionnaire sheet.
- Should the interviewers wish to ask additional questions, they will have to contact the questionnaire designer.
- Some of the questionnaire answers require a further explanation, therefore interviewer will have to ask the question "nr E" next to respondent's answer, where applicable.

E.g. 1: Do you use CAB?

A: Yes
B: No →1.1: Why?

QUESTIONNAIRE for CAB A and B	
Interviewer name: **Date of interview:** **Interview Area:** **Consent given: yes □ no □**	
1.	**Do you use the CAB installed in this area?** A. Yes B. No→ **1.1 Why?** → **1.2 What alternative means (practice) do you use?**
2.	**Did you start using CAB immediately after it was built?** A. Yes B. No→ **2.1 Why?** C. Other, please specify
3.	**How many times per day do you use the facility to do:** A. Fetching water………………………………. B. Laundry………………………………………. C. Washing up………………………………….. D. Shower……………………………………….. E. Personal matters …………………………….
4.	**Did you or anyone in your family receive any training on how to use maintain CAB?** A. Yes→ **4.1 Who provided it?** B. No C. I do not know
5.	**Whose advice on how to use and maintain CAB you trust most?** A. I trust only my self B. The municipality C. Neighbours D. Family members that already experienced it E. Other (please specify)
6.	**Have your habits changed since when CAB has been installed?** A. Yes→ **6.1 In what way?** B. No C. I do not Know
7.	**Do you have to pay for using the CAB?** A. Yes→ **7.1Who do you pay?** →**7.2 How much do you pay?** B. No C. I do not know
8.	**Is the caretaker always available, day and night?** A. Yes B. No C. I do not know
9.	**If the caretaker is not available what do you do?**
10.	**Have you ever had /are you experienced any problem with CAB?** A. Yes B. No C. Other, please specify

11.	**If you answered A in the previous question, please circle the problems you have experienced.** A. Odour/smell B. Difficulty to use/adopt C. Lack of privacy D. Distance from my house E. Lack of cleanliness F. Diseases caught by use G. Lack of safety H. Other, please specify
12.	**How often have the problems been occurring?** A. Always B. Most of the time C. Some times D. Never
13.	**Generally, do you consider CAB positive for you and your family?** A. Yes→ **13.1 Can you explain?** B. I do not know
14.	**Who fixes the technology when it breaks down?**
15.	**In case of breakage what do you do?** A. I inform the caretaker B. I call municipality C. I do nothing, I use alternative means D. I do not know E. Other, please specify
16.	**Do you think CAB could be improved?** A. Yes→ **16.1 Can you describe how you would improve it?** B. No C. I do not know
17.	**Have you ever found materials other than toilet paper inside the toilet?** A. Yes→ **17.1 What?** B. No C. I do not know
18.	**Can you find soap at the facility whenever you needed it?** A. Yes B. No C. I do not know
DEMOGRAPHIC DATA	
A.	**Gender**
B.	**How many people live in your dwelling during the week?**
C.	**How many of these are children?**
D.	**How many people live in your dwelling during the week end?**
E.	**Are you or any member of your family employed?** A. Yes B. No C. Other (please specify)
F.	**If yes, please indicate your job**
G.	**How much per month does your family spend on food?**
H.	**Respondent's ethic origin**

The following questions were asked on behalf of the municipality and not used for analysis:

1.	**Do you need a key for the Ablution Blocks?** A. Yes B. No
2	**If you have children, where do you change their nappies?**

QUESTIONNAIRE for CAB C	
Interviewer name: **Date of interview:** **Interview area:**	
1.	**Are you aware that a CAB is going to be introduced in your area?** A. Yes B. No→**1.1 What do you use for sanitation purposes?** →**1.2 Are you satisfied with what you are using at the moment?** →**1.3 What aspects will prevent you from using the facility?** C. I do not know
2.	**For which purpose will you be using the CAB? Circle if appropriate** A. To do laundry B. To Shower C. To Wash up D. For personal matters (toilet) E. Other, please specify F. I am not sure I will use it
3.	**If you answered F., can you explain?**
4.	**Have you already received any demonstration on how to use/maintain CAB?** A. Yes→ **4.1 Who provided the training?** B. No C. I do not know
5.	**Whose advice on how to use and maintain CAB would you trust most?** A. I trust only my self B. The municipality C. Neighbours D. Family members that already experienced it E. Other (please specify)
6.	**How will your habits change with the introduction of CAB?**
7.	**Will you be willing to pay to use the facility?** A. Yes→ **7.1 How much?** B. No C. I do not know
8.	**Do you know who the caretaker is going to be?** A. Yes→ **8.1 How has it been appointed?** B. No C. I do not know

9.	**Do you think CABs will bring benefits to you and to other people in your family?** A. Yes→ **9.1 Which ones?** B. No C. I do not know
10.	**Do you think you will be able to use the facility whenever you want?** A. Yes B. No→ **10.1 What kind of restrictions do you think you will experience?** C. Other, please specify
11.	**Do you think you will still be living here and using CAB in five years time?** A. Yes B. No C. Other, please specify
12.	**In case of breakage of the CAB what would do you do?** A. I inform the caretaker B. I call municipality C. I do nothing, I use alternative means D. I do not know E. Other, please specify
13.	**Overall how would you describe your feelings towards receiving anew facility?** A. I am very happy B. I am neither happy or unhappy C. I am unhappy D. I do not know
14.	**In case you answer C, can you explain?**
	DEMOGRAPHIC DATA
A.	**Gender**
B.	**How many people live in your dwelling during the week?**
C.	**How many of these are children?**
D.	**How many people live in your dwelling during the weekend?**
E.	**Are you or any member of your family employed?** A. Yes B. No C. Other (please specify)
F.	**If yes, please indicate your job**
G.	**How much per month does your family spend on food?**
H.	**Respondent’s ethic origin**

STATEMENT ON ETHICAL RESEARCH PRACTICE AND DATA PROTECTION

Statement on the conduct of research in an ethical and responsible manner

1. *Ethical responsibilities with regard to survey participants*

   - Research participants will explicitly agree to take part in the study and will not be forced to participate or misled so as to gain their consent. Participants will be made aware of the objectives of the study, who is funding the project, and what will be done with the information provided. Participants will be informed of their right to withdraw from the activity at any time.

   - Participants will be provided with the necessary information about what they are expected to take part in so that they can make an informed decision on whether to participate or not.

   - The researchers, to the best of their ability, will ensure that no harm will be done to the respondent due to their participation in the survey.

   - The personal identifiers (name, email/address) of participants, if willingly disclosed, will not be divulged to a third party unless agreed to by the participant. The anonymity of the participants within the thesis, reports or any other publication arising from the research will be maintained.

2. *Ethical practice with regard to the scientific community, colleagues, sponsors and the general public*

   - Scientific community and colleagues. A proper acknowledgement of the contributions made to the research from other sources will be referred to as appropriate. Sufficient information on the research will be included in the details so that other researchers can properly evaluate and if required, replicate the work.

   - Sponsors. The research sponsors and their involvement in the research will be included.

   - General public. Sufficient information will be given so that the findings are not misleading. Readers will be provided with details on the methods used, how the data collection and sampling were carried out and analysis of the data.

Statement on appropriate management of survey responses under the Data Protection Act 1998.

1. *Storage*

Access to any electronic data generated by the research activity will be password protected and securely stored. Any printed paper copies of the data held by the researchers will be ensured the equivalent level of security.

2. *Usage of the collected data*

Confidentiality will be maintained as far as possible, so that the interests of the individual respondents are protected. No respondent will be individually identified in the resulting thesis or associated reports and publications. The researcher however, cannot be held responsible for any participants that freely choose to reveal their participation in the survey.

3. *Dissemination of survey results to respondents*

If respondents express an interest in receiving the final survey results then this will be made available to them.

Fieldwork information sheet

Fieldwork Title: Investigating users' acceptance and experiences of Community ablution blocks in Durban, South Africa.

Introduction:

My name is Elisa Roma and I am a PhD student from the Centre for Water Science of Cranfield University in the United Kingdom.

Aim: The objective of this investigation and of interviewing process is to understand what are the challenges, problems or facilitating aspects involved in the process of adoption and used of sanitation technologies. The research adopts interviews conducted by two Zulu translators from the University of KwaZulu-Natal with people from your community who are using or used the CABs.

This investigation, which will be conduced in other countries has the purpose of initiating a process of understanding of technology transfer and adoption based on a focus on users' perspectives and opinions. This project has received ethical approval from the Cranfield University Ethical Research Committee.

I would like to ask you for your voluntary cooperation in (1) answering various questions pertaining to the systems used. I would like to request the use of this information in my study. Your community contribution to this project is extremely important since your opinions and ideas are fundamental to diagnose problems and develop potential solutions, which are based on your needs.

Please feel free to contact me if you have questions or would like further information regarding this study, I can be contacted via:

Email e.roma@cranfield.ac.uk

Tel: +44 (0)1234 750111 ext 333

Mobile: SA: +27 0716 21 79 81

or/

Translators' name and contacts address

Thank you for your time and participation.

Elisa Roma

B: Operational checklists

Table A1-1: Checklist I

CHECKLIST I				
Area of observation: Case Study Area A Dukezwe (Clermont) **Date of observation:** 07/07/2008 **Area description:** The area is steep and hilly and very densely populated. **Technology description**: Ablution Block				
Questions	**YES**	**NO**	**N.A.**	*Comments*
Is tap working?	√			
Is sink working?	√			
Is shower working?		√		The pipe in the shower (female) is broken. The care taker put a coin to stop water overflowing.
Is toilet working?	√			
Is there soap on the sink?		√		
Is there soap in the showers?	√			
Is the toilet or VIP latrine clean?		√		
Does the toilet smell?		√		
Is the place reachable by most of the community?		√		The area is steep and hilly. Furthermore there is at least one disabled person living in the community and she could not use the block.
Is there any leakage?	√			
Is users' privacy taken into account in the CAB design?		√		There are no locks for doors and there are no keys either.
Is there any danger in using the toilet (eg. Electrical wires)	√			People commented it is not safe to use the facility when it is dark.

Table A1-2: Checklist II

CHECKLIST II

Area of observation: Case Study Area B- Amaoti (Sigcawu)
Date of observation: 10/07/2008
Area description: The area is flat but wide. Presence of standpipes and VIP latrines in the interior part of the area.
Technology description: The ablution blocks are new. They have just handed in two weeks before the interviews took place.

Questions	**YES**	**NO**	**N.A.**	*Comments*
Is tap working?	√			
Is sink working?	√			
Is shower working?	√			
Is flush working?	√			
Is there soap on the sink?		√		
Is there soap in the showers?		√		
Is the toilet or VIP latrine clean?	√			
Does the toilet smell?		√		
Is the place reachable by most of the community?		√		The area is flat but wide. Presence of standpipes and VIP latrines in the interior part of the area making the use of CABs not an urgent need.
Is there any leakage?		√		
Is users' privacy taken into account in the CAB design?	√			
Is there any danger in using the toilet (eg. Electrical wires)		√		

Table A1-3: Checklist III

CHECKLIST III

Area of observation: Case Study area C Beachway (Clermont)
Date of observation: 15/07/2008
Area description: Steep and hilly area very densely populated. The area is densely inhabited and houses are built in corrugated iron or soil. Broken sewage pipes with running wastewater are everywhere in the community and children play next to it, animals breed on it. Electricity is present outside the house but inside people still used candles. For cooking purposed they use paraffin inside and outside places. The hygienic situation of Beachway is worrying. Waiting for the new CABs to start function the population has been provided with portable toilets.
Technology description: The AB is a brand new and the keys have been handed over to the caretaker on July 14^{th}. Although keys have been handed some parts of the technology are not fully working. No water connection no pipes to the sink.

