UNDERSTANDING THE SUSTAINABLE MANAGEMENT OF SMALL WATER TREATMENT PLANTS IN RURAL COMMUNITIES :

A SYSTEMS THINKING STUDY

Final Report to the
WATER RESEARCH COMMISSION

by

K Murray – Insight Modelling Services
M du Preez – Environmentek, CSIR
M Lebone - Tsinde Development Consultants
I A Pearson - WATSUP

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EXECUTIVE SUMMARY

Background

The workshop on Sustainability of Small Water Systems in Southern Africa, held on August 2002, in Johannesburg identified the management of small water treatment plants for rural communities and small towns in South Africa as being particularly problematic. Besides technical issues, a number of social and institutional issues were noted as having received inadequate attention in the past. It was believed that this was often responsible for lack of sustainability.

This report investigates a "systems thinking" approach to a better understanding of these issues and their inter-relationships in this challenging context.

Objectives

The objectives of this project were as follows:

- To test the use of a systems approach for analysing the issues affecting sustainable management of small water treatment plants in rural communities.
- To test the use of a systems approach for developing generic process guidelines that will complement existing technical guidelines and facilitate sustainable management in future.

Scope

- The primary purpose of this work was to test an approach, in particular, a "systems approach" or, equivalently, apply "systems thinking". It therefore does not go into significant detail in respect of all the issues identified.
- The emphasis is mostly on sustainable management of small water treatment plants in rural communities (typically manifest during the operation & maintenance phase). However, it is recognised that such plants are only one part of a larger water supply scheme. Therefore, issues relating to (a) this broader water supply scheme and (b) phases prior to operation & maintenance are also considered.
- Although both technical ("hard") issues and social ("soft") issues are addressed, emphasis is given to better understanding the latter.

Approach

The overall approach was as follows:

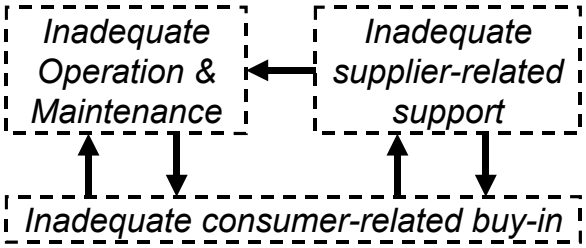
- Identify typical problems and understand their inter-relationships (captured in a systems model).
- Identify issues required for sustainable management.
- Break down selected issues into sub-models (or lower level issues).
- Develop a process model that addresses selected important issues.
- Perform a simple qualitative model validation exercise.

Sources of information for issue identification and model development were limited to the following:

- Personal experiences of the team and a few external parties involved in water treatment plant developments.
- Relevant publications.

Systems models

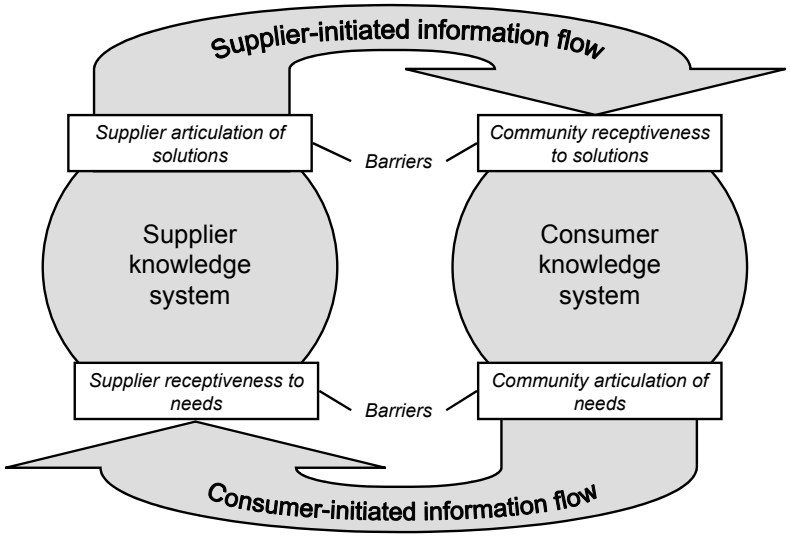
A systems model (consisting of a box and arrow diagram and associated explanatory text) was developed for potential pitfalls. This identified about 20 individual issues. These were grouped into three high-level categories, related as follows:



Feedback loops are evident in this model that illustrate the particular importance of consumer-related buy-in.

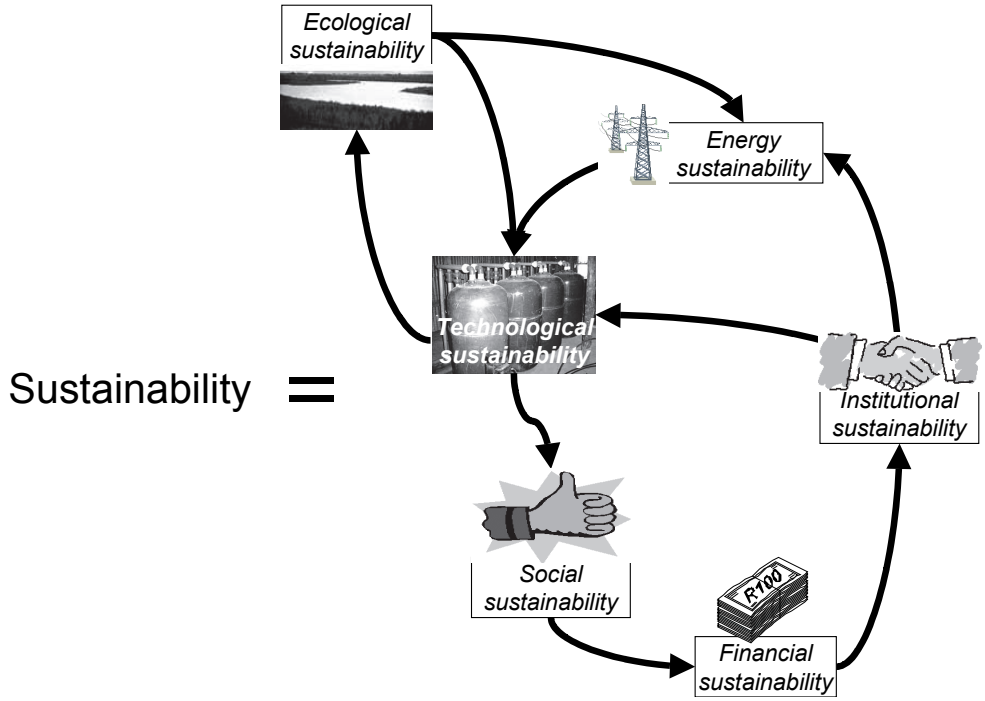
A sub-model was developed for effective information flow. This was based on a model developed by Havelock (1986) and adapted my Meyer (2000a). The latter model (not a systems model) identified four potential barriers to information flow (illustrated in the following figure):

- Community articulation of needs and supplier receptiveness to those needs.
- Supplier articulation of potential solutions and community receptiveness to those solutions.



The systems model identified a number of issues that overcome these potential barriers. These included desire and ability in each case. Desire is related to buy-in while ability is related to degree of empowerment.

Another sub-model was developed that examined some inter-relationships between components of sustainable management (financial sustainability, institutional sustainability, etc.). This specific model demonstrated that expressing a series of issues as a bullet list can be misleading. This can give the impression that the issues are independent. Depicting these same issues as interacting and dependent on one another is far more realistic. A systems model is eminently suited for this, as shown in the following figure:



A further model was then developed that depicted the consequences of unsustainable management. In particular, this identified ecological, social and economic impacts. This too demonstrated the ability of a systems model to communicate visually.

Process model

Effective information flow was identified as an apparently important issue in the systems models. This was chosen as the focal issue of the process model.

A particular emphasis in the systems model on effective information flow was the need for understanding of the respective knowledge systems of the supplier and community. Two dimensions of these reference systems were identified as:

- The bottom-up approach of suppliers (that is currently encouraged), and
- The Western and African reference systems.

These were examined in some detail. It was stressed that each side (supplier and community) should be aware that these different reference systems exist. These reference systems automatically determine the nature of any communication.

On the basis of this and the adapted Havelock model, a simple process model was developed. The backbone of this model was a series of questions aimed at the existence of the above-mentioned desires and abilities. If any is answered as negative, then simple guidance is given on what actions to carry out and specifically what those actions should focus on.

Model validation

A simple subjective process model validation exercise was undertaken by considering three case studies. This involved assessing the extent to which the questions in the process model were actually addressed in each case study. The degree of success of each actual development was also judged. This was based on the degree to which the original designs remained fully operational. The case studies varied from failure, to partially successful to successful.

The model validation exercise indicated in each case that the degree to which the questions in the process model were addressed in each actual development seemed correlated with the ultimate success of the project. Taken at face value, this implies that, even though the process model only addresses issues relating to information flow, these questions may be apparently critically important. It suggests that, even though, for example, the reason for a development failure might be ascribed to inadequate cost recovery, inadequate information flow (and ultimately inadequate consumer-related buy-in) was actually the root cause.

Although the model validation exercise gave encouraging results, it must be stressed that it was entirely subjective, limited and very simple.

Conclusions

The systems models developed have shown the following:

- Detailed examination of low-level issues can usually result in a sensible grouping of high-level issues. These in turn allow concise and accurate statements to be made about the most important issues. These are particularly useful in broad planning contexts and policy statements.
- Hard (technical) and soft (non-technical) issues can be easily incorporated in the same systems model.
- The use of simple images and icons in the visual depiction of a systems model greatly facilitate communication of the issues, especially to non-experts in the field.
- The models suggest that sustainable management of small water treatment plants, although primarily a supplier-related perspective, must be a co-operative dynamic partnership between all parties involved, in such a way that
  - They are all aligned with the mutually agreed objective of the development, and
  - The interests of no single party unreasonably dominate.

Process model development demonstrated the relative ease with which such models can be developed (if the systems model is in place). The primary reason for this is that the depth and breadth of examination of issues within the systems models enables the important issues to be identified with confidence and their interactions to be well understood. The series of actions that should comprise a process model become somewhat self-evident since they must address the important issues (otherwise the action is likely to be redundant).

Finally, it was noted that, in essence, understanding is the basis of genuine empowerment and capacity building. Systems models create understanding. They also have the added advantages of:

- Enabling highly focused process development, and
- Facilitating communication of that process to others.

Extent to which objectives achieved

- Systems thinking was found to be eminently suited to examining issues affecting sustainable management of small water treatment plants in rural communities. This was particularly so because systems thinking is very well suited to exploring soft issues.
- The development of a simple process model addressing the specific issue of effective information flow was found to be relatively straightforward. The generic process guidelines contained in this process, backed up with the information contained in the associated systems models, can quite reasonably be regarded as complementary to existing guidelines. This applies to existing technical and non-technical guidelines (like those that address participatory approaches). The current process model highlights specific focal points that should drive all interactions between supplier and rural community.

Capacity building

No formal capacity building was carried out in this project.

Recommendations for further research

The limited resources allocated to this specific project to test the approach has meant that many of the important issues have either not been investigated at all, or have been dealt with in a very shallow manner. A particularly prominent example is cost recovery on which much other work has been done. However, this (and other issues) has not been subjected to the rigours of systems thinking in the quest for more holistic thinking. The complexities of sustainable management are quite evident from the current investigation. The issues addressed here comprise the "tip of the iceberg".

If the approach demonstrated herein is considered by those experienced in the field to have provided, either:

- A few new perspectives on sustainable management of small water treatment plants in rural communities, or
- A potentially useful mechanism for learning, empowerment and capacity creation within the sector, then

it is strongly recommended that the work begun here be expanded to include a more detailed examination of the other critically important issues (besides effective information flow which was chosen as a focal point for this work). This will ensure that the ultimate identification of critical issues is more balanced that was possible in this work.

It is also quite conceivable that the approach could ultimately be broadened to other contexts in the water services sector.

Recommendations for technology transfer

Because this project was focused on testing an approach and not necessarily producing deliverables of practical use, the actual models developed herein may not necessarily be sufficiently all-encompassing to be significantly useful. Nevertheless, the process model does present a focus that may complement present approaches. The report itself should therefore be made available to practitioners, at the very least to get their feedback.

The pictorial presentation of systems models is highly amenable to a variety of visual enhancements that can greatly improve their ability to communicate issues. This is especially so with less experienced and even less well-educated people. In other words, a well-prepared full-colour pictorial systems model can be a powerful general communication and teaching aid. In particular:

- They can be easily incorporated into reports produced by practitioners in the water services sector.
- They can be used to produce overhead transparencies for use in presentations by such practitioners to both supplier-related and consumer-related organisations.
- They can be used in posters.

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GLOSSARY

Articulate. Express fluently and coherently.

Capacity building. Enhancing of the abilities of individuals, groups, institutions and organisations to (a) identify and solve problems and (b) to perform tasks and provide services effectively and efficiently [Koster, 2004].

