RECAP – An Early Post-Implementation Tool to Assess Watsan Technology Performance

Elisa Roma[1], Alison Parker[1], and Paul Jeffrey[1]

Background

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 1 shows how recent evaluation studies of WATSAN technologies in developing countries can be clustered using the assessment categories discussed above.

The examples and methods for evaluating WATSAN technologies outlined in Table 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.

[1] Centre for Water Science, Cranfield University, Cranfield, Beds. MK43 0AL. UK

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).

Table 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

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.

We argue that despite these recent contributions and a more general shift of focus towards the human dimensions of technology use, both researchers and practitioners remain uninformed about end-users experiences of WATSAN technologies, particularly in the immediate post-implementation phase. Although 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. This knowledge gap, coupled with the opportunities that rapid post-implementation evaluations provide to remedial interventions provide an opportunity for development of a new evaluation 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.

The theoretical background to the RECAP tool

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. 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. 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 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.

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.

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, two theoretical models of technology transfer and acceptance, 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.

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. 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. The model is characterised by four components, outlined in Table 2.

Table 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 3 presents an inventory of the most relevant contributions.

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, a number of specific features of WATSAN technologies are influential in the adoption and use process. These are discussed in the following sub-paragraph.

Table 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)

The Attribute Perception model

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 but also the *organisational* and *personal* attributes have to be considered. By *organisationa*l 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. The premise at the basis of an 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 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 4.

Table 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.

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 outlines of the most relevant studies using gap analysis to investigate service quality.

Table 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 1.

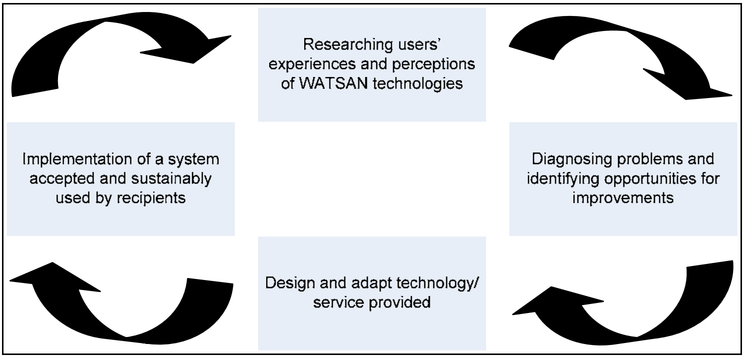

Figure 1: User involvement in the process of WATSAN technology implementation

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. Figure 2 summarizes the various models and components of the RECAP tool.

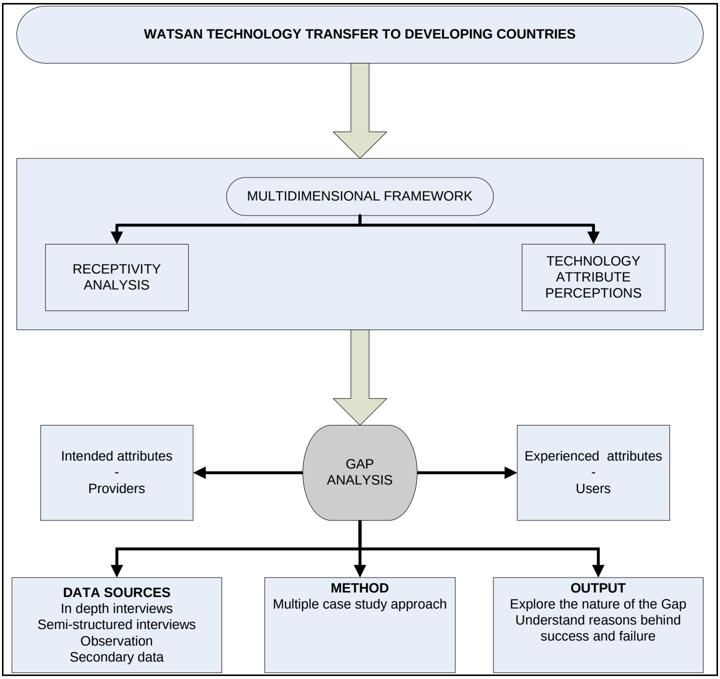

Figure 2: The multidimensional structure of the RECAP tool

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 3 illustrates the various steps of a RECAP assessment.