Questions	*Answers*			*Comments*
	YES	**NO**	**N.A.**	
Is tap working?		√		
Is sink working?		√		Information not available since AB locked
Is shower working?			√	Information not available since AB locked
Is flush working?				
Is there soap on the sink?			√	
Is there soap in the showers?				Information not available since AB locked
Is the toilet or VIP latrine clean?			√	Information not available since AB locked
Does the toilet smell?			√	
Is the place reachable by most of the community?		√		
Is there any leakage?		√		
Is users' privacy taken into account in the CAB design?	√			
Is there any danger in using the toilet (eg. Electrical wires)		√		

C: Data Analysis

Table A1-4: Frequencies for CAB A and B

Question Number	User experience of CABs	CAB A		CAB B	
		n	%	n	%
1	Respondents using CAB	(27)	93	32	56
	Respondents not using CAB	(2)	6.9	25	44
1.1	Reasons for not using CAB*				
	Have own toilet	(2)	66.7	2	6.7
	CAB is in bad conditions	(1)	33.3		
	CAB is distant from home	na	na	7	23.3
	I was unaware of it	na	na	4	13.3
	CAB is unaffordable	na	na	17	56.7
1.2	Alternative method used*				
	Local standpipe	(2)	50	25	50
	Pit latrine	(2)	50	12	24
	Neighbours' facilities	na	na	2	4
	Open defecation	na	na	11	22
2	Immediate use of the facility	(23)	85.2	30	93.8
	Non immediate use of the facility	(4)	14.8	2	6.2
	Reasons for not using the facility immediately				
	I was not aware of the CAB purpose	(1)	25	(1)	50
	I used other means	2	50	na	na
	I just moved to the area	1	25	na	na
	I could not afford them	na	na	(1)	50
3	Daily average use of the facility	2.5 times a day		1 time	
4	Training received	(6)	22.2	(13)	40.6
4.1	Knowledge of training provider				
	Municipality	(3)	50	(1)	3.1
	Caretaker	(3)	50	(5)	15.6
	Community committee	Na	na	(7)	21.9
	Unknown	Na	na	(2)	6.3
5	Advice trusted most				
	Caretaker and municipality	(11)	40.7	(14)	43.8
	I trust only myself	(12)	44.4	(16)	50
	Neighbours	(2)	7.4	(1)	3.1
	Family members	(2)	7.4	(1)	3.1
6	Habits changed since use	(10)	37	(7)	21.9
6.1	Description of how habits changed				
	Relief from using pit latrines or open defecation	(5)	50	na	na
	More frequent use water and sanitation systems	(3)	30	na	na
	I do everything at the CAB	(1)	10	(6)	18.8
	I use CAB less often	na	na	(1)	3.1
7	I do not have to pay to use CAB	(26)	96.3	(32)	100
	Unknown	(1)	3.7	Na	Na
8	Respondent identifies caretaker available	(1)	3.7	(23)	71.9
9	Attitude in case of caretaker's unavailability				

	The CAB is always open	(26)	96.3	na	na
	Guard the CAB	(1)	3.7	na	na
	Use alternative means	na	na	(5)	15.6
10	Respondent experienced problems with the facility	(22)	81.5	(7)	21.9
11	Problems identified*				
	Odour/smell	(6)	7	na	na
	Difficult to use	(1)	1.2	na	na
	Lack of privacy	(10)	11.6	na	na
	Distance from house	(7)	8.1	(7)	28
	Lack of cleanliness	(19)	22.1	na	na
	Diseases caught from use	(7)	8.1	na	na
	Lack of safety	(19)	22.1	(2)	8
	Malfunctioning facility	(14)	16.3	na	na
	Facility is crowded	(3)	3.5	na	na
	Unable to afford to pay for use	na	na	(13)	52
12	Problems frequency				
	Most of the time	(12)	54.5	Na	na
	Always	(2)	9.1	(4)	12.5
13	Respondent considering CAB positive	(11)	42.3	(17)	53.1
13.1	Reasons*				
	Comfortableness	(5)	55.6	(9)	47.4
	Cleaner and healthier environment	(3)	33.3	(10)	52.7
	Save money for water	(1)	11.1	Na	na
14	Knowledge of who fixes breakdown				
	Municipality	(10)	37	(2)	6.2
	Caretaker	(2)	7.4	na	Na
	Nobody	(9)	33.3	na	na
	Unsure/ I do not know	(6)	22.2	(30)	93.8
15	Attitude in case of breakdown				
	Inform the caretaker	(3)	11.1	(8)	25
	I do not know what to do	(11	40.7	(20)	62.5
	I use alternative means	(9)	33.3	na	na
	Try to solve the problems myself	(2)	7.4	na	na
16	Respondents who suggested improvements	(19)	70.4	(10)	31.2
16.1	Suggested improvements*				
	Regular cleaning	(5)	14.3	(1)	7.7
	Regular maintenance	(11)	31.4	(2)	15.4
	Improvement of personal safety	(7)	20	(2)	15.4
	Introduction of payment system	(4)	11.4	Na	na
	Free to use	na	na	(4)	30.8
	Improvement of privacy	(4)	11.4	(1)	7.7
	Increase the number	(3)	8.6	na	na
	Closer to home	(1)	2.9	(2)	23.1
17	Respondents who found materials in the toilets other than toilet paper	(21)	77.8	(1)	3.1
17.1	Types of materials found*				
	Newspapers	(20)	76.9	(1)	100
	Other types of paper	(2)	7.7	na	na
	Other (sanitary towels, condoms)	(4)	15.3	na	na
18	Users reporting availability of soap at the facility	(12)	44.4	(4)	12.5

Table A1-5: Frequencies for CAB C

Question number	Predicted perceptions of CAB	n	%
1	Respondent aware of CAB	(38)	76
	Respondents unaware of CAB	(12)	24
1.2	Sanitation systems used*		
	Local standpipe	(4)	21.1
	Illegal water connection	(2)	10.5
	Handmade flush toilet	(2)	10.5
	Pit latrine	(2)	10.5
	Portable toilet	(6)	31.6%
	Neighbours' facilities	(1)	5.3
	Other	(2)	10.5
1.3	Respondents satisfied with current WATSAN systems	(3)	25
	Aspects preventing from using CAB		
2	Predicted use of CAB*		
	Laundry	(29)	26.9
	Washing up	(14)	13
	Showering	(28)	75.7
	Toilet use	(37)	34.3
3	na		
4	Training received	(10)	26.3
4.1	Knowledge of training provider		
	Municipality	(10)	26.3
5	Advice trusted most		
	Myself	(15)	39.5
	Municipality	(19)	50
	Neighbours	(2)	5.3
	Family members	(1)	2.6
6	Expected habits change		
	Use of WATSAN facilities more often	(9)	23.7
	I will do everything at the facility	(13)	34.2
	I will have better sanitation	(5)	13.2
	I do not know	(10)	26.4
7	Willingness to paying for using the facility	(32)	84.2
7.1	Predicted cost for using the facility		
	30 cents of SA Rand	(22)	57.9
8	Knowledge of caretaker	(29)	76.3
8.1	Description of caretaker appointment		
	Appointed by community	(21)	45.3
	Voluntary appointment	(3)	7.9
9	Respondents predicting benefits associated with CAB use	(27)	71.1
9.1	Predicted benefits		
	Easy access to water and sanitation	(10)	25.6
	Healthy and clean	(22)	57
	Privacy	(1)	2.9
	Close to household	(2)	5.7
10	Predicted ability to use the facility	(22)	57.9
10.1	Predicted restrictions		
	Unable to use it at night	(17)	44.7
11	Predicted use of CAB in five years time	(27)	71.1
12	Predicted attitude in case of breakage:		

	Inform municipality or caretaker	(28)	73.7
	Use alternative means	(3)	7.9
	Unsure of what to do	(7)	18.4
13	Attitude towards CAB introduction in the area		
	Very happy to receiving CAB	(32)	84.2
	Unsure	(2)	5.3
	Neither happy nor unhappy	(4)	10.5

*Multiple responses set

D: Background documents and information

Table A1-6: Secondary document used for CAB areas selection

DOCUMENT SUMMARY	**Site: eThekwini Municipality, Health Department** **Date received:09/07/2008**
Name and description of the document:	Sanitation in Informal Areas: Action List
Event or contact with which the document is associated:	Document circulated during an internal meeting of the eThekwini Municipality, which took place in Durban in May 2008.
Significance of document:	The document provided the criteria for selection the case study areas of Ablution Block users during fieldwork.
Brief Summary of document:	Document provides a list of the areas of the municipality where community sanitation facilities have been installed. The document provides also the date in which transfer started and the percentage of completion at date.

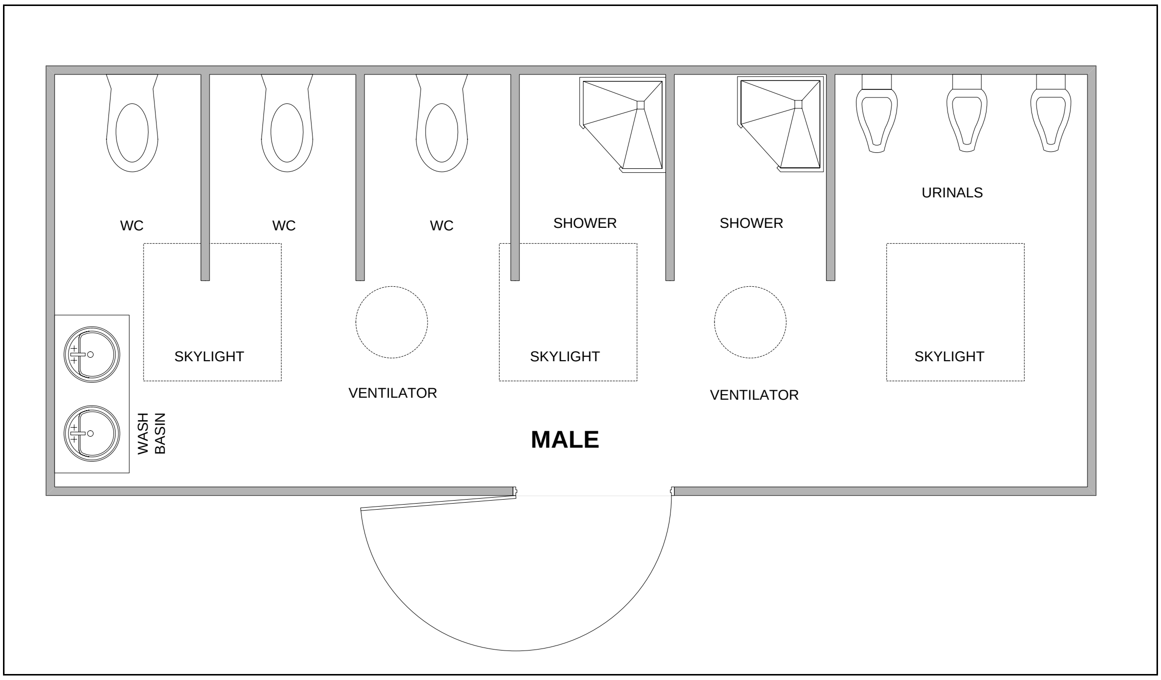

Figure A1-1: Design of typical male CAB in Durban

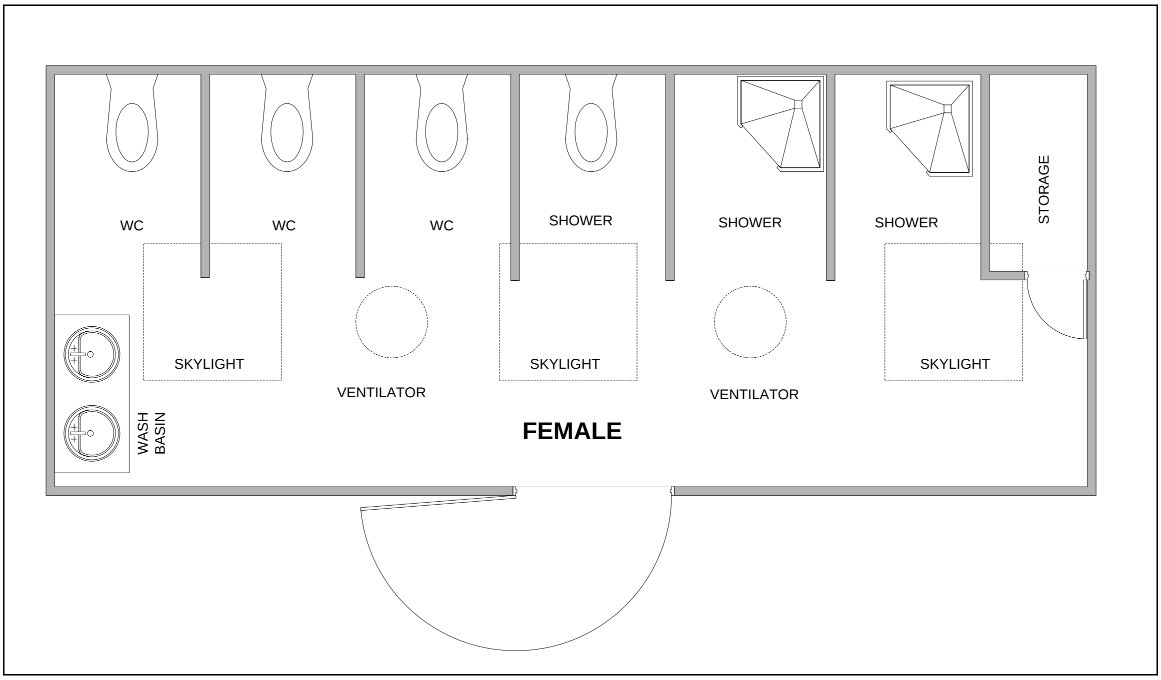

Figure A1- 2: Design of typical female CAB in Durban

APPENDIX II-RECAP

A TOOL FOR POST-IMPLEMENTATION EVALUATION OF WATSAN TECHNOLOGIES IN DEVELOPING COUNTRIES

Contents

Guidelines for the RECAP tool

Introduction

This booklet provides step-by-step guidance on applying a tool to identify early post-implementation issues surrounding water and sanitation (WATSAN) technologies. The RECAP tool is designed to be used in the early stages of technology introduction, during a trial period or when only a small group of people have been exposed to the technology.