Communication. Exchange of messages between people [Mchombu, 1992]

Indigenous knowledge system. The complex knowledge, technologies, customs and culture existing, and developed around, specific conditions in populations and communities indigenous to a particular geographic area [NRF, 2004].

Institution. A set of formal rules (*i.e.* laws, policies) and informal rules (codes of conduct, trust, norms of behaviour) and enforcement mechanisms providing a framework in terms of which organisations behave in the broader environment [Koster, 2004].

Organisation. A business or administrative concern united and constructed for a particular purpose [Collins Shorter English Dictionary, HarperCollins, 1994].

Water Committee. A collection of community members responsible for representing the community in water-related affairs.

White elephant. 1. A rare albino variety of the Indian elephant, regarded as sacred in parts of South Asia. 2. A possession that is unwanted by its owner. 3. A rare or valuable possession the upkeep of which is very expensive. [Collins Shorter English Dictionary, HarperCollins, 1994]

CHAPTER 1: BACKGROUND

1.1 INTRODUCTION

One of the most fundamental contributors to good quality of life is access to adequate amounts of good quality water. Two Acts are particularly relevant with respect to ensuring that everyone has access to this service:

- The National Water Act (No. 36 of 1998). This addresses the management of the nation's water resources.
- The Water Services Act (No.108 of 1997). This addresses the rights of access to basic water supply and basic sanitation.

Provision of a basic water supply frequently requires the treatment of water from raw water resources (like rivers, impoundments, groundwater, etc.) to ensure that the water supplied is of adequate quality for its intended use. In particular, provision of water for domestic use in rural communities, larger settlements and small towns often involves the installation of small water treatment plants. Such development initiatives are never trivial. A wide variety of issues must be addressed. On the one hand purely technical aspects relating to the design and physical construction and operation need to be considered. On the other hand, the water treatment plant must be viewed as an integral part of the overall water supply system. For small schemes in rural areas this requires that special attention be given to delicate social and institutional issues. These can have significant effects on the ability of the developers to ultimately deliver their technical product (the plant and the water it was designed to deliver) [Pybus *et al.*, 2000].

The workshop on Sustainability of Small Water Systems in Southern Africa, held on August 2002, in Johannesburg identified the management of small water treatment plants for rural communities and small towns in South Africa as being particularly problematic. This report investigates a "systems thinking" approach to a better understanding of the issues and their inter-relationships in this challenging context. It is believed that the holistic understanding provided by systems thinking will promote more insightful management.

1.2 SYSTEMS THINKING

"Systems thinking" is simply a tool for thinking. It involves, in essence, identifying issues and understanding their interactions. The term "systems modelling" can also be used. However, initially (in the thinking process) such models might be called "conceptual" models. This implies that the models are intended to improve ways of thinking (and particularly understanding).

It is possible (at least in principle) to convert these qualitative conceptual models into quantitative models that can be run on computers and that provide numerical results. However, this is not the intention in this application and will not be discussed further.

An "issue" is regarded as any quantifiable property or attribute. Mathematicians would call these "variables". Obvious examples of properties might be water flow or temperature. Each of these is measurable with some physical or chemical device. However, an issue is more general.

Issues may include "degree of understanding" or "degree of engagement of stakeholders". An issue need only be "quantifiable", not necessarily actually "measurable". In other words, as long as the attribute can be quantified *in principle* it can be regarded as an "issue". That is, being quantifiable means that some measure can potentially be assigned to it that describes its extent. This can be either by formal measurement (using some device) or just qualitatively estimated, and then even as simply as low, medium or high.

Forcing this requirement into one's thinking promotes a choice of words or phrases (to describe the issue) that imply that the issue is quantifiable. Importantly, it also ensures that a clear distinction can be made between issues and process steps. It is useful to think of issues as nouns. Process steps are verbs or actions. Systems models are not process models. Systems models address issues (not actions). Care needs to be taken when interpreting systems models because often an issue is simply worded as, for example, "understanding" or "engagement of stakeholders". However, the words "degree of" should be regarded as implicitly appearing before such phrases.

Systems models are very conveniently illustrated in diagrams of boxes and arrows. A box represents a quantifiable issue. An arrow represents an interaction between issues. An arrow from issue A to issue B means "issue A drives/increases/promotes issue B".

However, far more important than these detailed concerns about interpretation is the overall purpose of systems thinking. System thinking requires regarding the workings of the world around us as a network of interacting issues. There are causes and effects. There are "knock-on" effects and feedback loops affecting the original causes. Often a dynamic equilibrium exists between issues. It may be a balanced "give and take" or a balance between supply and demand.

The word "holistic" is a common buzzword, though often only paid lip service. However, systems thinking can be the ultimate tool for truly holistic thinking. The interactions between issues are only limited by the thinker's imagination and insight. It copes with both "hard" (*i.e.* technical) and "soft" (*i.e.* non-technical, social) issues in the same model, when necessary. Indeed, if anything, it is more suited to understanding the softer issues.

Systems thinking is a powerful thinking tool. At its core is the maxim: Don't think "bullet lists", think "dynamically balanced networks".

1.3 SCOPE

The following points are emphasised to ensure that the scope of this report is well defined.

- The primary purpose of this report is to test an approach. In particular, it examines a "systems approach" to a very specific developmental context. The purpose of this report is therefore not regarded as having to deliver a product that is actually useful in that context. Naturally, it is recognised that the more practically useful the product the more convincingly the approach will have been demonstrated. However, the context is broad and some aspects will almost certainly not have been covered to a degree of detail considered relevant by some practitioners in the field.
- The specific kind of development that is the focus of this work is a small water treatment plant in a rural community. However this is only one part of a larger

water supply scheme (including considerations from original water source through to points of collection, such as standpipes, to points of use in the household). Furthermore, this scheme is inevitably part of a larger regional Water Services Development Plan. Nevertheless, since this work is testing an approach, it tends to emphasise sustainable management of treatment plants. However, it also considers to some extent issues related the following:

  - The broader water supply scheme, and
  - Issues relating to phases prior to the operation & maintenance phase (the phase during which the degree of sustainable management is manifest).

- Finally, although both technical ("hard") issues and social ("soft") issues are addressed, emphasis is given to better understanding the latter. This is because, first, it has been realised that social aspects relating to service provision were somewhat ignored in the past while emphasis has rather been given to technical aspects [Bernhardt & Associates, 1998]. Both local and international experience has resulted in recognition of the critical relevance of social issues in addressing water supply schemes in rural communities. Secondly, the applicability of a systems approach to technical issues might be regarded by many as self-evident. It is therefore specifically intended that a systems approach to soft issues also be demonstrated.

1.4 APPROACH

The overall approach of this project was to first identify problems and other issues related to sustainable management (in particular reflected in operation & maintenance of the plant) and structure their inter-relationships in order to better understand them. Issue identification was achieved in the following ways:

- Making use of the personal experiences of the project team.
- Noting problems identified in relevant publications.

This report focuses on the sustainable management of small water treatment plants. However, many of the associated issues are common to the general supply of water and sanitation. Accordingly, some guidance has been obtained from that section of the literature.

1.5 STATUS QUO

1.5.1 Introduction

As a basis for the systems models presented in the following chapter, the following sections describe various components relating to the development and operation & maintenance of a small water treatment plant in a rural community.

1.5.2 Typical development phases

The following generic phases of development relating to small water treatment plants in rural communities are assumed to apply.

Table 1.1. Project phases and typical activities.

PHASE	**Typical activities**
Regional planning	Broad planning of water services in a region (*e.g.* district)
Project planning	Detailed project business plan, secure project funding
Design	Detailed engineering design
Construction	Plant construction, capacity building
Operation & Maintenance	Handover (phased if necessary), plant management, operation, monitoring, maintenance, mentoring

1.5.3 Institution versus organisation

1.5.3.1 General interpretation

It is proposed here that the distinction between an institution and an organisation is useful (see Glossary). This is explored in this section. For convenience, the definitions of the two entities are repeated here:

Institution. A set of formal rules (*i.e.* laws, policies) and informal rules (codes of conduct, trust, norms of behaviour) and enforcement mechanisms providing a framework in terms of which organisations behave in their broader environment [Koster, 2004].

Organisation. A business or administrative concern united and constructed for a particular purpose [Collins Shorter English Dictionary, HarperCollins, 1994].

In general, these may be interpreted as meaning that a number of organisations might commit themselves to behave within a set of rules (the "institution"). An individual organisation need not necessarily align all of its activities with this institution. However, those activities required to achieve the ultimate purpose of the institution must be so aligned. The other activities are, by definition, focussed on other purposes specific to that organisation and are not necessarily of any concern to the institution. In other words, only a subset of activities in each organisation need align themselves with the institution.

1.5.3.2 National interpretation

Let us now consider the specific context of water services provision in South Africa.

In this context, the institution (*i.e.* the set of rules) is determined primarily, though not only, by the Water Services Act (No. 108 of 1997) (that provides the formal rules) and such approaches as being "consumer oriented" (an informal rule). The "organisations" whose behaviours are determined by these rules (*i.e.* by this institution) include those that the Act defines as "water services institutions". These include a water services authority, a water services provider, a water board and a water services committee.

In terms of the definitions of institution and organisation proposed above, these "water services institutions" might be regarded as "organisations wholly aligned with the institution of water services encompassed by the Act and other less formal rules".

1.5.3.3 Project interpretation

It is also possible to take the concept further and apply it in a project-specific context. A project refers to a specific development with the objective of providing a water treatment plant to a rural community. In this project context, the "institution" will include the following:

- The formal and general informal rules associated with the institution of water services provision in a national context. This is in effect the "umbrella" or national institution referred to above in which the formal rules are primarily provided by the Water Services Act.

- Other project-specific rules that relate specifically to the interested and affected parties of the project.

Besides the above water services institutions, other organisations may commit themselves to the "local project institution". These may include individuals or groups representing the community. To become part of the institution these must also commit themselves to a set of rules, typically established by mutual agreement. These will inevitably underpin their responsibilities for which they can be held accountable.

1.5.4 Roles and responsibilities

The following roles and responsibilities are recognised in a typical generic implementation of a small water treatment plant in a rural community. It is not necessarily all-inclusive and detailed. It only includes those roles and responsibilities considered relevant to identifying problems in the current context. Much of the information is taken from Vermeulen (2002).

Table 1.2. Generic roles and responsibilities.

Role	Typical role players	Typical responsibilities
Regulator	Water Service Authority (WSA)	Realisation of the right to access to basic water services, preparation of water services development plans, selection of water services provider, regulation, communication with consumers, securing of funding, contracting, contract management, ultimate decision making, monitoring during operation & maintenance, ensuring overall provision of effective, efficient, sustainable and affordable service.
Project steering	Steering Committee (representatives from WSA, community, regional & local government)	Overall guidance, institutional integration, some decision making, monitoring of progress of the project
External Regulator	Provincial government departments, regional DWAF office, Catchment Management Agency	Ensure compliance with legislation, provide support to WSA, independent monitoring during operation & maintenance
Water Services Provider	Water services authority, water board, district or local municipality, private company, community-based organisations, partnership between any of the aforementioned.	Provide water services in accordance with Constitution, the Water Services Act and the by-laws of the water services authority and conditions of contract with water services authority, contribute to project planning, design and construction, daily management and operation of plant in operation and maintenance phase

Specialist	Engineers, social and institutional experts (may change from phase to phase)	Provide expert input, advice and support (all phases)
Consumer representation	Water Committee	Coordinates and guides water-related affairs within the community, communication between community and authorities, contributes to design, construction and operation & maintenance phases
Consumer	Rural community	Comment on design, contribute to construction where possible, report problems during operation & maintenance, pay for services

Table 1.3. Roles and respective involvement in phases (a shaded cell means involvement in that phase).

Role	Regional planning	Project planning	Design	Construction	Operation & Maintenance
Implementing authority					
Project steering					
Regulator					
Water services provider					
Specialist					
Consumer representation					
Consumer					

Table 1.4. Integrated roles.

Integrated Role	Specific roles
Supplier	Implementing authority, regulator, water services provider (including plant operator), specialist
Steering and liaison	Project steering, consumer representation
Consumer	Consumer

1.5.5 Summary of reported problems

This section does not intend to provide any analysis of the current situation. Rather it intends to set the scene for the analysis to follow (in the Systems Models chapter). It relates some specific observations and opinions of those who have been involved in the context of water services provision, both locally and internationally.

- Failure to successfully integrate all relevant variables into planning of sanitation projects and in selecting sanitation technologies has been recognised as an underlying cause of failed service delivery [Howard *et al.*, 2000].