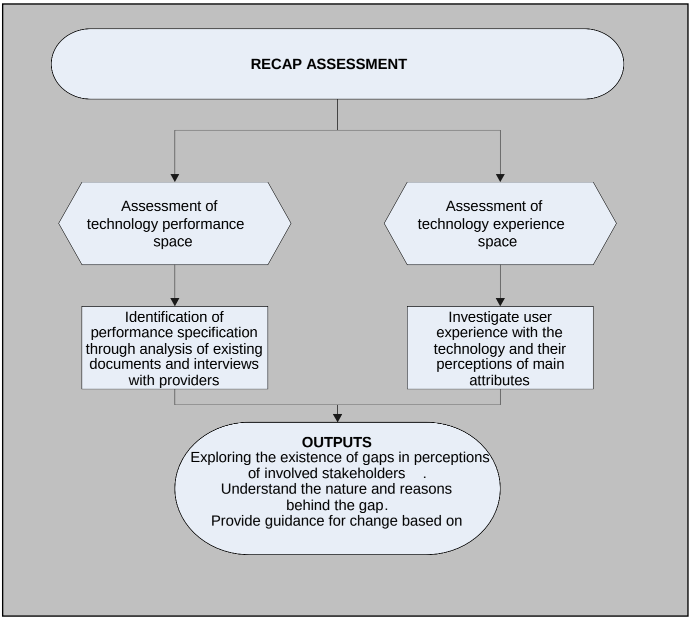

Figure 3: The RECAP assessment

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. Assessments 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. Users' receptivity and acceptance of WATSAN systems are affected by their ability to absorb, use and internalise technologies and 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.

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, and 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.

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 (Figure 4).

	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		

Figure 6: Swot analysis of the RECAP tool

In conclusion, we propose that 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.

References

Ademluyi, I. A. and Odugbesan, J.A. (2008). Sustainability and impact of community water supply and sanitation programmes in Nigeria: An overview. *African Journal of Agricultural Research*, 3 (12), p. 811-817.

Altherr, A., Mosler, H., Tobias, R. & Butera, F. (2008). Attitudinal and relational factors predicting the use of solar water disinfection: a field study in Nicaragua. *Health Education & Behavior*, 35 (2), p. 207-220.

Assefa, G. and Frostell, B. (2007). Social sustainability and social acceptance in technology assessment: A case study of energy technologies. *Technology in Society*, 29, p. 63-78.

Balkema, A.J., Preisig, H.A., Otterpohl, R. and Lambert, F.J.D. (2002). Indicators for the sustainability assessment of wastewater treatment systems. *Urban Water*, 4 (2), p. 153-162.

Beecham, M. and Cordey-Hayes, M. (1998). Partnering and knowledge transfer in the UK motor industry. *Technovation*, 18 (3), p.191-205.

Bewket, W. (2007). Soil and water conservation intervention with conventional technologies in northwest highlands of Ethiopia: acceptance and adoption by farmers. *Land Use Policy*, 24, p. 404-416.

Brown, S.W. and Swartz, T.A. (1989). A gap analysis of professional service quality. *Journal of Marketing*, 53 (2), p.92-98.

Burra, S., Patel, S. and Kerr, T. (2003). Community-designed, built and managed toilet blocks in Indian cities. *Environment and Urbanization,* 15 (2), p. 11-32.

Carter, R.C., Tyrrel, S.F. and Howsam, P. (1999). Impact and sustainability of community water supply and sanitation programmes in developing countries. *Journal of the Chartered Institution of Water and Environmental Management*, 13, p. 292-296.

Clarke, J. and Brown, R., (2006). Understanding the factors that influence domestic water consumption within Melbourne. *Australian Journal of Water Resources*, 10 (3), p. 261-268.

Cook, M.B., Bhamra, T.M. and Lemon, M. (2006). The transfer and application of product-service systems: from academia to UK manufacturing firms. *Journal of Cleaner Production*, 14 (17), p. 1455-1465.

Cromwell, G. (1992). What makes technology transfer? Small-scale hydropower in Nepal's public and private sector. *World Development,* 20 (7), p.979-989.

Diallo, M.O., Hopkins, D.R., Kane, M.S., Niandou, S., Amadou, A., Kadri, B., Amza A., Emerson, P.M. and Zingeser, J.A. (2007). Household latrine use, maintenance and acceptability in rural Zinder, Niger. *International Journal of Environmental Health Research,* 17 (6), p. 443-452

Downs, T. J. (2001). Making sustainable development optional: integrated capacity building for the water supply and sanitation sector in Mexico. *Journal of Environmental Planning and Management*, 44 (4), p. 525-544.

Dunmade, I. (2002). Indicators of sustainability: assessing the suitability of a foreign technology for a developing economy. *Technology in Society*, 24, p.461-471.

Friedler, E., Lahav. O., Jizhaki, H. and Lahav, T. (2006). Study of urban population attitudes towards various wastewater reuse options: Israel as a case study. *Journal of Environmental Management*, 81, p.360-370.

Gilbert, M. and Cordey-Hayes, M. (1996). Understanding the process of knowledge transfer to achieve successful technological innovation. *Technovation*, 16 (6), p. 301-312.

Gill, A. (2009). Knowledge management initiatives at a small university. International *Journal of Educational Management*, 23(7), p.604-614.