1. What is a RECAP assessment?

The RECAP assessment is an evaluation method to assess water and sanitation technologies using a comparison between intended technology performance and users' experiences of it.

2. Why should RECAP be used?

RECAP can identify the causes of differences between what a WATSAN technology is intended to achieve (the performance space) and what it actually achieves (the experience space), often manifested through recipients' unwillingness to use the technology. If appropriately managed, a RECAP assessment can provide evaluators with feedback from recipients to support interventions to improve acceptance and use of the technology. The RECAP assessment is a circular process: information gathered from users can help to build an understanding of the issues and problems involved and initiate a learning process for providers

3. Who should use the RECAP tool?

The RECAP tool is designed to be used by a variety of groups, who may be interested in either promoting or demonstrating that WATSAN technologies are achieving the objectives set for them. These include:

- Field personnel working in the WATSAN sector, members of NGOs;
- Decision makers or R&D officers in industry, central or local governments;
- Academics, researchers and technology trainers and educators;
- Individuals and communities benefiting from WATSAN interventions.

4. Timing of a RECAP assessment

A RECAP assessment should be conducted shortly after a WATSAN technology has been introduced to a user community. It is in this early stage, in fact, that problems and issues identified by a RECAP assessment can be transformed into interventions based on the analysis of recipients' experiences and opinions.

5. Setting up the assessment

To apply RECAP for evaluating WATSAN technology a set of fundamental conditions must be fulfilled:

- The technology to be assessed and/or its output must have been used by a recipient group long enough for them to have formed an opinion about its usefulness and effectiveness.
- The technology and the recipient group must be accessible.

6. RECAP assessment steps

A RECAP assessment is characterised by seven steps which are outlined below and illustrated in Figure A2-1.

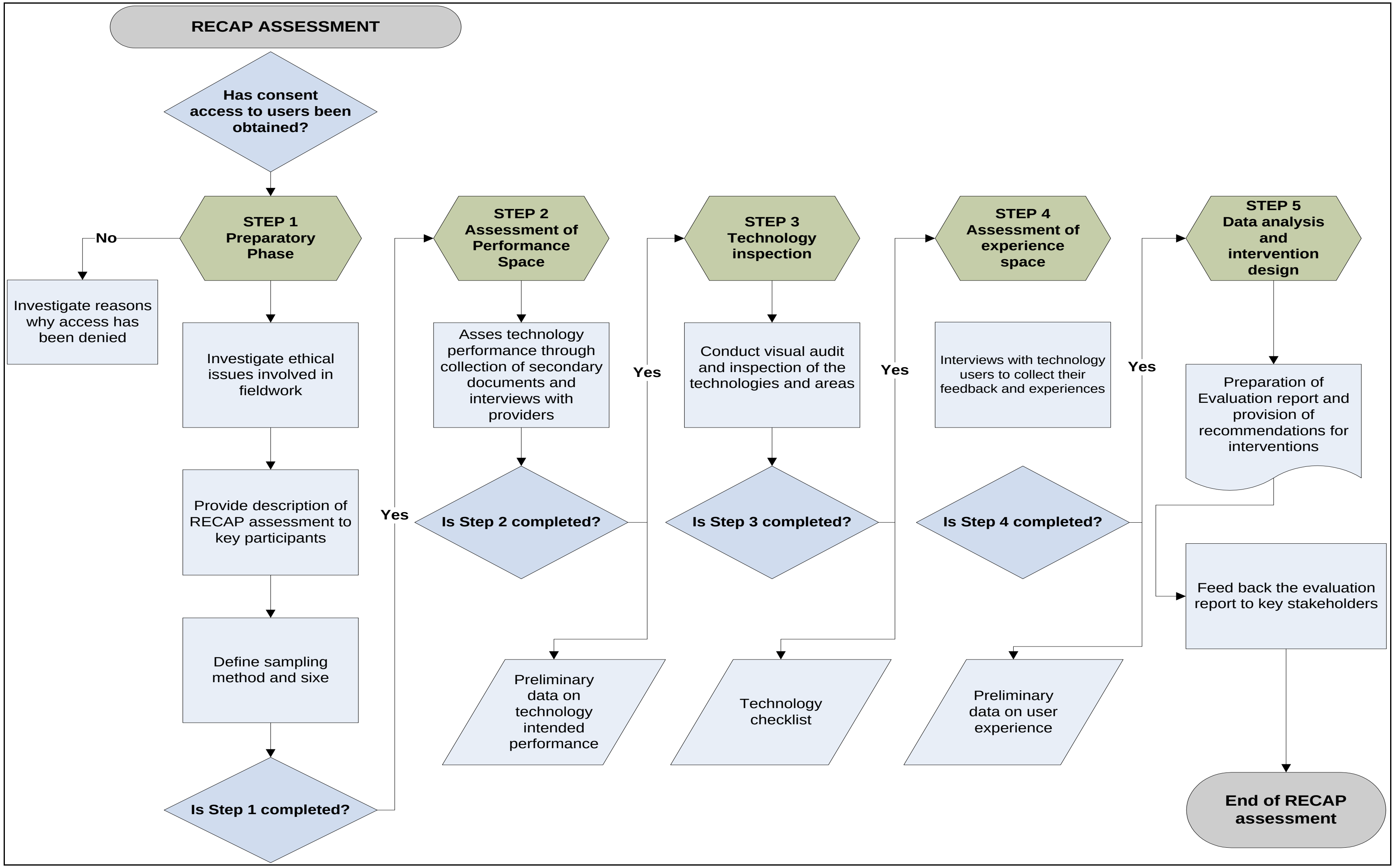

Figure A2-1: Recap assessment steps

Step 1-Preparatory phase

Step 1 is a preparatory phase involving a set of activities to be conducted before starting the assessment. These are the following:

a. Specification of the technology and user group to be included in the assessment.
b. Identification of potential ethical issues that may arise during in the fieldwork. Evaluators should make sure that risks and constraints that could potentially emerge have been identified and that a risk assessment has been prepared.
c. Obtain consented access to the technology (including documentation relating to its design, intended performance and context of application) and recipients by establishing contacts with the technology providers, local authorities, governmental bodies, local NGOs, etc.
d. A written description and explanation of the study should be left with key informants and stakeholders involved- e.g. community leaders, local authorities.
e. Provide key stakeholders with a summary of the purpose and activities of the assessment in order to stimulate dialogue and facilitate interventions as well as reciprocal learning.
f. Selection of adequate sampling methods for technology assessment and interviews. The choice of sampling method depends on the time and resources and on the population of interest. Ideally, probabilistic sampling techniques - e.g. random sampling, stratified or cluster sampling are privileged. Table A2-1 describes some of probabilistic sampling techniques and explaining when they are more suitable to use in this investigation.

Table A2-1: Description of some probabilistic sampling techniques

Sample Techniques	Description	Conditions for use
Simple random sampling	Create a sampling frame for all cases then select cases using a random process.	Household level technology
Cluster sampling	Create a sampling frame for larger clusters units (technology). Then a random sample of the cluster units is drawn. A sampling frame of cases within each selected cluster unit is drawn and a random sample of cases is drawn.	Lack of good sampling frame for a dispersed population High cost to reach the whole sampling frame.
Stratified sampling	The population is divided into strata/categories (female and male) on the basis of additional information. After dividing the population into categories a random sample is drawn from each category then the several samples are combined.	To be used when a category of interest is a small percentage of the population.

Once step 1 is completed the evaluators should proceed with the assessment of the technology performance space.

Step 2- Assessment of Technology Performance Space

The objective of this step is to characterise the intended performance and benefits of the technology and its use. This step involves the use of existing documentation on technology specification, scoping studies, scheme planning documents to identify planned and expected technology performance and benefits. These may relate to structural, functional, environmental, health and hygiene aspects of the technology. Evaluators should also conduct interviews with technology providers, designers and/ or implementers; whether feasible interview a representative for each category. Table A2-2 presents of a list of minimum required information that evaluators should gather in the assessment of performance space. Furthermore, a list of questions to be adopted in interviews with technology providers is presented on Table A2-3. Once step 2 is completed, the evaluator should proceed with a visual inspection of the technology.

Table A2-2: List of minimum information required in Performance space assessment

TECHNOLOGY:		
Activities	**Method**	**Description**
Design specification	Existing documents Interview with providers and designers	
Description of intended area of use	Existing documents	
Implementation specification	Existing documents Interview with implementers	
Use and maintenance specification	Existing documents Interview with providers	
Special requirements	Interview with providers	
Working life	Existing documents Interview with providers	

Table A2-3: Example of questions for interviewing technology providers

	Interviewee Name: **Date of interview:**
1.	What is your job position and responsibilities?
2.	Where has the technology been introduced?
3.	Are there any standards which need to be fulfilled by the technology?
4.	Why has the technology been introduced?
5.	What are the challenges and problems that the technology is designed to address? How is it going to address them?
6.	Are local issues making a difference in the implementation of the technology?
7.	What benefits is the technology designed to bring?
8.	What are the technology features that make it user friendly?
9.	Has training been provided to users? If so, Can you explain it?
10.	Do you believe that the training activities worked/will work well?
11.	If you have not provided any training can you explain why?
12.	What do you think are/were the main challenges in introducing the technology?
13.	Do you think recipients trust the technology and its providers?
14.	Do you have any feedback mechanisms for monitoring recipients' satisfaction with the technology?
15.	Do you think that the technology is easily accepted by recipients? Can you explain?
16.	Talk about technology ownership. What are the procedures you adopted to increase users' ownership?
17.	Is there or has been planned a technology "pay per use" scheme? If so could you describe it?
18.	Which improvement would you suggest for the technology?
19.	Is there a maintenance programme? If so can you describe it?
20.	Are operation and maintenance data record available?
21.	If yes, please specify the data available and the period these data are available.

Step 3- Technology inspection

In this step the evaluator should conduct inspection of the technology to verify its actual status. Ideally, users should not be informed of the inspection taking place so that the evaluators can take an unbiased picture of the technology. The list on Table A2-4 presents the minimum required information for the technology audit. Once step 3 is completed, the evaluators should proceed with the assessment of recipients' experience with the technology.

Table A2-4: List of minimum activities required for technology inspection

TECHNOLOGY		
Activities	**Method**	**Description**
Description of the technology		
Technology area of use		
Purpose of use of the technology		
Maintenance status		
Technology working conditions		
Environmental and health aspects		

Step 4- Assessment of Technology Experience Space

The assessment of the technology experience space involves an in depth investigation undertaken through interviews with technology recipients in order to explore:

- Their experience of using the technology.
- Their knowledge about the technology's functions and benefits.
- Their motivation to use the technology.
- Their ability to make use of the technology.

Interviews using close and open-ended questions are employed to investigate the technology experience space.

A guideline to questionnaire design as well as an example of questions that might be used in a RECAP assessment of technology experience space.

Questionnaire design and adaptation will follow 5 major stages:

1. Determine the information to be obtained in the course of the investigation and adopt relevant questions to gather answers. Table A2-5 presents the type of information evaluator should identify and the key concepts the questions should focus.