- Striking emphasis on the nature of the divide being addressed in this report is provided by Pybus *et al.*, 2000. In research relating to the level of communication between engineers and communities in the provision of engineering services, they noted, among other points, the following:
  - The majority of engineers interviewed saw the purpose of the project in technical terms.
  - The social, institutional and development aspects of the project were not seen to be as important as the technical requirements.
  - From the community perspective, it appeared that little or no consultation had taken place.
  - No needs analysis of the community had been undertaken and the water project was not necessarily the top priority.
- Mathew (2002) listed a wide variety of "problems with sustainability of community water schemes": These include "technical breakdown, lack of technical knowledge, inappropriate technology, inappropriate location, lack of access to spare parts, lack of management skills, lack of financial skills, lack of a bank to keep money securely, lack of transparency of village accounts, lack of collective resources, lack of individual resources, lack of conflict resolution skills, theft, lack of ownership, lack of democracy, lack of local control, dominance of corrupt individuals, lack of assertiveness, lack of trust, lack of gender balance, lack of community, lack of rain, too much rain". He adds "these are all compounded by a lack of experience of how to deal with situations when they arise".
- Swartz (2002) noted that "the biggest difficulty with small water treatment systems is sustainability". He also noted that the inability to produce the required quantities of safe drinking water was largely due to the following:
  - Lack of funds.
  - Lack of appropriate treatment.
  - Lack of well-trained operators.
  - Lack of maintenance support.
- Lessons from other countries can also serve South Africa well. The following relates to a water pump system in Uganda. In the 1930s the government introduced a borehole pump system to rural communities [Bwengye, 2002]. Some 5089 boreholes were drilled. These were ostensibly maintained by 15 "borehole maintenance units". By 1980 only 25% were working. The government, with UNICEF assistance, embarked on a strategy of emergency

pump repair and training of maintenance units. This was largely unsuccessful. A survey in 1983 revealed that only 32% were working. At that time thinking around "community management" emerged as an alternative.

- An evaluation of completed RDP community water supply projects in the Eastern Cape found that some communities felt that they had not been properly consulted and were merely informed that they were to receive a water project [Daniel, 2002]. This led to problems including inappropriate services, conflict and vandalism of pipes. Daniel goes on to observe that subsequent schemes that adequately addressed community participation were "more successful and sustainable". This he attributed to a local sense of ownership in the scheme.
- A recent study highlighted groundwater supply schemes in the Western Cape and Eastern Cape that provided water with inadequate microbiological water quality [Mackintosh and Colvin, 2003]. Where some treatment facility existed, failures were noted due to the following:
  - Pump failure, particularly wind pumps.
  - Contamination via the reticulation system, particularly where corrosive water were abstracted.
  - Contamination of storage reservoir (often because they are open).
  - Failure to chlorinate.
  - Inadequate or non-existent management practices, including failure to act upon monitoring results.

CHAPTER 2: SYSTEMS MODELS

2.1 INTRODUCTION

The following sections focus on potential problems and pitfalls related to small water treatment plants though also consider the interactions with issues in the broader water supply scheme. It must be emphasised that it is not the intention here to imply that all suppliers (or any specific suppliers) of small water treatment plants exhibit all (or any) of the specific shortcomings mentioned below. Rather, it systematically examines, in a generic sense, the kinds of problems that have been identified in a large number of projects to date. Indeed, many rural water projects have been very successful [Netshiswinzhe, 2002]

The word "development" is used in the following sections to refer to the whole process from planning to operation & maintenance of a small water treatment plant in a rural community. However, since sustainable management is the ultimate concern, the model tends to emphasise potential pitfalls relevant during the operation & maintenance phase. It is in this phase in which unsustainable management (or its effects) will become most evident. Naturally, some of the problems identified may have persisted from the initial phases of the project.

2.2 POTENTIAL PITFALLS

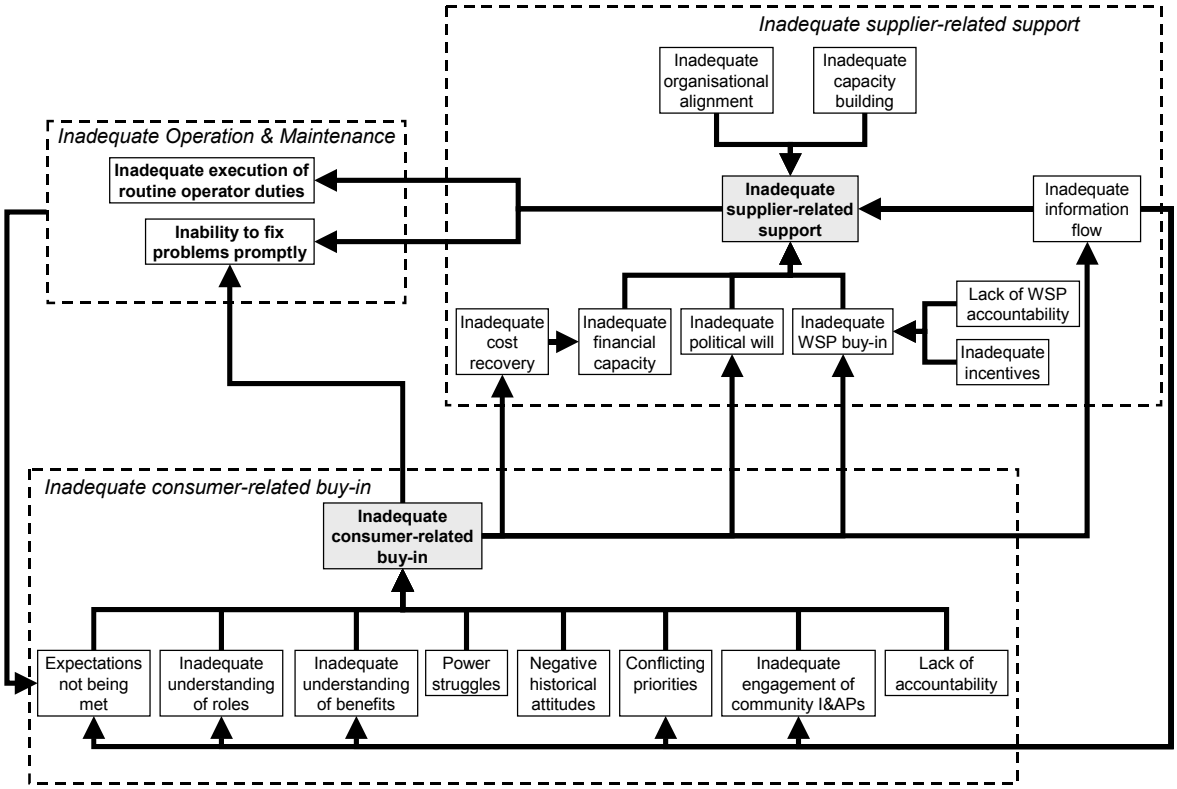


Figure 2.1. Low-level potential problems manifest during the operation & maintenance phase.

2.2.1 Inadequate operation and maintenance

Definition: The degree to which the functioning of a small water treatment works is caused to be incapable of providing the output water quality and flow for which it was designed.

Inadequate operation and maintenance increases the likelihood of

- *Expectations not being met* because typically community-related expectations will have been based on the plant operating within certain output water quality and flow specifications. *Inadequate operation and maintenance* means that these specifications are unlikely to be met, and hence expectations will also not be met.

Inadequate execution of routine operator duties

Definition: The degree to which execution of daily and other routine operator tasks is inadequate (*i.e.* unable to sustain the design water quality and flow specifications).

Comments: Routine operator duties include the following:

- Dosing of chemicals, maintaining good floc formation, cleaning of filters, desludging of settling tanks, running of pumps.
- Monitoring.
- Preventative maintenance.
- Record keeping and stock control.
- Problem reporting.
- Ensuring adequate treatment and disposal of residues from the treatment process.

Inability to fix problems promptly

Definition: The degree to which disruptions in the functioning of a plant are unable to be rectified within reasonable periods of time resulting in unacceptable interruptions to the provision of the design output water quality and flow.

2.2.2 Inadequate supplier-related support

Definition: The degree to which institutional structures, management processes and skills within supplier organisations (especially the Water Services Authority and Water Services Provider) are inadequate to support the degree of operation and maintenance necessary for the plant to meet its output specifications.

Comments: The following are potential problems:

- Lack of in-house capacity (within the Water Service Provider) to undertake minor repairs.
- Lack of access to effective and efficient maintenance support for major problems.
- Lack of personnel with knowledge of water treatment processes to address varying raw water quality.

Inadequate supplier-related support increases

- *Inadequate operation and maintenance* because (a) the plant operator may be unable to execute the necessary routine duties (*e.g.* because of lack of spares, chemicals, etc.) and/or (b) problems may not be rectified promptly (*e.g.* because of a lack of spares or skilled personnel).

The following are potential components contributing to such lack of supplier-related support:

Inadequate organisational alignment

Definition: The degree to which individual supplier-related organisations comprising the overall institution have conflicting priorities.

Comments: This lack of alignment can arise in two contexts:

- Individual supplier-related organisations (Water Services Authority, Water Services Provider, Regulators, etc.) usually have many responsibilities, one of which may be the management of a water treatment plant. If all these responsibilities are not adequately aligned with, or distinguished from, the latter *within each individual organisation*, the support given to the management of the plant by each organisation may be adversely affected.
- The organisations comprising the institution may not be fully aligned with each other.

Inadequate political will

Definition: The degree to which local government councillors and officials lack the political commitment to ensure on-going high-level attention to the management of treatment plants.

Comments: Development typically requires significant integration and partnerships. Without a strong political agenda that drives this, the development is unlikely to succeed.

Inadequate capacity building

Definition: The degree to which supplier-related individuals are subjected to inadequate capacity building to perform the necessary tasks, routine and otherwise, required for provision of the necessary support for operation & maintenance.

Comments: Capacity building is more than simply training [Koster, 2004]. Capacity building is an active process that creates an enabling environment (*e.g.* includes support systems, policy and network interactions) in which individuals, groups, institutions and organisations are able to do more than simply execute routine tasks (the latter addressed largely by traditional "training"). They must also be able to show initiative by identifying and solving problems that may arise from time to time.

This in no way should reduce the importance given to training *per se*. For example, this should include the following:

- Compliance with regulatory training standards.
- Adequate level of education of operator.
- Specific training of operator on existing plant operation.
- Operator upgrading programmes (including refresher courses).

Inadequate financial capacity

Definition: The degree to which the Water Services Provider has inadequate financial resources to provide the necessary management and support to ensure adequate operation and maintenance of the plant.

Comments: Many factors besides inadequate cost recovery (addressed immediately below) can contribute to inadequate financial capacity during the operation and maintenance phase:

- Poor initial financial planning.
- Inadequate funding allocations for operation & maintenance by the Water Services Provider.
- Poor financial management during operation and maintenance phase.
- Inappropriate diversion of funds (originally allocated to the development in question) to other purposes.
- Unnecessarily bureaucratic procedures that cause delays in supply of plant spares to adequately maintain the plant.
- Inadequate financial resource base to meet the general financial demands of a Water Service Provider's many service delivery demands.

Inadequate cost recovery

Definition: The degree to which the costs of service delivery relating to the plant (not covered from other sources) are not recovered from the community being served.

Comments: Despite government contributions towards financing the supply of "free basic water" in many areas, shortfalls are often inevitable. This frequently requires some degree of local cost recovery in order to ensure financial sustainability. Cost recovery is influenced by many factors, the degree of consumer-related buy-in being one. A thorough examination of these warrants a separate systems model.

Inadequate cost recovery increases

- *Inadequate financial capacity* directly by limiting the financial resources available for operation and maintenance.

Inadequate WSP buy-in

Definition: The degree to which members of the Water Services Provider maintenance team and the plant operators lack the necessary dedication or motivation to perform their duties adequately.

Inadequate incentives

Definition: The degree to which members of the Water Services Provider maintenance team and the plant operator are not given recognition for work well done.

Comments: Incentives can take the following forms:

- Clear career path development.
- Financial bonuses.
- Letters or certificates of commendation.
- Visits by management to plant specifically to congratulate the operator on a job well done.

Inadequate incentives increases

- *Inadequate WSP buy-in* because the endeavours of the maintenance team and operator may not be recognised and appreciated. This lowers morale that results in them shifting their commitment to other endeavours.

Lack of WSP accountability

Definition: The degree to which Water Service Provider role players accept their responsibilities including the degree to which they can be held accountable for not fulfilling their roles.

Lack of WSP accountability promotes

- *Inadequate consumer-related buy-in* because, feeling that they will not be held responsible for adhering to whatever their end of the bargain might be (like the operator not fulfilling the associated duties), there is little motivation to remain aligned with the common vision nor invest their resources.

Inadequate information flow

Definition: The degree to which the supplier-related role players (a) do not provide either sufficient or appropriate information to the community and (b) do not provide practical mechanisms for the community to provide information on their needs and preferences.

Comments: Information flow is evidently an important issue as it affects many community-related issues ultimately resulting in consumer-related buy-in (or lack of buy-in). Information flow is therefore examined in more detail below (Section 2.4).

Inadequate information flow increases

- *Inadequate engagement of community I&APs* by (a) not adequately empowering the community to make informed inputs and (b) by not treating their core needs and preferences with due consideration.
- *Expectations not being met* because role players, if inadequately informed on design specifications, may have unrealistic expectations that cannot possibly be met even if the plant operates to design specifications.
- *Inadequate understanding of benefits* if the community has not been informed (by the supplier) of the benefits of the development (such as improved health or potential for economic growth).
- *Inadequate understanding of roles* simply because role players have not been adequately informed on what might be expected of them.
- *Conflicting priorities* in circumstances in which such conflicting priorities arise out of a misunderstanding of the intentions of the development simply because the I&APs have not been adequately informed.