Goulet, D. (1994). Participatory technology assessment: institutions and methods. *Technological Forecasting and Social Change*, 45 (1), p. 47-61.

Graff, G., Roland-Holst, D. and Zilberman, D. (2006). Agricultural biotechnology and poverty reduction in low income countries. *World Development*, 34 (8), p.1430-1445.Grönroos, C. (1984). A service quality model and its marketing implications. *European Journal of Marketing*, 18 (4), p. 36-44. Harvey, P.A. and Drouin, T. (2006). The case for the rope-pump in Africa: a comparative performance analysis. *Journal of Water and Health*, 4 (4), p. 499-510.

Harvey, P.A. and Reed, R.A. (2007). Community-managed water supplies in Africa: sustainable or dispensable? *Community Development Journal*, 42(3), p. 365-378.

Headley, D.E. and Choi, B. (1992). Achieving service quality through gap analysis and basic statistical approach. *The Journal of Services Marketing*, 6 (1), p. 5-14.

Henriksen, A.D. (1997). A technology assessment primer for management of technology. *International Journal of Technology Management*, 13 (5/6), p. 615-638.

Hoos, I.R. (1979). Societal aspects of technology assessment. *Technological Forecasting and Social Change*, 13(3), p. 191-202.

Houben, G., Lenie, K. and Vanhoof, K. (1999). Knowledge-based SWOT-analysis system as an instrument for strategic planning in medium sized enterprises. *Decision Support Systems*, 26(3), p. 125-135.

Howard, G. (2003). Water safety plans for small systems: a model for applying HACCP concepts for cost-effective monitoring in developing countries. *Water Science and Technology*, 47 (3), p. 215-220.

IAIA- International Association for Impact Assessment (2003). *Social Impact Assessment.* Special Publication Series No.2, International Association for Impact Assessment, available at: http://www.iaia.org/publicdocuments/special-publications/SP2.pdf (accessed March 2010).

Jeffrey P. and Jefferson B. (2003). Public receptivity regarding "in-house" water recycling: Results from a UK survey. *Water Science and Technology: Water Supply,* 3 (3), p.109-116.

Jeffrey, P. and Seaton, R.A.F. (2004). A conceptual model of receptivity applied to the design and deployment of water policy mechanisms. *Environmental Sciences,* 1(3), p. 277-300.

Jones, S.A. and Silva, C. (2009). A practical method to evaluate the sustainability of rural water and sanitation infrastructure systems in developing countries. *Desalination*, 248 (1/3), p. 500-509.

Kalker, T.J.J., Maas, J.A.W. and Zwaag, R.R. (1999). Transfer and acceptance of UASB technology for domestic wastewater: two case studies. *Water Science and Technology*, 39 (5), p. 219-225.

Karani, P. (2001). Constraints for activities implemented jointly (AIJ) technology transfer in Africa. *Renewable Energy*, 22, p. 229-234.

Katz, T. and Sara, J. (1997). *Making rural water supply sustainable: Recommendations from a global study*. UNDP-World Bank Water and Sanitation Programme (WSP), Washington D.C.

Krepapa, A., Berthon, P., Webb, D. and Pitt, L. (2003). Mind the gap: an analysis of service provider versus customer perceptions of market orientation and impact on satisfaction. *European Journal of Marketing*, 37(1/2), p.197-218.

Lewis, R.C. and Booms, B.H. (1983). The marketing aspects of service quality. In: Berry, L. Shostack, G, and Upah, G. (eds), *Emerging perspectives on service marketing*, American Marketing, Chicago, p. 72-76.

Ling, F.Y.Y. and Gui, Y. (2009). Strengths, weaknesses, opportunities and threats: Case study of consulting firms in Shenzhen, China. *Journal of Construction Engineering and Management,* 135(7), p. 628-636.

Linstone, H.A., Meltsner, A.J., Adelson, M., Mysior, A., Umbdenstock, L., Clary, B., Wagner, D. and Shuman, J. (1981). The multiple perspective concept with application to technology assessment and other decision areas. *Technological Forecasting and Social Change*, 20 (4), p. 275-325.

Louis, G.E., Magpili, L.M. and Pinto, C.A. (2007). Deficit analysis: service capacity assessment and planning in developing countries: case study in the Philippines. *Environmental Monitoring and Assessment*, 135 (1-3), p. 77-84.

McIntosh, B., Seaton R.A.F. and Jeffrey, P. (2007). Tools to think with? Towards understanding the use of computer-based support tools in policy relevant research. *Environmental Modelling and Software*, 22 (5), p. 640-648.

Meierhofer, R. and Landolt, G. (2009). Factors supporting the sustained use of solar water disinfection- Experiences from a global promotion and dissemination programme. *Desalination*, 248, p.144-151.