Table A2-5: Questionnaire design

Type of information to be gathered	Description	Key concepts to focus on
Experience and routine	Users' past and present experience with the technology, the surrounding circumstances and events related to it.	Use and Maintenance Training. Restrictions/problems to use. Experience description and judgment.
Knowledge	To investigate the knowledge and information concerning the technology that users possess.	Users' knowledge and training received.
Opinion/value	To investigate users' opinions, beliefs and judgements about the technology.	Users' opinions and judgments Hypothetical scenarios concerning technology aspects.
Emotions	To understand emotional responses of people to their experiences.	Users' willingness to use and maintain the technology. Feeling of trust towards actors relevant in technology implementation and use Sense of inclusiveness in the technology implementation Positive and negative associative aspects
Sensory	To identify what users see, smell, taste when they use the technology.	Perceptions of smell and odours.
Demographics	To capture the identifying characteristics of users.	Age, education, occupation

2. Determine the length of the questionnaire. This will depend on the resources available to the evaluator (both financial and human) as well as on the amount of data that have to be collected. Ideally, questionnaire should be kept short enough to keep the respondent interested in the process.

3. Preparation of a questionnaire draft. Evaluator should determine the question content and wording, by referring back to Table A2-2, provided above. Questions should be neutral appropriate and relevant. Close-ended, scaled-response or open-

ended questions can be used. Table A2-6 presents the purpose of the various questions format and suggest when to use them (See Table A2-7 for examples of questions).

Table A2-6: Question format and suitability

Question format	**Description**	**Suitable for**
Close-ended	Respondent is offered a choice of alternative replies. These can be read aloud or shown on a prompt card. Alternatives can be yes/no or a list of choices the respondent has to choose.	• Descriptive factual information is to be collected, e.g. demographic questions. • Little time is available. • Interviewer is not very well trained. • Comparison between cases is privileged.
Scaled-response	Respondent's attitude towards a certain topic is measured through a scale response format. E.g. Likert scale (5 point-scale)	• Information is difficult to quantify. • Sensitive topics are explored.
Open-ended	Respondent is free to provide his/her own explanation to a question	• Investigation is explanatory. • There is time availability. • Bias is to be avoided.

4. Pre-test and revision of the questionnaire. Once the questionnaire is drafted the evaluator should pre-tested on a small sample of respondent to check that works as intended and to find put the amount of time needed to complete it. Three groups of people should be used to pre-test the questionnaire: colleagues, potential users of the data and potential respondents. Necessary revision and adaptation can be made at this stage based on the feedback obtained.

Table A2-7: Example of questionnaire for assessment of experience space

EXPERIENCE AND BEHAVIOUR

Scale-questions

1= Strongly agree
2= Agree
3= Neither agree or disagree
4= Disagree
5= Strongly Disagree
NA=Not applicable

Questions	**1**	**2**	**3**	**4**	**5**	**na**
I use the technology	°	°	°	°	°	°
I have been trained to use the technology	°	°	°	°	°	°
There is someone I can refer to in case of maintenance needed	°	°	°	°	°	°
There are some restrictions to use the technology	°	°	°	°	°	°

Open-ended

What is your experience with the technology?

Describe a typical day: how many times do you use the technology?

Describe your attitudes when problems arise with the technology.

KNOWLEDGE AND INFORMATION

Scale-questions

1= Strongly agree
2= Agree
3= Neither agree or disagree
4= Disagree
5= Strongly Disagree
na=Not applicable

Questions	**1**	**2**	**3**	**4**	**5**	**na**
I know how to use the technology	°	°	°	°	°	°
I know how to maintain the technology	°	°	°	°	°	°
I know what to do when problem with the technology arise	°	°	°	°	°	°

Open-ended

Do you describe your knowledge of the technology adequate to use it?

SENSORIAL ASPECTS

Scale-questions

1= Strongly agree
2= Agree
3= Neither agree or disagree
4= Disagree
5= Strongly Disagree
na=Not applicable

Questions	**1**	**2**	**3**	**4**	**5**	**na**
The are odour problems with the technology	°	°	°	°	°	°
The are taste problems with the technology product (water)	°	°	°	°	°	°

1= Very good
2= Good
3= Neither good or bad
4= Bad

Open-ended

Describe the sensorial experience you have when you use the technology.

5= Very bad
NA=Not applicable

Questions	1	2	3	4	5	na
The cleanliness conditions of the technology are	°	°	°	°	°	°

VALUES AND OPINIONS

Scale-questions

1= Strongly agree
2= Agree
3= Neither agree or disagree
4= Disagree
5= Strongly Disagree
NA=Not applicable

Questions	1	2	3	4	5	na
My traditional and religious habits are respected	°	°	°	°	°	°
The needs of children/ elderly/women are respected	°	°	°	°	°	°
My privacy and dignity are respected	°	°	°	°	°	°
People relevant to me think i should use the technology	°	°	°	°	°	°

Open-ended

Are there any group or people that would approve/disapprove of you using the technology?

What aspects of your religious habits are/are not respected?

What do you think would improve your ability to maintain the technology?

EMOTIONAL ASPECTS

Scale-questions

1= Strongly agree
2= Agree
3= Neither agree or disagree
4= Disagree
5= Strongly Disagree
na=not applicable

Questions	1	2	3	4	5	na
I am willing to perform activities if this is necessary to improve the technology	°	°	°	°	°	°
I feel included in the daily management of the technology	°	°	°	°	°	°
I trust the technology providers	°	°	°	°	°	°
My neighbours/ family 's opinions related to the technology are important to me	°	°	°	°	°	°

Open-ended

What positive aspects are associated with using the technology?

What negative aspects are associated with using the technology?

DEMOGRAPHICS

Close-ended questions

What is or will be your age at the end of this year?

☐	20-25
☐	26-30
☐	31-35

Open-ended

How many people live in your household?

What is the highest level of education inyour household?

5. Assessment of quality of data collection. The assessment is to be conducted by interviewers. The interviewers will fill in Tables A2-8 and A2-9, which evaluate respectively:

   - Appropriateness of data collection- self assess whether data were collected appropriately.
   - Quality of interviewing method, i.e. questionnaire.

Table A2-8: Assessment of data collection to be conducted by interviewers

Assessment of data Collection	Yes	No	Comments
Respondents' consent to participate was obtained before starting the interview			
Participants have been informed of the purpose of the interview			
The interviewer presence has exerted no pressure on respondents			
Appropriate sampling techniques were adopted throughout the interview process			
Respondents were willing to participate in the investigation			
Is there any evidence that questions have not been understood by respondents?			If yes which questions?
Is there any evidence that respondents have felt uncomfortable in answering some questions			If yes which questions?
Responses have been transcribed entirely			

Table A2-9: Assessment of questionnaire quality to be conducted by assessor

Assessment of Questionnaire quality	Yes	No	Comments/specify question number
Questions have correctly translated in respondents' spoken language (Cross check translation by asking bilingual people who are independent form the project to read the questionnaire and translate it in English).			

Step 5- Feedback to Technology Providers and Users

The preliminary results of the assessment of technology experience and performance space will be fed back to technology providers and recipients respectively. The purpose of this preliminary feedback stage is to check the validity of the answers given, obtain additional information as well as reactions to the assessment results. Once the assessment picture has been enriched with feedbacks, the evaluation will pass to the last step, which involves data analysis and intervention suggestions.

Step 6- Data analysis and Intervention Design

Data from experience and performance assessments should be analysed by the evaluator and the obtained results presented in an evaluation report and a conceptual map. The report should then be fed back to both technology recipients and providers in order to frame potential interventions. Examples of suitable interventions are provided. These are:

- Incentives: expedients and rewards to increase recipients' interest in adopting and using a WATSAN technology.
- Education: ability of influencing the core ideas and perceptions at the basis of recipients' acceptance of WATSAN technology or practice.
- Law enforcement: changes directed by law forcing behaviour towards acceptance.

APPENDIX III-CASE STUDY II

Community Sanitation centres with DEWATS technologies in Central Java and Bali, Indonesia

This Appendix presents the following information

A. Questionnaires employed for Case Study II interviews with users

B. Questionnaire templates employed for interviews with providers

C. Operational checklists of inspected facilities

D. Data analysis

A: User Questionnaire

Questionnaire guidelines

1. A copy of these guidelines should be provided to each interviewer.
2. Interviewers should introduce themselves and anyone else with them. They should briefly describe their background and the purpose of the survey. Interviewers should provide their contact details for participants to gain further information.
3. Principals of ethical research are to be followed. Interviewer should read the "Statement on ethical research practice and data protection".
4. Respondents should be informed of the purpose of the interview: an information sheet, should be provided to the community and a copy of it should be left with community leader.
5. The interviewer must be able to answer YES to the following statements:

CHECKLIST	**TICK IF YES**
This survey is conducted with informed consent of respondent	
Confidentiality will be preserved (participant's identity is unknown)	
Participant is informed of the purpose of the interview	
Participants will be informed of outcomes, subject to requirements of confidence	
Data from the project will be securely stored and retained for at least 5 years	
Researcher's contact details are provided	

Questionnaire Instructions:

- The Interview must be conducted face-to-face with respondent.
- The interviewer should read the questions out and record them on the questionnaire sheet.
- Should the interviewers wish to ask additional questions, they will have to contact the questionnaire designer.
- Some of the questionnaire answers require a further explanation, therefore interviewer will have to ask the question "nr E" next to respondent's answer, where applicable.

E.g. 1. Do you use the facility?

A: Yes
B: No →1.1: Why?

DEWATS SYSTEMS USER QUESTIONNAIRE	
Date: SANIMAS location: Consent given: yes □ no □	
1.	**Does everyone in your household use DEWATS systems?** A: Yes B: No → **1.1: Who does not use it?** → **1.2: What do they use?** → **1.3: Why?**
2.	**Please circle respondent's level of agreement with the following statement: "There is someone I can refer to in case of maintenance needed"** A: Strongly disagree B: Disagree C: Neither agree nor disagree D: Agree E: Strongly agree
3.	**If you pay for using DEWATS systems, can you afford it?** A. Yes B. No C. I do not know
4.	**If there is biogas digester, do you use it?** A. Yes → **4.1: For what purpose?** B. No
5.	**Have you experience any problem with the use of DEWATS-systems?** A. Yes → **5.1: What are the main problems you have experienced?** B. No
6.	**What do you if there is a problem with DEWATS technology?**
7.	**Did you or anyone in your household receive any training on how to use/ maintain DEWATS?** A. Yes → **7.1: Was the training easy to follow?** B. No C. I do not know
8.	**Do you think the facility addresses the needs of everyone in the community/household (children/ elderly/ women)?** A: Yes B: No → **8.1: Why?**
9.	**Does the facility respect your traditions (in terms of habits or privacy) and that of your community?** A: Yes B: No → **9.1: What aspects are not respected?**
10.	**Should you/ your community be in charge of the maintenance of DEWATS?** A: Yes B: No → **10.1: Who should be in charge?**
11.	**Are you generally satisfied with DEWATS systems?** A: Yes B: No → **11.1: Why?** C: Other, specify
12.	**Generally, do you consider the use of DEWATS system positive for your health and that of your family?** A: Yes B: No C: I do not know

13.	**What would you do if you could change anything of DEWATS?**
14.	**Please circle respondent's level of agreement with the following statement:** **"I would pay (more) if this improved DEWATS performance"** A: strongly disagree B: disagree C: Neither agree or disagree D: agree E: strongly agree
15.	**Please circle respondent's level of agreement with the following statement:** **"I feel included in the daily management of the DEWATS systems"** A: Strongly disagree B: Disagree C: Neither agree or disagree D: Agree E: Strongly agree
16.	**Whose advice on use and maintenance of the DEWATS do you trust most?**
17.	**Has your opinion of the system changed with its use?** A: Yes→ **17.1: In what way?** B: No C: Other, specify
18.	**Respondent gender** ☐ Male ☐ Female
19.	**What is or will be your age at the end of this year?** ☐ 15-19 years ☐ 20-24 years Female ☐ 25-29 years ☐ 30-39 years ☐ 40-49 years ☐ 50-59 years ☐ 60years and over
20.	**How many people live in your household?**
21.	**How many of these are** dependent children elderly

Cranfield UNIVERSITY

Fieldwork information sheet

Project Title: Using a RECAP assessment to diagnose problems and acceptance of DEWATS systems by communities.

Aim: The objective of this survey is to understand what are the problems or facilitating aspects involved in the implementation and use of DEWATS systems.

This study will employ a tool (RECAP) comprising of a series of steps for assessing users' acceptance of DEWATS systems, comparing users' and providers knowledge and experience. Your contribution to this project is extremely important since your opinions and ideas are fundamental to diagnose problems and develop new solutions.