2.2.3 Inadequate consumer-related buy-in

Definition: The degree to which consumer-related role players (see section 1.2 in Background chapter)

- do not share a common vision relating to the necessity and advantages of the development and/or its on-going operation & maintenance, and
- do not have a willingness to invest their resources (time, money, etc) into the operation & maintenance of the plant (including not paying for services and not reporting problems).

Comment: Inadequate consumer-related buy-in can manifest itself in any of three ways:

- Active opposition.
- Apathy.
- Unaligned enthusiasm (enthusiasm exists but is not properly focussed).

Inadequate consumer-related buy-in promotes

- *Inability to fix problems promptly* because either apathy or active opposition can result in problems not being reported promptly to the Water Services Provider.
- *Inadequate cost recovery* because the consumer is not willing to invest resources.
- *Inadequate political will* because councillors and officials do not give attention to issues that their constituency and consumers do not view as a priority.
- *Inadequate WSP buy-in* because, the Water Services Provider, realising that the consumer of its services is not enthusiastic about those services is, as a consequence, less likely to be fully committed and motivated to providing those services.
- *Inadequate information flow* because the desire for a successful development is a fundamental driver to successful information flow, irrespective of what abilities the respective parties may have regarding communication.

Expectations not being met

Definition: The degree to which role players such as the community or the water committee perceive that their expectations of the development have not been adequately met.

Expectations not being met increases

- *Inadequate consumer-related buy-in* because these role players can become disillusioned, losing faith in the development to the extent that they become either apathetic or, worse, actively opposed.

Inadequate understanding of roles

Definition: The degree to which role players, particularly the community itself and the water committee, do not fully understand their respective roles and associated responsibilities.

Comments: Inadequate understanding of roles arises from the following:

- Not ensuring the community understands why they have to pay and exactly what they are paying for (drinkable water, operation & maintenance, and repairs).
- The Water Services Provider and other role players not knowing what issues need to be communicated with whom, when and how.
- Not ensuring the community understands how, and to whom, to report technical problems (inadequate flow or water quality, environmental impacts) to the Water Services Provider.

Inadequate understanding of roles increases

- *Inadequate consumer-related buy-in* because role players do not know how to use their resources to maximum effect or know where they fit into the overall picture.

Inadequate understanding of benefits

Definition: The degree to which the community and water committee do not fully understand the benefits of the development to the community and using the overall water scheme effectively.

Comments: These benefits may include the following:

- Improved family hygiene and health and hence quality of life.
- Increased opportunities for small businesses that require treated water.
- Job creation within the project.

Inadequate understanding of benefits increases

- *Inadequate consumer-related buy-in* because community members, not appreciating the benefits to themselves, have little or no motivation to buy in to the development.

Inadequate engagement of community I&APs

Definition: The degree to which local community-related interested and affected parties (I&APs) are not afforded their rightful place, or are inadequately represented, or given inadequate opportunities for communication in the process of decision-making.

Comments: Community I&APs include at least the following:

- *Women* often have a unique local knowledge relating to local water affairs and provision of health care to their families.
- *Youth* can be directly, and negatively, affected by a local water-related development, for example by forcing them to change traditional meeting places such as water collection points. School-going youth are also an important conduit of information between their school and the local community that can contribute to a better understanding of the benefits of the development by the community. The youth are also future mothers and fathers. Their early involvement ensures continuity of buy-in.
- *Disabled* persons have special requirements regarding access to water. If the development of a water treatment plant affects the physical provision of the water, then this group will be affected and therefore consulted.

Inadequate engagement of community I&APs increases

- *Inadequate consumer-related buy-in* because alienating any group by not respecting their needs and preferences, not only affects their buy-in directly but they can also alienate those around them. This can also occur if inappropriate representatives are chosen who might place their own personal interests (like improved status, financial income, etc.) over those of the group they supposedly represent.

Power struggles

Definition: The degree to which certain parties exert intimidating influences on others who may be favourably inclined towards the envisaged development.

Comments: Power struggles are distinguished here from *conflicting priorities* in the sense that the latter are either genuinely perceived as conflicts or are real conflicts. Power struggles, on the other hand, are defined here as inherently intimidating, typically destructive in nature and sometimes apparently irrational from the point of view of the developer. Local community members may intimidate other community members simply to exert their power while having no logical opposition to the development. "Dominance of corrupt individuals" has been explicitly noted as one of many problems contributing to lack of sustainability of community water supplies [Mathew, 2002]. Although corruption *per se* is a different issue, a *dominant* corrupt individual may sustain his/her position through intimidation.

Power struggles increase

- *Inadequate consumer-related buy-in* because these parties, and those influenced by them, are likely to be either apathetic (at best) or directly opposed (at worst) to the development. These parties, by their very nature, will be difficult to negotiate with because their opposition will typically not be rational.

Negative historical attitudes

Definition: The degree to which some historical experience has resulted in an inherent negative attitude towards developments such as the implementation of small water treatment plants.

Comments: Such experiences may include the following:

- Apartheid-era top-down approaches of government to local developments.
- Previous failed or unsatisfactory attempts at related developments.

Negative historical attitudes increase

- *Inadequate consumer-related buy-in* because certain role players are inherently either suspicious or actively negative about such developments from the start.

Conflicting priorities

Definition: The degree to which certain role players, particularly the community itself, the water committee or the steering committee, experience significant differences in priorities.

Comments: Conflicting priorities may arise within communities in which some (or all) members perceive some other development as a greater priority (*e.g.* clinic, school, electricity, etc.).

Conflicting priorities increases

- *Inadequate consumer-related buy-in* because these role players have priorities that are directly threatened (perceived or real) by the development.

Lack of accountability

Definition: The degree to which role players such as the community or the water committee accept their responsibilities including the degree to which they can be held accountable for not fulfilling their roles.

Lack of accountability promotes

- *Inadequate consumer-related buy-in* because, feeling that they will not be held responsible for adhering to whatever their end of the bargain might be (like paying for the services), there is little motivation to remain aligned with the common vision nor invest their resources.

2.2.4 Model interpretation

The following figure illustrates the inter-relationships between the three ("high-level") problems addressed above.

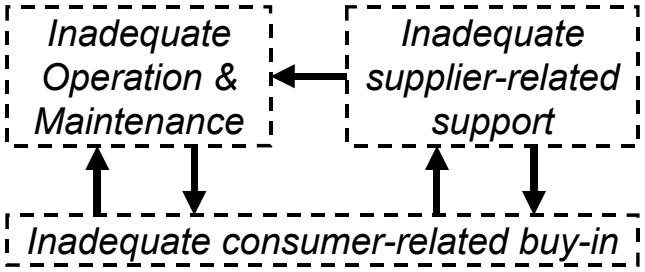


Figure 2.2. High-level potential problems manifest during the operation & maintenance phase.

The model suggests the above-mentioned low-level problems (depicted in Figure 2.1) can be summarised into the following:

Inadequate consumer-related buy-in is influenced by

- Inadequate suppliers-related support (e.g. through inadequate information flow), and
- Inadequate operation & maintenance (by consequently not meeting community expectations).

Inadequate operation & maintenance is caused by

- Inadequate supplier-related support (e.g. caused by many factors including inadequate organisational alignment, inadequate capacity building, inadequate WSP buy-in and inadequate financial capacity), and
- Inadequate consumer-related buy-in (e.g. by not reporting problems when they occur), and

Inadequate supplier-related support (caused directly by the many factors mentioned above) is also influenced by

- Inadequate consumer-related buy-in (e.g. resulting in inadequate cost recovery and hence inadequate financial capacity of simply because their clients, the community, are not showing enthusiasm for the development, the latter also potentially affecting the degree to which the two parties communicate effectively).

It is important to place the above model in perspective. Any one of the issues driving inadequate supplier-related support (inadequate financial capacity, etc.) can potentially be analysed in the same way as inadequate consumer-related buy-in. That is, each such issue may have a number of drivers that are not identified here and that, in effect, constitute sub-models in themselves. Inadequate cost recovery is a good example. Much work has been done on this issue in recent years and many factors, including soft issues, may affect the degree of cost recovery. This has not been done here mainly because this study is a preliminary study undertaken to demonstrate an approach, not necessarily intended to produce full-blown detailed models that address all conceivable issues.

The consequence of this omission is that the model depicted in the above figure may suggest that supplier-related support is as important as (*i.e.* has the same weight as) consumer-related buy-in in ensuring adequate operation & maintenance. This should not be regarded as a conclusion of this model, simply because the approach adopted has not given equally detailed attention to all issues.

Nevertheless, with this deficiency noted, the following demonstrates how such a model (taken at face value) might be interpreted.

Of particular relevance are the feedback loops suggested by the model, illustrated as follows:

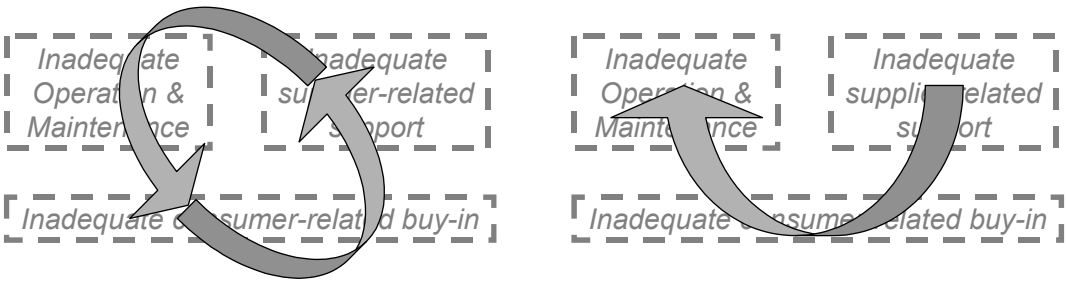


Figure 2.3. Feedback loops relating to high-level potential problems manifest during the operation & maintenance phase.

The first feedback loop is cyclical. It suggests that, for example, if inadequate supplier-related support exists, this causes inadequate operation & maintenance which in turn causes inadequate consumer-related buy-in which in turn worsens the original cause, namely inadequate supplier-related support. This is a particularly problematic scenario as the causes of problems are exacerbated by those problems.

It must be noted here that the previous paragraph is not suggesting that inadequate supplier-related support is the original cause. The model suggests that if any of the three potential problems exist, this can potentially start the indicated cyclical spiral of influences.

Similarly, the second feedback loop, although not cyclical, can also be problematic. It suggests that, for example, inadequate supplier-related support can decrease consumer-related buy-in that in turn causes inadequate operation & maintenance.

Since it is possible that both feedback loops can operate simultaneously, the latter can apparently further worsen the undesirable effects of the first cyclical feedback loop.

If the underlying low-level model (captured in Figure 2.1) was sound and complete, and specific deficiencies have been noted above, this situation would be alarming. It suggests that the interplay between consumer-related buy-in, supplier-related support and operation & maintenance is profound and, if not managed with care, can be potentially highly detrimental to the success of the development.

Finally, this model suggests that in order to break the re-enforcing nature of both these feedback loops, ensuring adequate consumer-related buy-in is a key issue. By carefully promoting such buy-in, the first feedback loop suggests that any inadequate supplier-related support that may exist is at least not worsened by a lack consumer buy-in. Similarly, the second feedback loop suggests, again, that if inadequate supplier-related support is an issue, then at least the indirect effects on operation & maintenance through inadequate consumer-related buy-in can be avoided. In effect, inadequate operation & maintenance will then only be caused by the inadequate supplier-related support and not have anything to do with the community.

Buy-in, either consumer-related or supplier-related, is a property that not only needs to exist in the early stages of development but it also needs to be maintained throughout the whole project life cycle. That is, efforts focussed on creating buy-in are applicable in the following three scenarios:

- In the early project phases, to create initial buy-in.
- During all subsequent project phases to maintain buy-in (even when the plant is operating successfully).

During difficult times (*e.g.* when the plant is not operating) to ensure that adequate buy-in is maintained.

2.3 AVOIDING THE PITFALLS

The wording and structure of the above model allows a model to be depicted that emphasises avoiding the pitfalls in a very straightforward manner. Most individual issues can simply be reworded from the negative to the positive (*e.g.* "Inadequate understanding of roles" to "Understanding of roles"). Issues such as "power struggles" and "negative historical attitudes" are not sensibly so converted because these are issues over which the supplier will have less control. They are therefore not included explicitly in the model of positively oriented issues that the supplier would typically focus on in order to maximise the chances of sustainable management.

Since most of the issues are simply the positive perspective of the perspective in the "potential pitfalls" model above, redefining each individual issue and the important

interactions is unnecessary. The definitions relating to this positively oriented model can easily be inferred from the definitions given above.

The visual representation of the model is given in the following figure.