Morrison, M. (2008). SWOT analysis. CIPD (Chartered Institute of Personnel and Development), London, available at: http://www.cipd.co.uk/subjects/corpstrtgy/general/swot-analysis.htm (accessed July 2010).

Narayan, D. (1993). *Participatory evaluation. Tools for managing change in water and sanitation*. World Bank Technical Paper No. 207, The World Bank, Washington, D.C.

Narayan, D. (1995). *The contribution of people's participation. Evidence from 121 rural water supply projects*. Environmentally sustainable Development Occasional Paper Series No.1, The World Bank, Washington, D.C.

Oliveira, S.M.A.C., Parkinson, J.N. and von Sperling M. (2006). Wastewater treatment in Brazil: institutional framework, recent initiatives and actual plant performance. *International Journal of Technology Management and Sustainable Development*, 5 (3), p. 241-256.

Palm, E. and Hansson, S.O. (2006). The case for ethical technology assessment (eTA). *Technological Forecasting and Social Change*, 73 (5), p. 543-558.
Parasuraman, A., Zeithmal, V.A. and Berry, L.A. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, 49, p.41-50.
Rainey, R.C. and Harding, A.K. (2005). Acceptability of solar disinfection of drinking water treatment in Kathmandu Valley, Nepal. *International Journal of Environmental Health Research*, 15(5), p. 361-372.
Ramanathan, K. (1994). The polytrophic components of manufacturing technology. *Technological Forecasting and Social Change*. 46 (3), p. 221-258.
Ramanujam, V. and Saaty, T.L. (1981). Technological choice in the Less Developed Countries: an analytic hierarchy approach. *Technological Forecasting and Social Change*, 19 (1), p.81-98.
Rijal, K. (1999). Renewable energy policy options for mountains communities: experiences from China, India, Nepal and Pakistan. *Renewable Energy*, 16, p.1138-1142.
Rogers, E.M. (2003). *Diffusion of innovations*, (5th ed.), Free Press, New York, USA.
Rogers, E.M. (2004). A prospective and retrospective look at the diffusion model. *Journal of Health Communication: International Perspectives*, 9 (6), p. 13-19.
Schott, J. and Rip, A. (1996).The past and future of constructive technology assessment. *Technological Forecasting and Social Change*, 54 (2-3) p. 251-268.
Seaton R.A.F. and Al-Ghailani H. (1997). “Innovative effort" in small manufacturing companies in development economies. Proceeding of Sixth International Conference on Management of Technology - MOT 97, Goteborg, Sweden, ISBN 91-630-5611-9, p. 666-679.
Seaton R.A.F. and Cordey-Hayes M. (1993). The development and application of interactive models of industrial technology transfer. *Technovation,* 13 (1), p. 45-53.
Seaton, R.A.F. (1997). *Technology, knowledge translation and policy: conceptual frameworks and case-studies*, (unpublished PhD Thesis), Cranfield University, Cranfield.

Srivatava, P.K., Kulshreshtha, K., Mohanty, C.S., Pushpangadan, P. and Singh, A. (2005). Stakeholder-based SWOT analysis for successful municipal solid waste management in Lucknow, India. *Waste Management*, 25(5), p. 531-537.

Steinman, C., Deshpandé, R. and Farley, J.U. (2000). Beyond market orientation: when customers and suppliers disagree. *Academy of Marketing Science*, 28 (1), p. 109-119.

Terrados, J., Almonacid, G. and Hontoria, L. (2007). Regional energy planning through SWOT analysis and strategic planning tools. Impacts on renewables development. *Renewable and Sustainable Energy Review*, 11, p. 1275-1287

Tran, T.A. (2007). Review of methods and tools applied to technology assessment literature. In: *PICMET Proceedings*, 5-9 August 2007, Portland, Oregon.

Trott P., Cordey-Hayes M. and Seaton R.A.F. (1995). Inward technology transfer as an interactive process. *Technovation,* 15 (1), p. 25-43.

Vickers, I. and Cordey-Hayes M. (1999). Cleaner production and organizational learning. *Technology Analysis & Strategic Management*, 1, p.75 -94.

Vishnudas, S., Savenije, H.H.G., Van der Zaag P., Kumar, C.E.A. and Anil, K.R. (2008). Sustainability analysis of two participatory watershed projects in Kerala. *Physics and Chemistry of the Earth*. 33, p. 1-12.

Von Münch, E. and Mayumbelo, K.M.K. (2007). Methodology to compare cost of sanitation options for low-income peri-urban areas in Lusaka, Zambia. *Water SA*, 35 (5), p. 593-602.

Yacoob, M. (1990). Community self-financing of water supply and sanitation: what are the promises and pitfalls? *Health Policy and Planning*, 5 (4), p. 358-366.

Yang, C. (2003). Establishment and application of the integrated model of service quality measurement. *Managing Service Quality*, 13 (4), p.310-324.