Introduction:

My name is Elisa Roma and I am a Ph.D student from the Centre for Water Sciences of Cranfield University in the United Kingdom.

I would like to ask you for your voluntary cooperation in (1) answering some questions pertaining to DEWATS systems and (2) possibly providing access to information/documents which are not available in the public domain. I would like to request the use of this information in my study. This project has received ethical approval from the Cranfield University Ethical Research Committee.

I highly value your contribution to this project as it will help shed further insight on the current health and sanitation problems afflicting developing countries. Please feel free to contact me if you have questions or would like further information regarding this study, I can be contacted via:

Email e.roma@cranfield.ac.uk

Mobile phone: 0897 6811924

Thank you for your time and participation.

B: Questionnaire template for provider interviews and consent forms

IN-DEPTH INTERVIEWS QUESTIONNAIRE TEMPLATE	
Name of interviewee: Job position: Date of Interview:	
1.	**What is the local government (NGO) strategy to implement and manage DEWATS? Additional question:** Does the local government have a programme to increase users' awareness about improved sanitation?
2.	**What are the benefits that SANIMAS brings/has brought to communities?**
3.	**What do you think are/were the main challenges in implementing and managing SANIMAS?**
4.	**Do you think local (social and cultural) issues influence/ have influenced the implementation and use of DEWATS systems? If yes in what way?**
5.	**Does the local government have procedures for monitoring DEWATS? Additional Questions** How is the monitoring process structured? How often is it conducted? How is monitoring coordinated with NGO and other government agencies? Do you have a record for monitoring? Who do you think should be responsible of monitoring and why?
6.	**Do you have a health and environmental impact assessment of SANIMAS?**
7.	**Do you believe DEWATS systems are easily accepted by users?**
8.	**Which improvements would you suggest for the sustained use of the technology?**
9.	**Is there a legal agreement on responsibility of DEWATS technology to increase sustainability after the programme is implemented?**

Interview consent form

Project Title: Using a RECAP assessment to diagnose problems and acceptance of DEWATS systems by communities.

I have been asked to participate in an interview and/or provide information regarding water and sanitation technologies for a research project conducted by Elisa Roma, Ph.D student from the Centre for Water Sciences at Cranfield University (UK). I understand that this research project is being carried out as requirement for her Ph.D.

I have understood the information sheet provided and I consent to voluntary participation in this study. I thereby authorize the written or verbal information I provide to be used in papers/reports, which will be made available in the public domain.

I give consent for recording the interview

□ Yes

□ No

I give consent for

□ anonymous quotation

C: Operational checklists of inspected communities

Table A3-1: Summary of operational checklists

SAN (impl. date)	Date of Inspection	Physical description	Area of use	Operational conditions
1 (2007)	27/07/2009	6 toilets, 2 bathrooms and 2 laundry valves.	Urban flat area of Solo, Java. Only few people had own toilet in their houses and the others practiced open defection in the nearby river.	Very good Clean conditions, no smell. Users pay 3000 IRP per month
2 (2007)	06/08/2009	SSS connected to DEWATS plant managed by the community.	Urban very densely populated area in Denpasar.	Very good No problems reported, no smell
3 (2005)	31/07/2009	6 toilets, 4 bathrooms, 1 laundry.	Urban densely populated area in Semarang, Java.	Clean but smell.
4 (2007)	27/07/2009	6 toilets, 3 bathrooms, 2 laundry valves.	Urban area, Java. Only few people own their own toilet and normally used open defecation in the nearby river.	Smell, bad conditions. People were hanging out there. Security problems Users pay 5000 IRP per month
5 (2007)	23/07/2009	4 toilets, 2 bathrooms and 6 laundry valves.	Peri-urban area in Magelang, Java. Before SANIMAS, 30% of the community had toilets, the remaining 70% practiced open defecation.	Good working conditions but sometimes there are clogged pipes Fairly clean
6 (2006)	23/07/2009	6 toilets, 4 bathrooms, 3 laundry valves.	Urban area in Java. 30% had toilets but no septic tank, and open defecation.	Sink was clogged. Water was flowing out of toilets.
7 (2006)	05/08/2009	SSS connected to DEWATS plant managed by community.	Urban area densely populated in Denpasar, Bali.	Strong smell of wastewater
8 (2006)	31/07/2009	6 toilets, 1 bathrooms, 1 laundry valve and 1 kitchen.	Urban area in Java.	No problems identified
9 (2003)	06/08/2009	CSC, communal toilets and bathrooms.	Urban densely populated area of Denpasar, Bali.	Good status and cleanliness
10 (2005)	05/08/2009	SSS connected to DEWATS plant managed by community	Urban densely populated area of Denpasar	No problems identified

11 (2008)	27/07/2009	4 toilets, 2 bathrooms.	Urban flat area of Java.	Clean no smell. No sign of problems. Very good working conditions. Users must pay 5000 IRP per month.
12 (2008)	21/07/2009	SSS connected to DEWATS plant managed by community.	Urban areas within Yogyakarta, Java.	Users pay 2000 rp per month. No broken pipes, no overflow of wastewater
13 (2007)	22/07/2009	Communal sanitation systems	Urban areas in the centre of Yogyakarta, Java.	Good status

* Community 3 and 8 checklist completed by interviewer.

C. Data Analysis

User interviews

Table A3-2: Frequencies of user experience with CSC

Question Number	User experience of DEWATS technology with CSC	n	%
1	DEWATS use	(65)	78
1.1	Member of household who does not use it	(18)	22
	Elderly people	(11)	61.1
	Children	(4)	22.2
	Other family member	(3)	16.7
1.2	Alternative systems used:		
	Open Defecation in the river	(12)	66.7
	Old septic tank toilet	(6)	33.3
1.3	Reasons for not using DEWATS systems		
	Open defection is a habit	(3)	16.7
	Toilets are too far from household	(5)	27.8
	CSC are not comfortable	(8)	44.4
	Not willing to pay	(2)	11.1
2	“There is someone I can refer to in case maintenance of the system is needed”	(79)	95
	Agree	(79)	95.2
	Neither agree nor disagree	(3)	3.6
3	Household considering DEWATS affordable	(51)	61.4
4	Households using biogas digester for cooking purposes, where available	(57)	68.7
5	Households who experienced problems with technology	(56)	67.5
6	User attitude in case of problems		
	Report to operator	(28)	40.6
	Try to solve problems myself	(6)	7.2
	I do nothing	(6)	7.2
	Discuss problems with community	(13)	15.7
	Report to community based organisation	(16)	19.3
7	Users participated in training activities	(48)	57.8
7.1	User found training easy	(45)	93.8
	DEWATS-system management and maintenance		
8	Households perceiving technology fulfils their needs	(62)	74.7
8.1	Reasons given in case of negative answer		
	Too crowded	(2)	10
	It is not good for elderly	(10)	50
	Not good service provided	(8)	40
9	Households perceiving technology respects own traditions	(78)	94
9.1	Reasons: it is not clean enough	(2)	100
10	User feeling the community is responsible for technology maintenance	(76)	91.5
	User feels only the Community Based Organisation should be in charge	(7)	8.5
11	User satisfied with technology	(53)	65.4
11.1	Nature of dissatisfaction:		
	Technical (poor water supply systems, problems with pipes)	(8)	28.6
	Health and hygienic (problems with cleanliness and smell)	(11)	39.3
	Management (poor management of in cleanliness and fee	(6)	21

	payment)		
	Social (antisocial behaviour, lack of community awareness of how to use DEWATS)	(2)	7.1
	Economic (I do not want to pay)	(1)	3.6
12	Users perceiving technology benefits to health	(69)	83.1
	Users not perceiving health benefits	(8)	9.6
	Unsure	(6)	7.2
13	Users who suggested changes to technology	(36)	43.4
	Nature of suggested changes:		
	Technical (Improvement of system maintenance, expert help to fix structural problems)	(18)	50
	Social (recreational activities, increase community awareness, involve children in technology management activities)	(5)	13.9
	Health and hygiene (improve cleanliness, smell)	(5)	13.9
	Management (improve collection fee systems, engage all users to contribute to systems)	(8)	22.2
14	"I would pay more if this improved DEWATS performance"		
	Agree	(41)	49.4
	Strongly agree	(12)	14.5
	Neither agree nor disagree	(3)	3.6
	Disagree	(18)	21.7
	Strongly disagree	(6)	7.2
15	"I feel included in the daily management of DEWATS systems"		
	Agree	(52)	62.7
	Strongly agree	(9)	10.8
	Neither agree nor disagree	(10)	12
	Disagree	(6)	7.2
16	Trust for maintenance and use:		
	Community Based Organisation	(19)	23.5
	DEWATS operator	(22)	27.2
	Myself and household	(30)	37
	Community	(5)	6.2
17	Opinion changed with use	(39)	47
17.1	How opinion changed		
	DEWATS better for my health	(12)	30.8
	I understand the importance of cleanliness	(12)	30.8
	It is better than what I used previously	(8)	20.5
	Other (I appreciate the biogas, I cannot say)	(3)	7.8

When missing responses are present % are calculated on the total of valid responses.

Table A3-3: Frequency of user experience with SSS

Question Number	User experience of DEWATS technology with SSS	n	%
1	DEWATS use	(39)	100
2	"There is someone I can refer to in case maintenance of the system is needed"		
	Agree	(39)	100
3	Household considering DEWATS affordable	(30)	76.9
4	na		
5	Users who experienced problems with technology	(22)	56.4
6	User attitude in case of problems:		
	Report to operator	(18)	47.4
	Try to solve problems myself	(1)	2.6
	I do nothing	(5)	13.2
	Discuss problems with community	(1)	2.6
	Report to community based organisation	(13)	34.2
7	Users participated in training activities	(16)	41
7.1	User found training easy	(14)	87.5
	DEWATS-system management and maintenance		
8	Households perceiving technology fulfils their needs	(36)	94.9
8.1	Reasons given in case of negative answer		
	Biogas not available	(1)	50
	Community does not know how to use DEWATSA	(1)	50
9	Households perceiving technology respects own traditions	(39)	100
10	User feeling the community is responsible for technology maintenance	(31)	79.5
	User feels only the operator should be in charge	(8)	100
11	User satisfied with technology	(27)	69.2
11.1	Nature of dissatisfaction:		
	Technical (need more help to fix DEWATS, pipes are not regularly checked)	(9)	75
	Management (More communication between caretaker and users)	(2)	16.7
	Social (Increase other community members sense of responsibility for DEWATS)	(1)	8.3
12	Users perceiving technology benefits to health	(34)	87.2
	Users not perceiving health benefits	(2)	5.2
	Unsure	(7)	7.7
13	Users who suggested changes to technology	(12)	30.8
	Nature of suggested changes:		
	Technical (Improvement of system maintenance, expert help to fix structural problems)	(7)	58.3
	Social (increase community awareness and sense of responsibility)	(2)	16.7
	Management (Improve professionalism of CBO in dealing with DEWATS)	(3)	25
14	"I would pay more if this improved DEWATS performance"		
	Agree	(11)	28.2
	Strongly agree	(8)	20.5
	Neither agree nor disagree	(3)	7.7
	Disagree	(16)	41
	Strongly disagree	(1)	2.6
15	"I feel included in the daily management of DEWATS systems"		
	Agree	(35)	89.7
	Neither agree nor disagree	(1)	2.6

	Disagree	(3)	7.7
16	Trust for maintenance and use		
	Community Based Organisation	(21)	55.3
	DEWATS operator	(9)	23.7
	Myself and household	(2)	5.3
	Community	(6)	15.8
17	Opinion changed with use	(4)	10.3
17.1	How opinion changed		
	DEWATS better for my health	(3)	75
	Other (I cannot say)	(1)	25

When missing responses are present % are calculated on the total of valid responses.