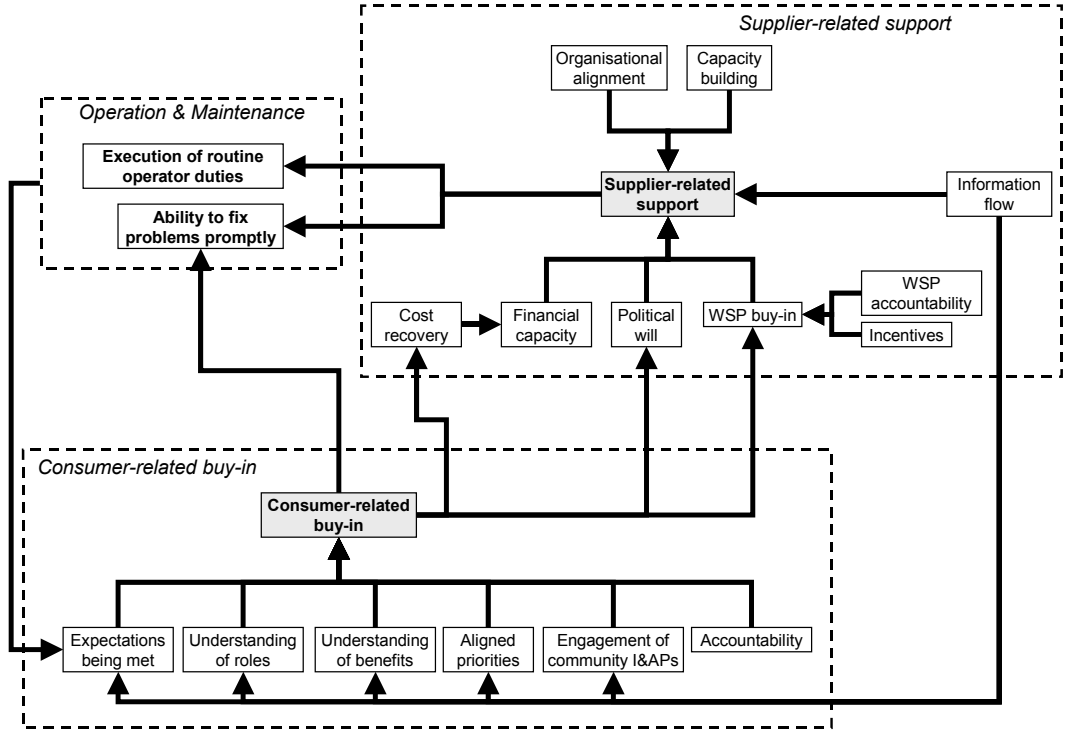


Figure 2.4. Low-level issues manifest during the operation & maintenance phase that ultimately determine the degree of sustainable management.

A similar high-level model to the one above exists.

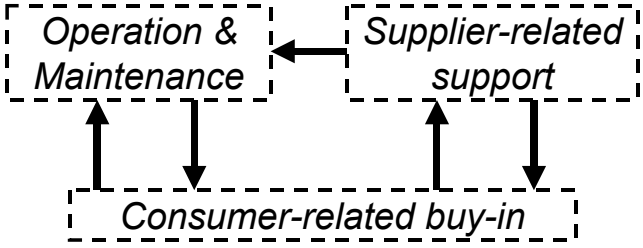


Figure 2.5. High-level issues manifest during the operation & maintenance phase.

This model can be summarised as follows:

Consumer-related buy-in is increased by
- Supplier-related support (e.g. through information flow), and
- Operation & maintenance (which ensures that community expectations are met).

Operation & maintenance is improved by
- Consumer-related buy-in (e.g. reporting problems when they occur), and
- Supplier-related support (e.g. through many factors including internal institutional alignment, capacity building, WSP buy-in and financial capacity).

Supplier-related support is improved by
- Consumer-related buy-in (e.g. resulting in cost recovery and hence adequate financial capacity or simply because their clients, the community, are showing enthusiasm for the development and hence are also more likely to communicate effectively).

Naturally, the same deficiencies noted above for the negatively oriented model, upon which this is based, apply here. Nevertheless, to further demonstrate the approach, the following can be noted.

This high-level model also has feedback loops though now operating in a positively reinforcing sense (as opposed to the negatively reinforcing sense in Figure 2.3).

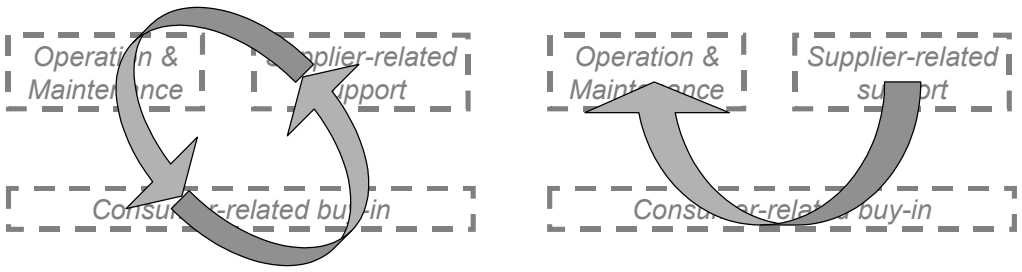


Figure 2.6. Feedback loops relating to high-level issues manifest during the operation & maintenance phase.

The first cyclical feedback loop suggests that effective supplier-related support promotes a degree of operation & maintenance that is more likely to meet community expectations, that in turn maintains consumer-related buy-in. This buy-in is likely to improve cost recovery and generally positively influence supplier-related organisations and individuals to continue to strive for a high level of service delivery.

The second feedback loop suggests that supplier-related support, particularly through provision of adequate information, promotes consumer-related buy-in. This in turn promotes operation & maintenance through effective fault reporting.

Again, and not surprisingly, consumer-related buy-in is implicated as the common issue in both these loops suggesting its general importance in promoting operation & maintenance and hence sustainable management.

2.4 SUB-MODEL: EFFECTIVE INFORMATION FLOW

2.4.1 Havelock model

The above "potential pitfalls" model suggests that inadequate information flow is an important issue. Information flow is indeed either a direct or indirect issue linking all three high-level issues (operation and maintenance, supplier-related support and consumer-related buy-in).

A useful model has been suggested by Havelock (1986) and adapted by Meyer (2002a). Their work focussed on the issues affecting communication of science and technology to rural communities. Their model has been developed a little further in this work (in the sense of suggesting systematic descriptions of the barriers they noted to such communication). The overall model is illustrated in the following figure. Their model is not a systems model *per se*, but rather a model highlighting the process of information flow and four specific barriers to such information flow. It suggests that four distinct barriers to flow may exist, each associated with information either leaving or entering the supplier or consumer knowledge systems.

The ***supplier knowledge system*** refers to the system of knowledge within which supplier-related organisations operate. It includes their expertise relating to their scientific and technological knowledge, management approaches, etc. These form an integral part of the supplier "institution" (see Section 1.5.3).

A number of issues determine the nature of the ***consumer knowledge system***. It can be highly site-specific and include the following:

- The Indigenous Knowledge System. This is the complex knowledge, technologies, customs and culture existing, and developed around, specific conditions in populations and communities indigenous to a particular geographic area [adapted from NRF (2004].
- The nature and extent of previous "development experience" relating to water services provision. Although many communities will be focussed on collecting

water from traditional sources when supplied systems have failed, most will have experienced improved water supplies to some degree over the years.

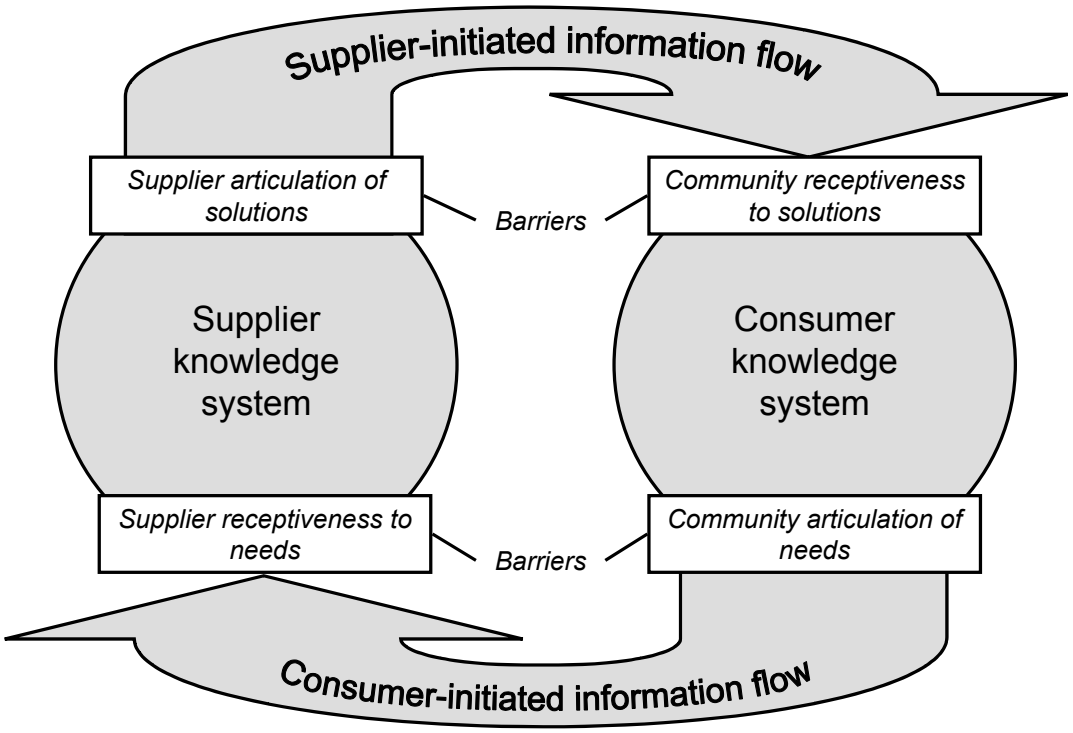
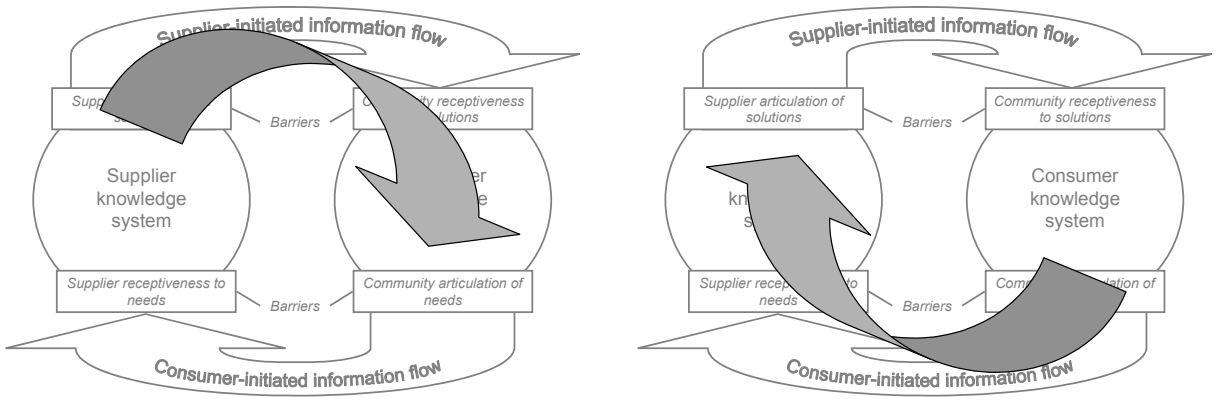


Figure 2.7. Information flow and barrier model (adapted from Havelock, 1986).

2.4.2 Assessment of suitability

The above model suggests that for effective information flow to occur in both directions, each of the four potential barriers must be considered. The attractiveness of this model is that, conceptually, it is simple and intuitively obvious.

The model can be used as a basis for depicting the two alternative approaches to technology transfer, namely technology-driven and demand-driven.



Technology-driven **Demand-driven**

Figure 2.8. Technology- and demand-driven approaches to technology transfer.

The technology-driven model, now generally discredited when dealing with rural communities, typically starts with the supplier assuming that a market exists for a specific product or service. This would then be followed by an "advertising" campaign in which the supplier attempts to convince the consumer that they have a need for the product or service. Even worse than this is the situation in which the supplier provides the consumer with the product or service without engaging with them in any significant way.

The demand-driven model places more emphasis on first establishing the needs of the consumer and then attempting to satisfy those needs with available technology. This does not necessarily mean that technologies need only be developed after the needs have been identified. Rather it emphasises that, even if a technology exists (from the supplier's point of view), creating recognition in the consumer of the real need (or indeed even a perceived need) for the product or service is essential for sustained acceptance and hence successful technology transfer (sustainable management). However, it also emphasises the need for suppliers to be flexible in the product or service offerings in the sense of being able to adapt as much as is possible to meet the precise needs of the consumers. Not surprisingly, Meyer (2002a) implicitly assumes that the demand-driven model is the more appropriate. The same is assumed henceforth in this work. This approach has also been referred to a "demand-responsive" approach, particularly relevant when dealing with rural communities.