Table A3-4: Frequencies of reported problems

Community	Technical	Social	Management	Hygiene	No problems	Space	Total Responses
1- CSC	11.1% (1)	0	22.2% (2)	22.2% (2)	44.4% (4)	0	100% (9)
2-SSS	0	0	0	0	100% (10)	0	100% (10)
3-CSC	20% (1)	40% (2)	0	0	40% (2)	0	100% (5)
4-CSC	0	80% (8)	0	20% (2)	0	0	100% (10)
5-CSC	66.7% (6)	0	0	0	33.3% (3)	0	100% (9)
6-CSC	55.6% (10)	11.1% (2)	0	22.2% (4)	11.1% (2)	0	100% (18)
7-SSS	81.8% (9)	0	0	9.1% (1)	9.1% (1)	0	100% (11)
8 -CSC	0	0	0	66.7% (6)	33.3% (3)	0	100% (9)
9-CSC	64.3% (9)	0	28.6% (4)	7.1% (1)	0	0	100% (14)
10-SSS	53.8% (7)	0	0	30.8% (4)	15.4% (2)	0	100% (13)
11-CSC	0	0	0	0	8.8% (9)	18.2% (2)	100% (11)
12-SSS	20% (2)	0	0	40% (4)	40% (2)	0	100% (10)
13-CSC	0	0	0	50% (4)	50% (4)	0	100% (10)

Multiple responses set

Provider interviews

Table A3-5: Code co-occurrence presence

	Acceptance	Benefits	Challenges	Implementation	Longevity	Monitoring
Economic	Yes	Yes	Yes	Yes	Yes	Yes
Environment	Yes	Yes	No	Yes	No	Yes
Health	Yes	Yes	No	Yes	No	No
Legal	Yes	No	Yes	Yes	Yes	Yes
Knowledge	Yes	No	Yes	Yes	Yes	No
Social	Yes	No	Yes	Yes	Yes	Yes
Space	No	No	Yes	Yes	Yes	No
Functional	No	Yes	No	Yes	Yes	Yes

Table A3-6: Code co-occurrence frequency

	Acceptance	Benefits	Challenges	Implementation	Longevity	Monitoring
Economic	2	1	2	2	2	1
Environment	1	3	0	1	0	1
Health	1	2	0	3	0	0
Legal	2	0	2	2	4	1
Knowledge	3	0	3	6	4	0
Social	2	0	7	1	1	5
Space	0	0	3	1	2	0
Functional	0	1	0	1	3	2

Table A3-7: Provider and user questions comparison for gap analysis

Questions Providers	Questions users
Q1 What is the local government (NGO) strategy to implement and manage DEWATS systems?	Q7 and 7.1; Q12 Q17 and 17.1
Q2 What are the benefits that SANIMAS brings/has brought to communities?	Q12
Q3 What do you think are/were the main challenges in implementing and managing DEWATS?	Q3; Q5 and 5.1
Q4 Do you think local (social and cultural) issues influence/ have influenced the implementation and use of DEWATS systems? If yes in what way?	Q8; Q9
Q5 Does the local government (NGO) have procedures for monitoring DEWATS systems?	Q2; Q10 and 10.1
Q6 Do you have a health and environmental impact assessment of DEWATS?	Q12
Q7 Do you believe DEWATS systems are accepted by users?	Q6; Q11; Q13; Q15
Q8 Which improvements would you suggest for the sustained use of DEWATS systems?	Q14
Q9 Is there a legal agreement on responsibility of DEWATS technology to increase sustainability after the programme is implemented?	Q10

Secondary data

Table A3-8: Secondary data: document analysis

DOCUMENT 1	**Site: Borda, Yogyakarta** **Date received: July 2009**
Name and description of the document	DEWATS – Decentralised Wastewater treatment in developing countries
Event or contact with which the document is associated	Internal documents provided by Borda NGO describing technical, environmental and financial characteristics of DEWATS.
Significance of document	Provided useful information for investigating technology intended performance.
Brief summary of document	Describes technical social environmental and economic characteristics of DEWATS technologies, their dissemination, monitoring and maintenance.
DOCUMENT 2	**Site: Borda, Yogyakarta** **Date received: July 2009**
Name and description of the document	Community-based sanitation
Event or contact with which the document is associated	Internal document provided by Borda
Significance of document	Provided useful information for investigating technology intended performance.
Brief summary of document	Describes various concepts to improve livelihood of poor areas in East Asia.
DOCUMENT 3	**Site: Borda, Yogyakarta** **Date received: July 2009**
Name and description of the document	Reference of Borda Network on DEWATS
Event or contact with which the document is associated	Document provided by Borda
Significance of document	The document provides a list of communities with DEWATS systems.
Brief summary of document	Document provides a list of the areas where DEWATS systems have been installed. The document provides also year of implementation and number of households.
DOCUMENT 4	Site: Borda, Yogyakarta Date received: July 2009
Name and description of the document	Instructive method for promotion of Environmental Health
Event or contact with which the document is associated	Document provided by Borda.
Significance of document	The document presents BORDA activities for environmental health promotion in the communities.
Brief Summary of document:	It describes with pictures and simple language the problems related to poor hygiene and sanitation practice.

APPENDIX IV-CASE STUDY III

SODIS and AQUATAB water treatment methods in Flores, East Nusa Tenggara, Indonesia

This Appendix presents the following information

A. Questionnaires employed for Case Study III interviews with users

B. Questionnaire templates employed for interviews with providers

C. Data analysis

A: User Questionnaire

Questionnaire guidelines

1. A copy of these guidelines should be provided to each interviewer.
2. Interviewers should introduce themselves and anyone else with them. They should briefly describe their background and the purpose of the survey. Interviewers should provide their contact details for participants to gain further information.
3. Principals of ethical research are to be followed. Interviewer should read the "Statement on ethical research practice and data protection".
4. Respondents should be informed of the purpose of the interview: an information sheet, should be provided to the community and a copy of it should be left with community leader.
5. The interviewer must be able to answer YES to the following statements:

CHECKLIST	**TICK IF YES**
This survey is conducted with informed consent of respondent	
Confidentiality will be preserved (participant's identity is unknown)	
Participant is informed of the purpose of the interview	
Participants will be informed of outcomes, subject to requirements of confidence	
Data from the project will be securely stored and retained for at least 5 years	
Researcher's contact details are provided	

Questionnaire Instructions:

- The Interview must be conducted face-to-face with respondent.
- The interviewer should read the questions out and record them on the questionnaire sheet.
- Should the interviewers wish to ask additional questions, they will have to contact the questionnaire designer.
- Some of the questionnaire answers require a further explanation, therefore interviewer will have to ask the question "nr E" next to respondent's answer, where applicable.

E.g. 1. Does everyone in your household use SODIS?

A: Yes
B: No →1.1: What do they use?

QUESTIONNAIRE A- SODIS	
Household number: **Gender:** **Respondent age:** **Date of interview:** **Village: Sub-village: RT/RW:** **Wealth classification: miskin/sedang/kaya**	
1.	**When was SODIS introduced in your household?**
2.	**Did you use and drink SODIS water immediately after its introduction?** A: Yes B: No →**2.1: How long did it take you to start using SODIS?** →**2.2: Can you explain the reasons?**
3.	**Do you drink SODIS water every day?** A: Yes B: No → **3.1: Why?**
4.	**Do all your family members drink SODIS water?** A: Yes B: No → **4.1: Who does not drink SODIS water?** → **4.2: Why?** →**4.3: What kind of treated water do they drink?**
5.	**Did you or anyone in your household receive any training on how to prepare/ maintain SODIS?** A: Yes → **5.1: Was it easy to follow?**. B: No C: I do not know
6.	**Who trained you to treat water with SODIS method?**
7.	**Who prepares SODIS water in your household?**
8.	**Please explain the steps to prepare SODIS water**
9.	**What is the water source use for SODIS** → **9.1: Please indicate distance from household**
10.	**Do you filter the water before using SODIS treatment?** A: Yes → **10.1: What type of filter do you use?** B: No
11.	**What type of bottle do you use to prepare SODIS water?** A: Plastic bottle 1500 ml B: Plastic bottle 600 ml C: Others, please specify
12.	**How do you get SODIS bottle?** A: Purchase/batter→ **12.1: How much does it cost?** B: Collect → **12.2: From where?** C: Given → **12.3: By whom?**
13.	**How long do you expose SODIS bottles to the sun?**
14.	**How long do you usually use SODIS bottle until you discard it?**
15.	**Which problems do you face in using SODIS treatment method?**
16.	**Do you like the taste of SODIS water?** A: Yes B: No → **16.1: Why?**
17.	**Does SODIS water smell?** A: Yes B: No
18.	**In general, are you satisfied with SODIS water and treatment method?** A: Yes

	B: No → **18.1: Which improvements do you suggest?** C: Other, please specify
19.	**Since using SODIS water treatment method, have you experienced health problems (such as diarrhoea, poisoning, other diseases)?** A: Yes →**19.1: What type of problems?** →**19.2: What do you think the cause of the problem is?** →**19.3: What do you do to solve these problems?** B: No
20.	**Please circle the main reason for using SODIS water treatment method:** A: Inexpensive method B: Safe water C: Practical easy to prepare D: Good water quality – no smell no taste E: Environmental benefits (decrease of pollution from burning wood and fuel used for boiling water)
21.	**Does SODIS provide enough daily water supply to your household?** A: Yes B: No → **21.1: Why?**
22.	**Please circle respondent's level of agreement with the following statement:** "Drinking SODIS water can prevent diarrhoea and diseases to me and my family" A: Strongly disagree B: Disagree C: Neither agree nor disagree D: Agree E: Strongly agree
23.	**Are/were there any people that disapprove of you using SODIS?** A: Yes→ **23.1: Who?** B: No C: Other, specify
24.	**Whose advice on use and maintenance of SODIS do you trust most?**
25.	**Has your opinion with SODIS changed with use?** A: Yes→**25.1: In what way?** B: No
26.	**Would you be willing of continue to use and buy SODIS in the future?** A: Yes B: No→ **26.1 Why?**

The following three questions were asked to household on behalf of the local NGO and not used as part of this research design.

1	**Who introduced SODIS in your household?**
2	**Are weather conditions a problem to use SODIS treatment method?** A: Yes → **2.1: In which months?** → **2.2: How long for?** B: No
3	**Are/were there people that recommend you to use SODIS?** A: Yes→ **3.1: Who?** B: No C: Other, specify
4	Related to question **10 How do you get the filter?**

QUESTIONNAIRE B- AQUATAB	
Household number: **Gender:** **Respondent age:** **Date of interview:** **Village: Sub-village: RT/RW:** **Wealth classification: miskin/sedang/kaya**	
1.	**When was AQUATAB introduced in your household?**
2.	**Did you use and drink AQUATAB water directly after introduction?** A: Yes B: No →**2.1: How long did it take you to start using AQUATAB?** → **2.2: Can you explain the reasons?**
3.	**Do you drink AQUATAB water every day?** A: Yes B: No → **3.1: Why?**
4.	**Do all your family members drink AQUATAB-treated water?** A: Yes B: No → **4.1: Who does not drink AQUATAB treated water?** → **4.2: Why?** → **4.3: What kind of treated water do they drink?**
5.	**Did you or anyone in your household receive any training on how to prepare water with AQUATAB?** A: Yes → **5.1: Was it easy to follow?** B: No C: I do not know
6.	**Who give you training on AQUATAB?**
7.	**Who does the treatment with AQUATAB in your household?**
8.	**Please describe the steps to treat drinking water with AQUATAB**
9.	**Which source of water does your household use to treat water with AQUATAB?** **9.1: Please indicate distance far/near (far= > 300 m)**
10.	**Do you filter the water before treatment with AQUATAB?** A: Yes→**10.1: What type of filter do you use?** B: No
11.	**What container do you use to treat water with AQUATAB?** A: Jerry can tank........... litres B: Bottle ....dispenser C: Bucket …….litres D: Plastic container…….litres E: Other, please specify
12.	**How do you get AQUATAB tablets?** A: Purchase B: Use samples given
13.	**How long does it take to treat the water before drinking it?**
14.	**How often do you do treatment with AQUATAB?**
15.	**Which problems do you face in using AQUATAB treatment method?**
16.	**Do you like the taste of the AQUATAB treated water?** A: Yes B: No → **16.1: Why?**
17.	**Do you think the AQUATAB water smell?** A: Yes B: No

18.	**In general, are you satisfied with AQUATAB as drinking water treatment method?** A: Yes B: No → **18.1: Can you suggest any improvement?** C: Other, please specify.
19.	**Since using AQUATAB, have you experienced health problems (such as diarrhoea, poisoning, other diseases)?** A: Yes →**19.1: What type of problems?** →**19.2: What have you done to solve this problem?** →**19.3: What do you think the cause of the problem was?** B: No
20.	**Please circle the main reasons for using AQUATAB water treatment method:** A: Inexpensive method B: Safe water C: Practical easy to prepare D: Good water quality – no smell no taste E: Environmental benefits (decrease of pollution from burning wood and fuel used for boiling water)
21.	**Are/were there any people that disapprove of you using AQUATAB?** A: Yes→ **21.1: Who?** B: No C: Other, specify
22.	**Whose advice on AQUATAB do you trust most?**
23.	**Has your opinion with AQUATAB changed with use?** A: Yes→ **23.1: In what way?** B: No
24.	**If you have used SODIS bottles in the past, which system do you prefer? Why?**
25.	**Are you willing to continue using AQUATAB in the future?** A: Yes B: No→ **25.1: Why?**

The following questions were asked to households on behalf of the local NGO and not used as part of this research design.

1.	**Who has introduced AQUATAB to you?**
2.	**Do you often find problem that AQUATAB is not available?** A: Yes→**2.1: When?** → **2.2: For how long?** B: No
3.	In question 9→**How do you get the filter?**
4.	**How many tablets do you use daily to prepare water for your household?**
5.	**Where do you buy AQUATAB tablets?**

QUESTIONNAIRE C- NO SODIS NO AQUATAB	
Household number: **Gender:** **Respondent age:** **Date of interview:** **Village: Sub-village: RT/RW:** **Wealth classification: miskin/sedang/kaya**	
1.	**Which of these water treatment systems are you aware of?** A. SODIS: Yes □ No □ B. AQUATAB tablet: Yes □ No □
2.	**Please circle any of these water treatment systems your household uses.** A. SODIS B. AQUATAB tablets C. Both of them D. Other, please specify
3.	**Have you ever used?** A. SODIS: Yes □ No □ B. AQUATAB: Yes □ No □
4.	**Is your household currently using SODIS?** A: Yes B: No→ **4.1: How long have you used it for?** → **4.2: Why did you stop using it?**
5.	**Is your household currently using AQUATAB?** A: Yes B: No→ **5.1: How long have you used it for?** → **5.2: Why did you stop using it?**
6.	**Have you received any training on how to treat drinking water with SODIS?** A: Yes B: No
7.	**Have you received any training on how to treat drinking water with AQUATAB?** A: Yes B: No
8.	**Do you think that the water treated with SODIS or AQUATAB could improve the health of your family?** A: Yes → **8.1: In what way?** B: No →**8.2: Why?**
9.	**Is there anyone that disapproves of you in using SODIS?** A: Yes→ **9.1: Who?** → **9.2: Why?** B: No
10.	**Is there anyone that disapproves of you using AQUATAB tablets?** A: Yes→ **10.1: Who?** → **10.2: Why?** B: No
11.	**Whose advice on the use of SODIS and AQUATAB do you trust most?**
12.	**If SODIS or AQUATAB was reintroduced in your village would you be willing to use it again?** A: Yes → **12.1: What would you suggest as improvement?** B: No → **12.2: Why?**

The following questions were asked to households on behalf of the local NGO and not used as part of this research design.

1.	**Has anyone recommended you to use SODIS water treatment method?** A: Yes→**1.1: Who and why?** B: No C: Other, please specify
2.	**Has anyone recommended you to use AQUATAB tablets?** A: Yes → **2.1: Who and why?** B: No C: Other, please specify

Cranfield UNIVERSITY

Fieldwork information sheet

Project Title: Using a RECAP assessment to diagnose problems and acceptance of SODIS and AQUATAB treatment methods in your village.

Aim: The objective of this survey is to understand what are the problems or facilitating aspects involved in the implementation and use of DEWATS systems.

This study will employ a tool (RECAP) comprising of a series of steps for assessing users' acceptance of DEWATS systems, comparing users' and providers knowledge and experience. Your contribution to this project is extremely important since your opinions and ideas are fundamental to diagnose problems and develop new solutions.

Introduction:

My name is Elisa Roma and I am a Ph.D student from the Centre for Water Sciences of Cranfield University in the United Kingdom.

I would like to ask you for your voluntary cooperation in (1) answering some questions pertaining to DEWATS systems and (2) possibly providing access to information/documents which are not available in the public domain. I would like to request the use of this information in my study. This project has received ethical approval from the Cranfield University Ethical Research Committee.

I highly value your contribution to this project as it will help shed further insight on the current health and sanitation problems afflicting developing countries. Please feel free to contact me if you have questions or would like further information regarding this study, I can be contacted via:

Email e.roma@cranfield.ac.uk

Mobile phone: 0897 6811924

Thank you for your time and participation.

B: Provider questionnaire templates

SODIS AND AQUATAB IN-DEPTH INTERVIEWS QUESTIONNAIRE TEMPLATE	
Name of interviewee: Job position: Date of Interview:	
VILLAGE LEADERS	
1.	**What are the main benefits that SODIS and AQUATAB brought to the village?**
2.	**What are the main problems encountered with SODIS and AQUATAB in the village?**
3.	**What are the strategies used to guarantee a sustained use of water treatment technologies in your village?**
HEADS OF HEALTH CLINICS	
1.	**What were the health conditions in the village before and after introducing AQUATAB and SODIS?**
2.	**What are the health benefits brought by SODIS and AQUATAB in the villages?**
3.	**How do you monitor progress in health made by SODIS and AQUATAB?**
4.	**What is the contribution of the health clinics to SODIS/AQUATAB acceptance and sustained use?**
LOCAL GOVERNMENT	
1.	**What are the main challenges in introducing SODIS and AQUATAB programmes in the area?**
2.	**Does the local government have educational programmes to increase users awareness about water treatment?**
3.	**Do you think SODIS and AQUATAB are easily accepted in the villages?**
4.	**Does the LG have procedures to monitor the performance of AQUATAB and SODIS?**
5.	**What is the Local Government's strategy to improve sustained use of SODIS/AQUATAB?**
LOCAL IMPLEMENTING AGENCY	
1.	**What are the main benefits that SODIS and AQUATAB brought to the villages where they were implemented?**
2.	**What are the main problems encountered with implementing SODIS and AQUATAB in the villages?**
3.	**What, do you think, affects SODIS and AQUATAB users' acceptance?**
4.	**What is the NGOs strategy to guarantee SODIS and AQUATAB sustained use?**

Interview consent form

Project Title: Using a RECAP assessment to diagnose problems and acceptance of SODIS and AQUATAB programmes.

I have been asked to participate in an interview and/or provide information regarding water and sanitation technologies for a research project conducted by Elisa Roma, Ph.D student from the Centre for Water Sciences at Cranfield University (UK). I understand that this research project is being carried out as requirement for her Ph.D.

I have understood the information sheet provided and I consent to voluntary participation in this study. I thereby authorize the written or verbal information I provide to be used in papers/reports which will be made available in the public domain.

I give consent for recording the interview

□ Yes

□ No

I give consent for

□ anonymous quotation

C: Data analysis

User interviews

Table A4-1: Data from questionnaire A-SODIS

Question Number	**Village A questionnaire for SODIS use**	Users n= 91		Non users n=9	
		(n)	**%**	**(n)**	**%**
1.	Date of SODIS introduction: December 2007	(99)	100		
2.	Immediate SODIS use	(95)	95		
2.1	Non immediate SODIS use	(6)	5		
	Time taken to begin using SODIS:				
	One week	(4)	80		
	3 months	(1)	20		
3.	Households drinking SODIS water regularly *	(91)	86.7		
3.1	Other treatment methods used in households:				
	AQUATAB	(1)	1		
	Boil water	(13)	12.4		
	Households who stopped using SODIS	(9)	9		
	Reasons for stopping SODIS:				
	Sample bottles broke and household is unable to buy new ones	(8)	88.8		
	Laziness	(1)	11.1		
4.	Entire household drink SODIS water:	(86)	92.3		
	Member of household do no drink SODIS water:	(7)	7.7		
4.1	Father	(5)	62.5		
4.2	Main reasons reported:				
	Taste disliked	(3)			
	Gets stomach pain	(2)			
4.3	Method used (boiled) water	(3)			
	Purchase water	(2)			
	Grandmother: (taste disliked) Method used: boiled water	(1)	12.5		
	Mother (taste disliked, I gives her diabetes) Method used: boiled water	(2)	25		
5.	Household received training on SODIS	(91)	100	(9)	100
5.1	Training was easy	(91)	100	(9)	100
6.	NGO trained me for SODIS	(88)	96.7		
	My neighbours	(3)	3.3		
7.	Person who prepares SODIS in household*				
	Female in the house	(88)	71		
	Children	(22)	17.7		
	Father	(14)	11.3		
8.	Correct steps to prepare SODIS water (One point for each step mentioned) Clean water bottle Use a filter to pour water in bottle Pay attention not to get air Put a black cloth in the area of exposure Leave for 24hours				

	48 hours if cloudy				
	6 points (Very accurate)	(62)	68.1		
	5 points (accurate)	(22)	24.2		
	4 points (Moderately accurate)	(7)	7.7		
9.	Water source used by household for SODIS:				
	Hand dug well	(63)	70.8		
	Public tap	(18)	20.2		
	Rainwater catchment	(8)	9		
9.1	Reported water source distance from household				
	More than 300 metres	(35)	39.3		
	200 metres or less from household	(13)	14.6		
	Less than 100 metres from household	(41)	46.1		
10.	Use of filter	(90)	98.9		
10.1	Type of filter cloth	(90)	100		
11.	Type of bottles used for SODIS: plastic bottle 1500 ml	(91)	100		
12.	SODIS bottle acquisition:				
12.1	Purchase from NGO	(83)	91.2		
12.2	Collect from market or beach	(7)	7.7	(4)	44.4
12.3	Given free from Ngo	(1)	1.1	(5)	55.6
13.	Exposure time of SODIS bottles in the sun				
	24 hours	(43)	47.3		
	1 day 2 days if cloudy	(31)	34.1		
	12hours	(17)	18.7		
14.	Mean months of use of SODIS bottle before discarding it	5.04			
15.	Reported problems faced with SODIS:				
	Household cannot afford the cost of bottles	(21)	32.8	(2)	28.6
	I am too busy in the field to prepare SODIS	(25)	39.1		14.3
	SODIS preparation is tiring	(3)	4.7		
	SODIS is not practical	(15)	23.4	(4)	57.1
16.	Taste of SODIS water appreciated	(90)	98.9	(9)	100
16.1	No taste disliked as it tastes like raw water	(1)			
17.	SODIS water does not smell	(91)	100	(9)	100
18.	Satisfaction with SODIS method	(91)	100		
19.	Health problems experienced since using SODIS	(6)	6.6	(2)	22.2
19.1	Reported types of problems:				
	Diabetes	(3)	50		
	Diarrhoea	(2)	33.4		
	Burns when urinating	(1)	16.7		
	Stomach pain			(2)	100
19.2	Reported causes				
	Non SODIS related:(drink raw water eat raw vegetables)	(6)	100		
	Mistakes made in SODIS preparation			(2)	100
19.3	Use SODIS as remedy	(6)	100		
20.	Main reason for using SODIS method:				
	Economic (SODIS is an inexpensive method)	(34)	37.4		
	Health (water is good for my health and safe to drink)	(6)	6.6		
	Functional (Practical and easy to prepare)	(44)	48.4		
	Taste (no smell no taste)	(4)	4.4		
	Environment (decrease of pollution from	(3)	3.3		

	burning wood and fuel used for boiling water)				
21.	SODIS provides enough water for my household	(78)	85.7	(4)	44.4
22.	"Drinking SODIS water can prevent diarrhoea and diseases to me and my family"				
	Disagree	(2)	2.2		
	Undecided	(4)	4.4	(2)	22.2
	Agree	(40)	44	(6)	66.7
	Strongly agree	(45)	49.5	(1)	11.1
23.	Water vendor disapproves of us using SODIS	(1)	1.1		
	Nobody disapproved using SODIS	(90)	98.9	(9)	100
24.	Advice on use of SODIS trusted*				
	NGO and cadre	(120)	89.7		
	Health operators	(14)	10.2		
25.	Opinion changed with SODIS use	(35)	38.5	4	44.4
	How it changed				
	More time to do other activities	(25)	73.5	(2)	
	Better health conditions	(6)	17.7	(2)	
	It is easy method	(4)	11.8		
26.	Willingness to continue use and buy SODIS	(77)	84.6		
	Unwillingness to continue use and buy SODIS	(14)	15.4	(9)	100
26.1	Reasons for not continuing SODIS:				
	Refilled water gallon are preferred	(3)	50		
	SODIS bottles are too expensive	(2)	33.4	(9)	100
	Bottles are not enough	(1)	16.7		