In conclusion, therefore, this model seems eminently suited to the current context of sustainable management of a small water treatment plant. Effective communication should be occurring from the outset, namely the planning phase, through to the operation & maintenance phase. The following systems model uses this model as a framework and does so considering all these phases, not only the operation & maintenance phase (which was the main focus of the "potential pitfalls" model).

2.4.3 Systems model development

The issues in the adapted Havelock model can be linked to effectiveness of information flow (supplier-initiated and consumer-initiated) as follows.

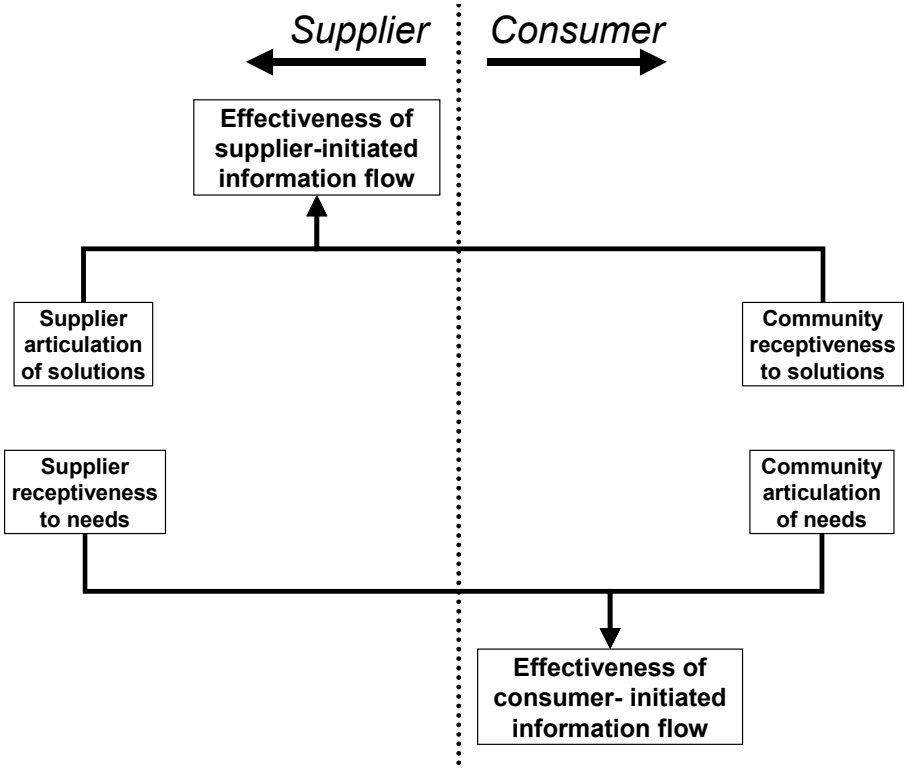


Figure 2.9. Main issues in the adapted Havelock model.

The degree to which articulation and receptiveness is effective will depend on, first, a desire to be effective and, secondly, abilities and existence of processes and mechanisms. The following sections address the desire for success and the existence of abilities separately.

2.4.3.1 Articulation and receptiveness issues

Community articulation of needs

Definition: The degree to which a rural community has the capacity to express its needs in a manner understandable to the supplier-related organisations.

Supplier receptiveness to needs

Definition: The degree to which supplier-related organisations are inclined to receive the expressed needs of the community favourably.

Supplier articulation of solutions

Definition: The degree to which supplier-related organisations are able to communicate potential solutions in a manner understandable to the community.

Community receptiveness to solutions

Definition: The degree to which a rural community is inclined to consider potential solutions offered by the supplier favourably.

Comments: In respect of immediate water-related needs (like domestic use), the community does not typically require any significant degree of formal technical training or education in order to properly use the water supplied to them. (This is unlike other technologies, like some in-house interventions, that may require specific technical training in order for them to benefit from the supplied product.) If improved hygiene, and the associated health benefits, have been identified as a specific need, then some degree of hygiene- and health-related education and training may be advantageous. Typically this would focus on the risks of contamination of the water between point of collection and point of use (in the household). Basic education on the optimum use of the water would also be advantageous (like avoiding wasting water).

On the other hand, if their identified water-related needs are further removed from such obvious benefits (perhaps relating to economic opportunities), then the community may well require some further education and training in order to satisfy those needs.

Nevertheless, either way, the community will need to be receptive to potential solutions offered by the supplier. However, significant technical abilities in the present context are not normally required for this.

2.4.3.2 Desire for effective information flow

Meyer (2002a) points out that at each potential information flow barrier a desire to overcome the barrier must exist. This applies equally to the consumer and the supplier. The core role that this plays is also somewhat self-evident. Irrespective of the existence of any abilities to overcome these barriers (technical abilities, existence of specific communication mechanisms, etc.), if there is no desire to do so there is simply no driving force for any kind of effective information flow in the first place.

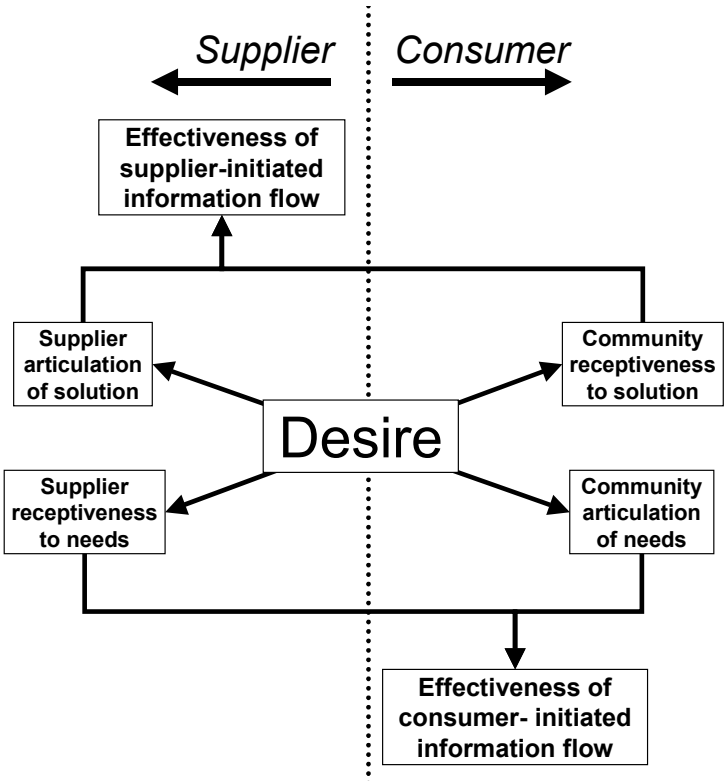


Figure 2.10. Desire to overcome barriers is a core issue for success.

The following illustrates the "desire-related" aspect for each of the four barriers:

Community articulation of needs

The desire must exist within the community to (a) articulate their needs to the supplier and (b) to try to do so in a way that is understood by the supplier. This

desire seems a necessary condition for any subsequent level of buy-in from the community. If it does not exist there will be a danger that the development will not actually address the real needs of the community.

It should exist from the initial planning phases of the development. An attitude that may initially be encountered is "what's in it for me?". This will need to be addressed by exposing the community to ways in which their quality of life can potentially be improved. Of course, the danger here is that this may develop into a technology-driven approach (with its potential pitfalls). This is somewhat of a "chicken-and-egg" situation: On the one hand it is preferable that the community desires to articulate its needs so that the development is demand-driven. However, if the desire does not exist, the development is necessarily somewhat technology-driven initially. However, the essence of the current model is that this should be undertaken with as much care and consideration as possible for the community's needs.

Finally, the existence of this desire to articulate needs is also relevant to new or changing needs in subsequent phases of the development, including the operation & maintenance phase.

Supplier receptiveness to needs

The instinctive desire to be receptive to (*i.e.* prepared to listen carefully to) community needs should ideally exist within all supplier-related organisations. This is the cornerstone of the demand-driven technology transfer model and an overall "consumer oriented" development. In effect, this is part of "knowing your customer".

Supplier articulation of solutions

The desire must exist within all supplier-related organisations to communicate potential solutions that address the needs (that the community have articulated) in a way likely to be understood by the community.

Community receptiveness to solutions

The desire must exist within the community to receive, consider, negotiate if necessary and finally, implement the solutions (if the solution adequately addresses the needs they have expressed). This issue is closely related to the consumer-

related buy-in identified in the above "avoiding the pitfalls" model. Issues such as meeting expectations, understanding of roles, understanding of benefits, engagement of community I&APs all contribute to such buy-in.

2.4.3.3 Understanding of respective knowledge systems

Although a number of other issues may contribute to the four articulation and receptiveness issues. Central to those is an *ability* to articulate (needs and solutions) and be receptive (to needs and solutions). A number of obvious issues can potentially promote such abilities (*e.g.* relating to language, degree of education, etc.) However, an understanding by each party (supplier and consumer) of the other's knowledge systems is considered particularly important and implicitly captures many of these lower-level issues [Meyer, 2002a]. This is illustrated as follows:

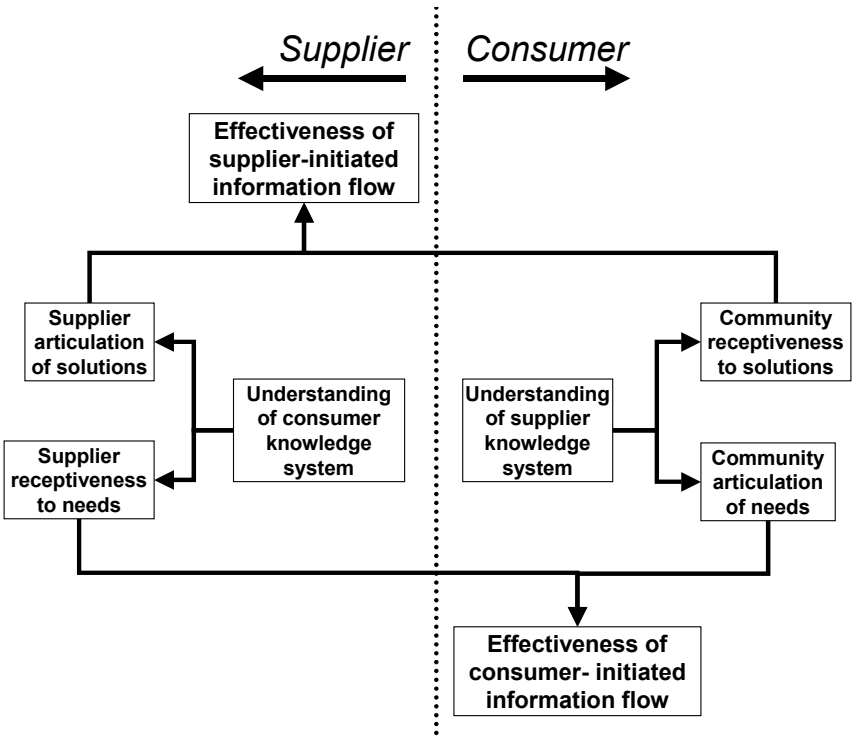


Figure 2.11. Ability-related issues supporting the four articulation and receptiveness issues

Understanding of supplier knowledge system

Definition: The degree to which the local community appreciates and comprehends the supplier knowledge system, including their scientific and technological knowledge, management approaches etc.

Understanding of supplier knowledge system promotes

- *Community articulation of needs* and *Community receptiveness to solutions* because this helps the community understand the degree to which the supplier system (from managerial through to technological) can be flexible in addressing their expressed needs. This helps the community adapt their expectations to those that can more reasonably be satisfied.

Understanding of consumer knowledge system

Definition: The degree to which supplier-related organisations appreciate and comprehend the local consumer knowledge systems, including their general Indigenous Knowledge System and their water services-related development experience.

Understanding of consumer knowledge system promotes

- *Supplier receptiveness to needs* and *Supplier articulation of solutions* because the supplier will better understand the local community context within which the community's needs are being articulated. Potential solutions can then be communicated in a manner better tailored to that particular community.

2.4.4 Conslusion

In essence, the adapted Havelock model addresses two fundamental concepts of current times, namely buy-in and the need for capacity building.

To overcome the four potential barriers there must exist:

- A desire to articulate and be receptive, and
- An ability to articulate and be receptive.

Without a desire to articulate and be receptive, neither is likely to occur, irrespective of the degree of ability. Equivalently, irrespective of the existence of a desire to articulate and be receptive, if there is no ability to do so neither is likely to happen.

Desire is related to buy-in. Capacity building creates the necessary abilities. The adapted Havelock model helps puts these two concepts into perspective in the context of information transfer between supplier and consumer.

2.5 SUB-MODEL: SUSTAINABLE MANAGEMENT

2.5.1 Introduction

Within the general scope described in the Background chapter, the primary focus of attention is the "sustainable management" of small water treatment plants. One might define this as follows:

Sustainable management: The degree to which the administration and control of a small water treatment plant is able to provide the designed output water quality and flow

- *For the percentage of time for which it was designed,*
- *Within budget,*
- *With a motivated workforce, and*
- *With acceptable environmental impact.*

Rivett-Carnac (2002) identifies a number of components of sustainability of community water supply and sanitation systems. As is often the case, these are presented as a bullet list. Such lists often imply (at least visually) a degree of mutual exclusiveness (illustrated in the following figure). It is argued here that, from a systems thinking perspective, this creates an inaccurate impression of reality. These components are obviously not mutually exclusive. In other words, some components affect other components.