*Multiple responses set

Table A4-2: Data from questionnaire B-AQUATAB

Question Number	Questionnaire for Village B (AQUATAB)	Users n= 91		non users n=7	
		(n)	**%**	**(n)**	**%**
1.	Date of AQUATAB introduction: May 2007	(98)	100		
2.	Immediate AQUATAB use	(96)	98		
2.1	Non immediate AQUATAB use 3 months later as I used SODIS or boiled water	(2)	2		
3.	Households drinking AQUATAB water regularly *	(91)	92.9		
3.1	Other methods used:				
	SODIS	(5)	5		
	Boiling water	(4)	4		
	Households who stopped using AQUATAB			(7)	7.1
	Reasons for stopping AQUATAB				
	Household does not like taste of water			(2)	28.6
	Household does not like smell			(4)	57.1
	We have not tried yet			(1)	14.3
4.	Entire household drink AQUATAB water	(87)	95.6		
4.1	Member s of household not drinking AQUATAB water	(4)			
	Father	(1)			
	Children	(2)			
	Mother	(1)			
4.2	Main reasons reported:				
	AQUATAB taste disliked	(1)			
	AQUATAB smell disliked	(1)			
4.3	Method used: SODIS	(4)			
5.	Households received training on AQUATAB	(91)	100	(6)	85.7
5.1	Training was easy	(91)	100	(3)	50
6.	NGO trained us	(91)	100		
7.	Person preparing AQUATAB in household*				
	Female in the house	(89)	79.5		
	Children	(9)	8		
	Father	(14)	12.5		
8.	Correct steps to prepare AQUATAB water (1 point for each step mentioned) Clean tank Filter to water in the tank and add tablet Cover tank Leave for 30 minutes				
	4 points (very accurate)	(2)	2.2		
	3 points (accurate)	(39)	97.8		
9.	Water source used by household for preparing AQUATAB				
	Hand dug well	(91)	100		
	Distance of water source:				
	More than 300 metres	(78)	85.7		
	Less than 300 metres from household	(13)	14.3		
10.	Household filtering water for treatment	(91)	100		
10.1	Households using cloth as filter	(91)	100		
11.	Type of container used for AQUATAB:				
	Dispenser 20L	(52)	57.1		
	Jerry can tank 20L	(15)	16.5		
	Bucket 20L	(21)	23.1		

	Other traditional containers more than 20 L	(3)	3.3		
12.	Tablets acquisition				
	Purchase from NGO	(70)	76.9		
	Use samples	(21)	23.1		
13.	AQUATAB treatment time				
	30 minutes	(64)	70.3		
	60 minutes	(27)	29.7		
14.	Frequency of treatment:				
	Every 1 or 2 days	(53)	58.2		
	Every 3 or 4 days	(23)	25.3		
	Every 5 or 6 days	(7)	7.6		
	More than every 6 days	(8)	8.8		
15.	Reported problems faced with AQUATAB	(10)	11		
	Lack money to buy tablets	(4)	40		
	Too busy in the field to prepare AQUATAB	(6)	60		
16.	Taste of AQUATAB water liked	(87)	95.6		
16.1	AQUATAB not liked as it tastes of chlorine	(4)	4.4	(7)	100
17.	AQUATAB water smells	(78)	85.7	(7)	100
18.	Household satisfied with AQUATAB method	(91)	100		
19.	Household reported no health problems since using AQUATAB	(91)	100	(7)	100
20.	Main reason for using AQUATAB method:				
	Economic: AQUATAB is an inexpensive method	(58)	63		
	Health: water is good for my health and safe to drink	(6)	6.5		
	Functional: practical and easy to prepare	(20)	21.7		
	Taste: no smell no taste	(8)	8.7		
21.	Respondents reporting that nobody disapproves of us using AQUATAB	(91)	100	(7)	100
22.	Advice on use of AQUATAB trusted:				
	NGO and cadre	(70)	76.9		
	Health operators	(21)	23.1		
	Preferred not to answer			(7)	100
23.	Respondents whose of opinion of AQUATAB changed with use	(26)	(28.6)	(1)	14.3
23.1	How opinion changed				
	AQUATAB water is positive for my health	(15)	57.7		
	AQUATAB is practical	(6)	23.2		
	AQUATAB is very cheap	(4)	15.4	(1)	100
24.	Treatment method preferred:				
	AQUATAB	(72)	73.5		
24.1	Reported reasons for preferring AQUATAB:				
	More practical than SODIS	(25)	27.8		
	Cheaper than SODIS	(44)	48.9		
	Smells and taste better than SODIS	(2)	2.2		
	Healthier method	(5)	5.6		
	Easier to prepare	(8)	8.9		
	Reported reasons for preferring SODIS (the taste is better)	(5)	5.1		
	Both (SODIS is better in dry season, AQUATAB in wet seasons)	(18)	18.4		
	Boiled water (it is cheaper and taste better)	(3)	3.1		
25.	Willingness to continue use AQUATAB	(90)	98.9		
	Unwillingness to continue use AQUATAB	(1)	1.1	(7)	100

Table A4-3: Data from questionnaire C- No SODIS no AQUATAB

Question Number	Village A questionnaire for Village C (No SODIS and no AQUATAB)	n=100	
		(n)	**%**
1.	Awareness of SODIS	(91)	91
	Awareness of AQUATAB	(80)	80
2.	Reported methods used by household*:		
	SODIS	(8)	7.8
	AQUATAB	(3)	2.9
	Other (boiling water)	(91)	89.2
3.	Household used SODIS in the past	(89)	89
	Household used AQUATAB in the past	(26)	26
4.	Household currently using SODIS	(8)	9
4.1	Average period of time of SODIS use (months)	8.05	
4.2	Reasons for stopping SODIS:		
	Economic: Cannot afford to buy bottles	(64)	79
	Health: (SODIS was not good for my family health)	(4)	4.9
	Taste: we do not like the taste	(3)	3.7
	Functional: lack time to prepare SODIS	(8)	9.9
	Social: neighbours stopped	(2)	2.5
5.	Currently using AQUATAB	(3)	3
5.1	Average period of time of AQUATAB use		
	1 day trial	(9)	39.1
5.2	Reasons for non-using AQUATAB:		
	Economic: sampling tablets finished and I have no money to buy new	(8)	34.8
	Health: experienced problems with AQUATAB	(2)	8.7
	Taste: water tastes of chlorine	(13)	56.5
6.	SODIS training received	(90)	90
7.	AQUATAB training received	(65)	65
8.	Perception that water treated with SODIS is good	(79)	79
8.1	SODIS heals from diseases	(42)	53.2
	SODIS water kills bacteria	(12)	15.2
	SODIS water is pure as contained in bottles	(13)	16.5
	Taste of SODIS is good	(2)	2.5
	It is like boiling water	(8)	10.1
	AQUATAB treated water is good for our health	(8)	8
8.2	SODIS treated water is not good for our health	(18)	18
	Gives us health problems (diarrhoea, flu stomach pain)	(8)	66.7
	Boiling water is better	(4)	22.2
	I do not know if SODIS is good for our health	(3)	3
	AQUATAB is not good for our health	(79)	79
	I do not know if AQUATAB is good for our health	(12)	12
9.	Respondents reporting people disapproving use of SODIS	(1)	1
9.1	Neighbours	(1)	100
10.	Respondents reporting people disapproving use of AQUATAB:	(6)	6
	Member of family	(1)	16.7
	Neighbours (they say it taste of medicine)	(5)	83.3

11.	Advice trusted*		
	NGO	(27)	22.1
	Paramedics	(90)	73.8
	Village leader	(3)	2.5
	Myself	(2)	1.6
12.	Respondent willingness to use SODIS:		
12.1	Only if free bottles are provided	(60)	60
	Yes (provide discussion with all villagers on benefits of SODIS)	(27)	14
12.2	Not at all (boiling water is better)	(13)	13
12.1	Respondent willingness to use AQUATAB (provide small group demonstration, discuss problems)	(23)	23
12.2	Not at all (it tastes like a medicine)	(77)	77

*Multiple responses set

Table A4-4: Reasons for not using SODIS and AQUATAB

Reasons for not using SODIS (Aggregate data from Village A and C)			**Reasons for not using AQUATAB (Aggregated data from Village B+ Village C)**		
n=92	n	%	n=83	n	%
Economic: Free bottles finished and have no money to buy new	73	79.3	Economic: Free tablets finished and I do not have money to buy new ones	8	9.6
Health: SODIS is not good for my health	4	4.3	Health: AQUATAB gives me health problems	3	3.6
Taste: dislike the taste of SODIS water	4	4.3	Taste: water taste of chlorine and smells	56	67.5
Functional: it is not a practical method	9	9.8	na		
Social: neighbours stopped using SODIS	2	2.2	Social: neighbours stopped and say it tastes of medicine	16	19.3

Table A4-5: Data on diarrhoea incidence

VILLAGE DIARRHOEA INCIDENCE DATA			
	Village A (Kolisia)	**Village B (Gunung Sari)**	**Village C (Watuliwung)**
Month -Year	**Estimated pop. 2007=1819 2008=2157**	**Estimated pop. 2008=725 (no data for 2007)**	**Estimated pop. 2007=1790 Estimated pop. 2008= 1898**
Average Jan-Apr-07	12.5	27.7	7
May-07	12	9	3
Jun-07	10	15	0
Jul-07	22	17	0
Aug- 07	18	19	0
Sep-07	18	39	0
Oct-07	4	38	0
Nov-07	8	22	2
Dec-07	7	11	1
Jan-08	16	39	9
Feb-08	13	78	6
Mar-08	7	26	3
Apr-08	5	24	9
May-08	7	14	6
Jun-08	6	14	3
Jul-08	3	14	9
Aug-08	11	16	9
Sep-08	16	24	6
Oct-08	3	61	8
Nov-08	4	18	9
Dec-08	5	2	12

Source: Data provided by Health Clinics and NGO

In- depth interviews

Table A4-6: Code co-occurrence presence

	Benefits	**Challenges**	**Strategies**
Behavioural	Yes	Yes	Yes
Economic	Yes	Yes	Yes
Environmental	Yes	Yes	No
Functional	Yes	Yes	No
Health	Yes	Yes	No
Institutional	No	Yes	Yes

Table A4-7: Code co-occurrence frequency

	Benefits	Challenges	Strategies
Behavioural	3	4	4
Economic	2	4	4
Environmental	1	1	0
Functional	1	1	0
Health	3	1	0
Institutional	0	1	3

Table A4-8: Comparison providers and users-gap analysis

Questions Providers	Questions users
What are the main challenges in introducing SODIS and AQUATAB programmes in the area?	Q3; Q17; Q18
Does the local government have educational programmes to increase users awareness about water treatment?	Q6; Q7; Q8; Q11; Q21; Q23
Do you think SODIS and AQUATAB are easily accepted in the villages?	Q3; Q5; Q17; Q18; Q19
Does the LG have procedures to monitor the performance of AQUATAB and SODIS?	Q16; Q20; Q23
What is the Local Government’s strategy to improve sustained use of SODIS/AQUATAB?	Q26; Q27

Secondary Data

Table A4-9: List of secondary data

DOCUMENT 1	Site: Maumere, Indonesia Date received: August 2009
Name and description of the document	Information on Villages (Kolisia, Gunung Sari and Watuliwung)
Event or contact with which the document is associated	Internal documents provided by local implementing agency.
Significance of document	Provides useful information for understanding context in the investigated villages.
Brief Summary of document	Describes context in terms of population, education, employment and water and sanitation conditions.
DOCUMENT 2	Site: Maumere, Indonesia Date received: August 2009
Name and description of the document	Data on diarrhoea incidence in Villages
Event or contact with which the document is associated	Internal document provided by village health clinics (Puskesmas) in the course of interview with head of clinic.
Significance of document	Provided useful information for investigating technology intended performance and on health status in the areas.
Brief summary of document	Raw data on diarrhoea cases.
DOCUMENT 3	Site: Maumere, Indonesia Date received: August 2009
Name and description of the document	AQUATAB, Technical report by Medentech
Event or contact with which the document is associated	Document provided by local NGO, for internal consultation.
Significance of document	Important to investigate Aquatab performance. It presents technical information on preparation and use of Aquatab, as well as examples of its introduction and dissemination to other countries.
Brief summary of document	The document provides a technical description on AQUATAB and presents case studies of its successful implementation in developing countries.
DOCUMENT 4	Site: Maumere, Indonesia Date received: August 2009
Name and description of the document	Progress report SODIS- May-September 2007
Event or contact with which the document is associated	Document provided by local NGO, for internal consultation.
Significance of document	Important to understand training conducted by NGO and participatory activities in the villages.
Brief summary of document	The document presents NGO participatory activities conducted to introduce and disseminate SODIS in the villages investigated.