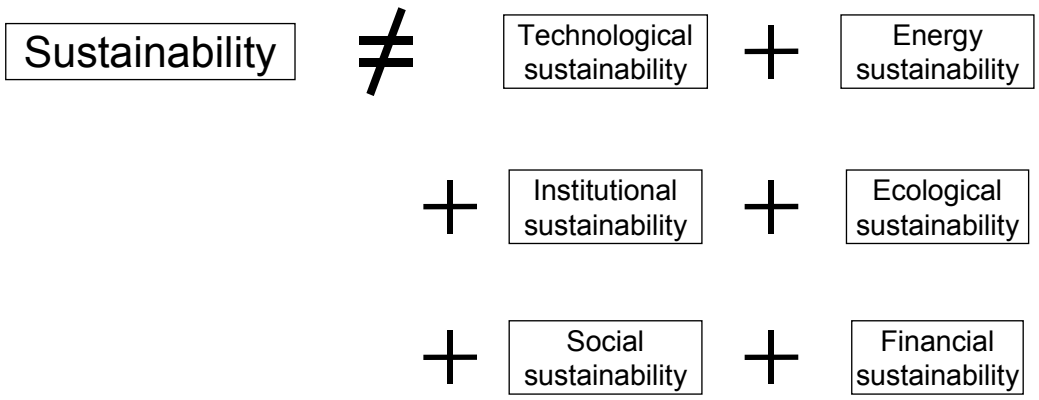


Figure 2.12. The mutual exclusivity implied by bullet lists.

The following analysis systematically (though briefly) examines the inter-relationships between some of the components. An attempt was made to do this without explicit influence from (*i.e.* independently of) the above low-level "avoiding the pitfalls" model. In other words, the definitions of each of the components of sustainability are examined in their own right and descriptions of their likely interactions presented, as much as is possible, *in these terms*.

Furthermore, since the emphasis in this report is on testing an approach, an attempt has not been made to examine in detail whether Rivett-Carnac's division into the six types of sustainability is fundamentally appropriate or not. For example, one might question whether energy sustainability is sensibly separated from technological sustainability. The former could be regarded as a part of the latter. Similarly, technological sustainability could be regarded as intimately associated with institutional sustainability. Nevertheless, the six types of sustainability are taken "as is" and "converted" into a systems model.

2.5.2 Systems model

Sustainability should not be thought of existing simply if each of its principle components exists. Sustainability can only exist if a state of dynamic balance is achieved between these components. This balance cannot exist without feedback loops. This is the essence of systems thinking and is illustrated in the following figure and described in the subsequent text.

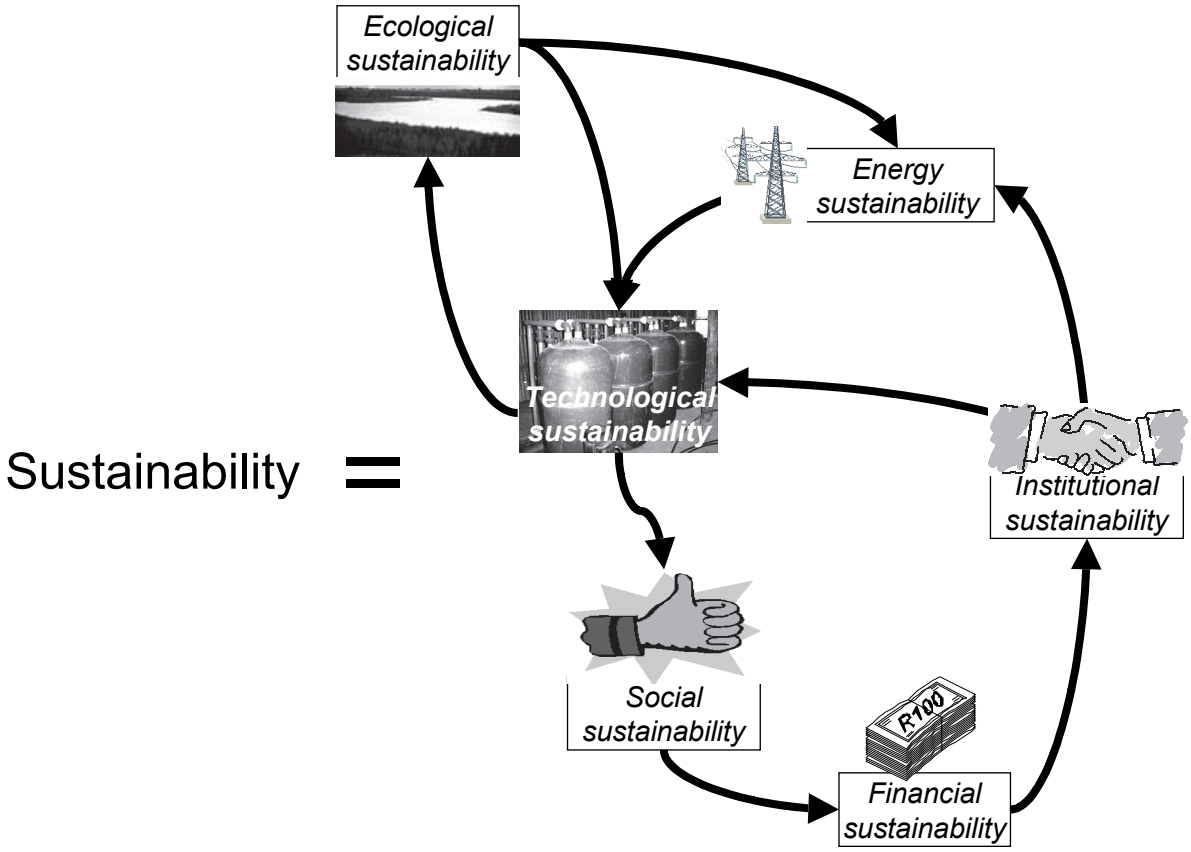


Figure 2.13. Interactions between the components of sustainability listed by Rivett-Carnac (2002).

The following suggest some definitions for the components (largely based on Rivett-Carnac (2002)) and describe some likely interactions.

Financial sustainability

Definition: The degree to which the development can be adequately financed in the long term.

Financial sustainability increases

- *Institutional sustainability* because money, and its effective management, is essential to support all the activities of the supplier-related organisations (such as salaries of staff, support for training and refresher courses, administration, operation & maintenance, etc.).

Technological sustainability

Definition: The degree to which the development is technically sustainable (in respect of maintenance, spares, and general appropriateness to local conditions and the community's needs and preferences).

Technological sustainability increases

- *Social sustainability* because the appropriateness of the technology to local conditions and its continued effective functioning are necessary pre-requisites to acceptance by the community (because it addresses real needs and does so on a sustained basis).
- *Ecological sustainability* because if the plant is operating within specifications, environmental impacts should be within acceptable limits. (This assumes adequate environmental impact assessments have been performed.)

Energy sustainability

Definition: The degree to which the energy requirements for the development can be satisfied in the long term.

Energy sustainability increases

- *Technological sustainability* because the operation of the development typically relies directly on the availability of energy.

Institutional sustainability

Definition: The degree to which the collection of supplier-related and consumer-related organisations are able to maintain continuity in the effective execution of their respective roles and responsibilities.

Institutional sustainability increases

- *Technological sustainability* because sustainability of the institution promotes the sustainability of its constituent organisations, one of which (the Water Services Provider) is primarily responsible for operation & maintenance of the development.
- *Energy sustainability*, the Water Services Provider is primarily responsible for ensuring that the energy supply is paid for while the energy supply organisation also needs to ensure adequate energy provision.

Social sustainability

Definition: The degree to which the community feels a sense of ownership of the development that reflects its importance to, and its acceptance by, the community both now and in the future.

Social sustainability increases

- *Financial sustainability* because continued acceptance of the development is likely to result in continued cost recovery from the community which is one aspect of financial sustainability.

Ecological sustainability

Definition: The degree to which the development can be managed without unacceptable environmental impact and within the ability of the environment to supply the necessary water and energy in the long term.

Ecological sustainability increases

- *Energy sustainability* because maintaining integrity of the ecosystem from which the energy is obtained increases the chances of that ecosystem continuing to supply that energy into the future.
- *Technological sustainability* because maintaining integrity of the ecosystem from which the water is obtained increases the chances of that ecosystem continuing to supply that water into the future. (Surface water and groundwater resources have finite capacities that should not be exceeded.)

2.5.3 Observations

The model above contains a circular feedback loop encompassing financial, institutional, technological (and energy, which can sensibly be grouped with other technological issues) and social sustainability. This corresponds very closely to a feedback loop in the above "avoiding the pitfalls" model (Figure 2.4). This is evident from the following:

Table 2.1. Comparison of the feedback loop in the sustainability and "avoiding the pitfalls" models.

Sustainability model	"Avoiding the pitfalls" model
Social sustainability increases financial sustainability	Consumer-related buy-in drives (among other things) cost recovery and therefore financial capacity.
Financial sustainability drives institutional sustainability	Financial capacity drives supplier-related support.
Institutional sustainability drives technological sustainability (and energy sustainability)	Supplier-related support drives operation and maintenance (which implicitly requires energy)
Technological sustainability drives social sustainability	Operation & maintenance drives consumer-related buy-in by ensuring that expectations are met.

The model suggests that the four (or five, including energy) issues that form the feedback loop are each important to ensure a positively reinforcing dynamic balance that ultimately will contribute to overall sustainability. Equivalently, it is somewhat self-evident that if any one fails to be achieved, then the overall balance between issues is affected.

The usefulness of icons and other images to enhance communication of the concepts is also demonstrated in the figure. Although the boxes and arrows contain the "formal" system model, the images (if well chosen) improve the ability of the figure to convey not only the issues but their interactions. This broadens the potential audience with which the model can be communicated by including those not particular familiar with the concepts.

2.5.4 Conclusion

The above sustainability systems model suggests the following:

- Apparently different perspectives on the core issues can provide similar conclusions. In the above case, when the issues are expressed in terms of "sustainability", social sustainability and institutional sustainability (two largely "non-technical" issues) are shown to be essential components for success. The same general message emanates from the "avoiding the pitfalls" model.

Presenting related lists of issues in a more systematic way than bullet lists can add much value and insight. The systems model illustrates (and formally describes in text) the inter-relationships between the components of sustainability. It emphasises

the importance of regarding sustainability as an ever-fluctuating network within which feedback loops are in a state of dynamic balance.

2.6 IMPACTS OF UNSUSTAINABLE MANAGEMENT

2.6.1 Introduction

Sustainable management of a water treatment works ensures that inadequate water quality is largely eliminated as a contributory cause to the spread of disease and associated morbidity and, in some cases, even mortality. It generally improves quality of life not only by reducing the incidence of disease but also by creating opportunities for growth and development.

The following section develops a systems model that examines the negative impacts of unsustainable management. Whereas the above "potential pitfalls" model examined issues primarily contributing to unsustainable management (reflected as "inadequate operation & maintenance"), this model looks at the knock-on effects of this in the broader ecological, social and economic environment.

2.6.2 Systems model

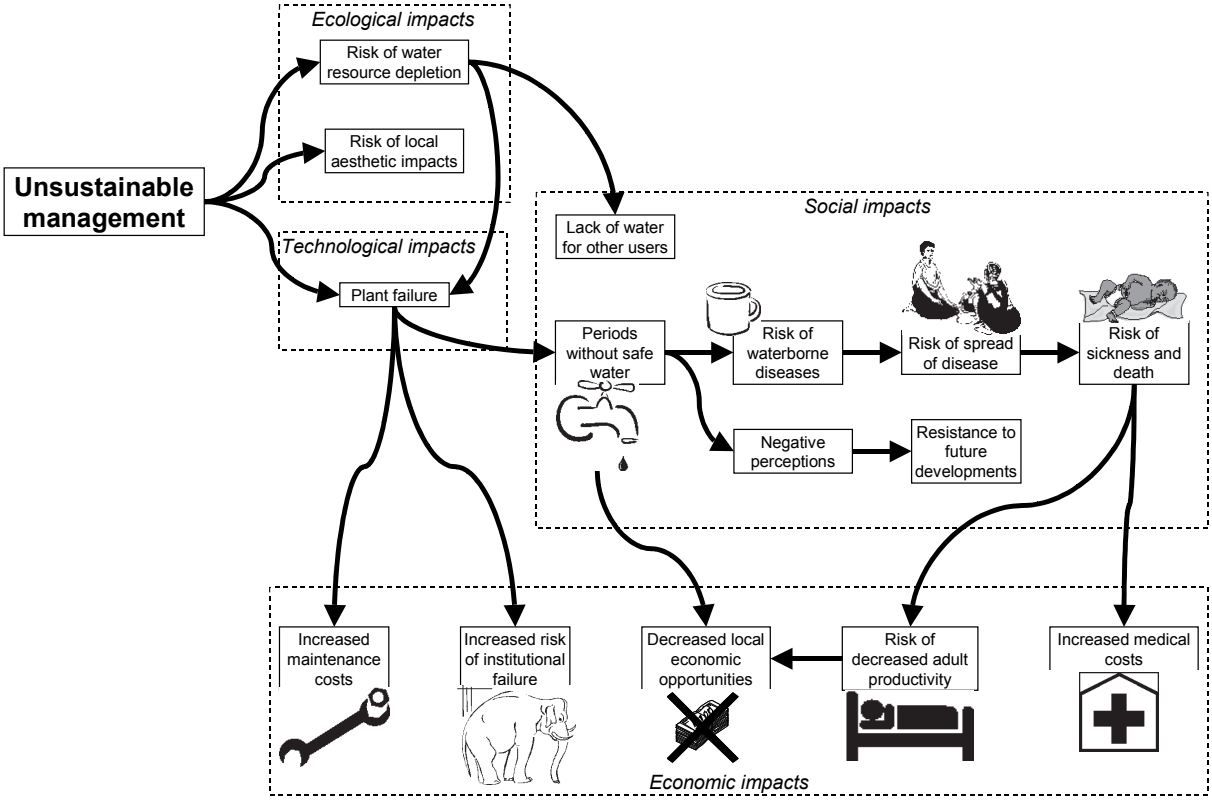


Figure 2.14. Knock-on ecological, social and economic impacts of unsustainable management.

Unsustainable management

Definition: The degree to which the administration and control of a small water treatment plant is unable to provide the designed output water quality and flow (a) for the percentage of time for which it was designed, (b) within budget, and (c) with acceptable environmental impact.

Unsustainable management can result in

- *Risk of water resource depletion* in cases where the raw water resource is either limited by available surface flow (*e.g.* during a low flow period) or aquifer recharge rates.
- *Risk of local aesthetic impacts* in cases where inappropriate discarding of waste materials is not done to acceptable standards.
- *Plant failure* simply because the administration and control is inadequate.

Risk of water resource depletion

Definition: The risk of completely depleting the raw water resource supplying water to the plant.

Risk of water resource depletion increases the risk of

- *Lack of water for other users* if the same raw water resource is used by other water users.
- *Plant failure* simply because the plant has no raw water to treat.

Risk of local aesthetic impacts

Definition: The risk of unsightly or maloderous impacts in the immediate vicinity of the plant.

Comments: This may be caused by careless disposal of wastes generated by the plant.

Plant failure

Definition: The degree to which the plant fails to provide the designed output water quality and flow. Such failure may be temporary or permanent.

Plant failure can result in

- *Periods without safe water* either because the plant (a) is being inadequately operated (resulting in poor quality water due to insufficient treatment) or (b) has stopped completely (either temporary or permanently).
- *Increased maintenance costs*, particularly if such failures are occurring at rates not anticipated during the design phase.
- *Increased risk of institutional failure* because if failures occur too frequently the fabric of the entire institution may be threatened (for reasons given in the "potential pitfalls" model above).

Lack of water for other users

Definition: The degree to which there is a lack of water available to users using water directly from the same raw water resource (but not receiving water from the treatment plant).

Periods without safe water

Definition: The amount of time that the plant is not producing water of adequate quality or quantity.

Periods without safe water promotes

- *Risk of waterborne diseases* because either the plant is being operated inadequately (*i.e.* with insufficient treatment) or because the community is forced to obtain their water from other, potentially untreated and hence contaminated, water resources.
- *Negative perceptions* because the community perceives the plant as not living up to their expectations.
- *Decreased local economic opportunities* because either water is completely unavailable, or is of inadequate quality, for the local water use (other than domestic).

Increased risk of institutional failure

Definition: The degree to which the risk of complete breakdown of the overall institutional structure related to the project (including supplier-related organisations and the community) is increased.

Comments: This may lead the complete shutdown of the plant. This is the ultimate expression of the "white elephant" syndrome (see Glossary)

Increased maintenance costs

Definition: The degree to which the routine costs of maintenance are increased.

Risk of waterborne diseases

Definition: The risk of contracting waterborne diseases directly from the water.

Risk of waterborne diseases increases the

- *Risk of spread of disease* because those infected can pass on the disease even to those who may be using safe water.

Negative perceptions

Definition: The degree to which the community regards the plant in a negative way.

Negative perceptions promotes

- *Resistance to future developments* because having seen such a development fail once, they may not have good reason to think that another will be more successful.

Decreased local economic opportunities

Definition: The degree to which local business opportunities are not created (by the unavailability of adequate safe water).

Risk of spread of disease

Definition: The risk of contracting waterborne diseases from other carriers (not directly due to water use).

Risk of spread of disease promotes

- *Risk of sickness and death* because some infected people will show symptoms of the disease (like diarrhoea) to varying extents while others, especially immuno-compromised people, may die if not treated.

Resistance to future developments

Definition: The degree to which the community becomes so disillusioned with the current development that buy-in to future developments is severely threatened.

Risk of sickness and death

Definition: The risk of community members showing significant symptoms of waterborne diseases (like diarrhoea) and of dying there from.

Risk of sickness and death promotes

- *Increased medical costs* (ultimately to the government) through facilities and services supplied via clinics or local hospitals.
- *Risk of decreased adult productivity* because community members are so sick they cannot perform their daily household chores or perform tasks at their workplace.

Increased medical costs

Definition: The degree to which costs of providing medical treatment either for the sick or dying increase.

Risk of decreased adult productivity

Definition: The degree to which the risk of adult community members not being able to lead productive lives, either around the house or at work, increases.

Risk of decreased productivity promotes

- *Decreased local economic opportunities* because community members are not able to either go to work or perform adequately at work.

2.7 CONCLUSION

The above models suggest the following:

- Sections 2.2.4 and 2.3 show that a detailed examination of low-level issues can usually result in a sensible grouping of related high-level issues. These in turn allow concise and accurate statements to be made about the most important issues and interactions. This can be particularly useful in broad planning contexts and for justifying policy statements.
- Section 2.3 shows that sometimes (though not always) a systems model focussing on problems and their interactions (*i.e.* a negatively-oriented model) can be sensibly and logically converted into a positively-oriented model.
- All the above models show how both hard and soft issues can be accommodated in the same model.
- The visual depiction of the models for sustainability and impacts of unsustainable management (Figures 2.13 and 2.14) show how the use of icons and other images can greatly increase the ability of the visual model to communicate the concepts. This broadens the potential audience with which the model can communicate.
- To facilitate transfer of the insights achieved by systems models, electronic copies of full colour diagrams could be developed and made available. These can then be used as follows:
  - They can be easily incorporated into reports produced by practitioners in the water services sector.
  - They can be used to produce overhead transparencies for use in presentations by such practitioners to both supplier-related and consumer-related organisations.
  - They can be used in posters.

- The models suggest a new perspective on sustainable management: *Sustainable management of small water treatment plants, although primarily a supplier-related perspective, must be a co-operative dynamic partnership between all parties involved in such a way that*
  - *They are all aligned with the mutually agreed objective of the development, and*
  - *The interests of no single party unreasonably dominate.*

CHAPTER 3: PROCESS MODEL

3.1 INTRODUCTION

The previous chapter (Systems Models) addressed potential problems responsible for unsustainability. On the basis of this, issues were identified that would promote sustainable management. Some attention was also given to a model of effective information flow (*i.e.* communication). It is assumed here that this issue is at the core of many problematic soft issues relating to water services. To examine this in more depth, this chapter identifies the kinds of considerations that would facilitate better communication. It finally proposes a simple process model, based on these and other considerations, that can potentially be used in all development phases.

3.2 COMMUNICATION MODELS

The term "soft issue"" is used to suggest intangible matters usually related to human behaviour. These are typically associated with people's feelings, sensitivities or emotions. The systems models of the previous chapter focussed on soft issues from both supplier and consumer points of view.

Consumer behaviour, in a formal marketing sense, has been defined as *the behaviour that consumers display in searching for, purchasing, evaluating, and disposing of products, services and ideas which they expect to satisfy their needs* [Schiffman and Kanuk, 1987]. It is a multidisciplinary science borrowing heavily from the following [Schiffman and Kanuk, 1987]:

- *Psychology*. This is the study of the motivation, perception, attitudes, personality and learning patterns of the individual.
- *Sociology*. This is the study of group behaviour.
- *Social psychology*. This is an amalgam of sociology and psychology that focuses on how an individual operates in a group. This often differs from the individual's behaviour when operating alone.
- *Cultural anthropology*. This is the study of human beings in society. It traces the development of core beliefs, values, and customs that are passed down to individuals from their parents and grandparents.
- *Economics*. This studies how consumers spend their money, how they evaluate alternatives, and how they make decisions to maximise satisfaction.

It is evident that all of these issues may be relevant to the current context. Furthermore, effectiveness of communication is likely to depend on many of these issues. A simple model for communication is the following:

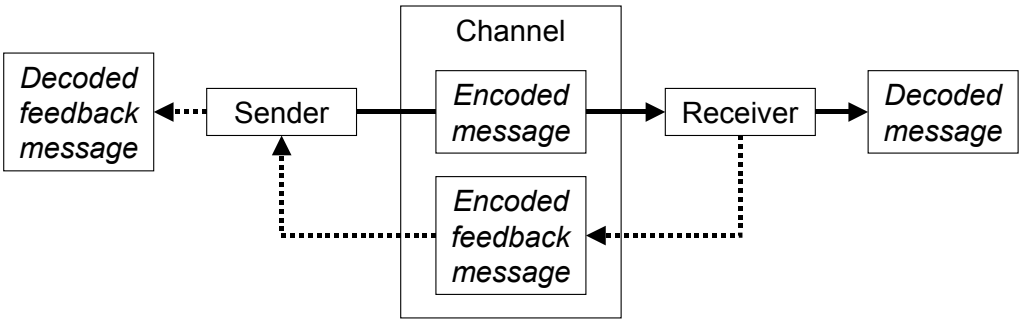


Figure 3.1. Simple communication model [adapted from Schiffman and Kanuk, 1987].

The message may be formal (like the written word or a presentation) or it may be implicit, sometimes subtly, in the behaviour of the person. The behaviour of the receiver may sometimes be the only means by which the sender can judge the effectiveness of the initial message. However, behaviour has a particular property of concern, especially to those whose preferred communication system is more formal (like scientists and engineers): *Behaviour can be easily misunderstood*.

The outward manifestation of behaviour may be readily recognisable and, sometimes, so may be the underlying emotion driving it (anger, happiness, frustration, and so on). However, it may not always be clear what is driving the underlying emotion. Emotions can also be easily concealed.

Frequently, the sender will have formed preconceptions of likely receiver behaviour and will automatically assume the existence of certain cause-and-effect relationships, *i.e.* what is likely to cause certain behavioural effects. These will inevitably be heavily based on the sender's own knowledge system (or reference system). This reference system will often determine the nature of the "encoding" of the communicated message.

The simplest model for understanding observed behaviour is that the observer matches the behaviour with the list of possible effects and hence establishes the cause to which it is linked.

This approach to understanding behaviour would be expected to work well if the receiver has the same reference system. However, this may not be the case. The receiver's reference system may be significantly different. The less the observer knows about the receiver's reference system, the greater the likelihood that the sender's reference cause-and-effect relationships will be restricted to the sender's own reference system.

Obviously the same applies to a feedback message sent from the original receiver back to the original sender. The feedback message is "encoded" within the original receiver's reference system. This is then "decoded" within the original sender's reference system.

Cryptography (the science of analysing and deciphering codes) provides a simple analogy. It usually works on very simple principle. The sender encodes a message using a secret key (the "code") to convert the original message to the encoded message. The latter is sent to the receiver who then decodes (deciphers) it using the same key. The message is safe in transit as long as only the sender and receiver know the key.

Identification of incorrect causes of behaviour can have a number of possible undesirable consequences. Further communication between the two groups can be confusing, inevitably to both sides, as each continues to "talk at cross purposes". Such situations can, at the very least, be frustrating to both parties. Worse, it can lead to unnecessary conflict.

3.3 IMPORTANT REFERENCE SYSTEMS

3.3.1 Historical development

In the current context of interaction between a supplier of a water service and a community (the consumer or receiver of that service), the above issues are particularly relevant. In effect, to ensure that communication is effective, the message must be encoded in a way accessible to both parties. It has already been noted that this is achieved through an understanding of the two respective knowledge systems (see Section 2.4). It was shown that such understanding can result in better communication because it can improve both the supplier's and consumer's ability to articulate issues and their receptiveness to communicated issues.

Traditionally (over the past four or five decades) South African water services provision was largely dominated by a top-down approach. This was also applied in other African countries [Bwengye, 2002]. However, in South Africa, this was made more complicated by the "Western" (versus "African") perspective of the water services providers.

Now, emphasis is more on a bottom-up approach in which the true needs and preferences of society are taken into account. This is illustrated in the following figure.

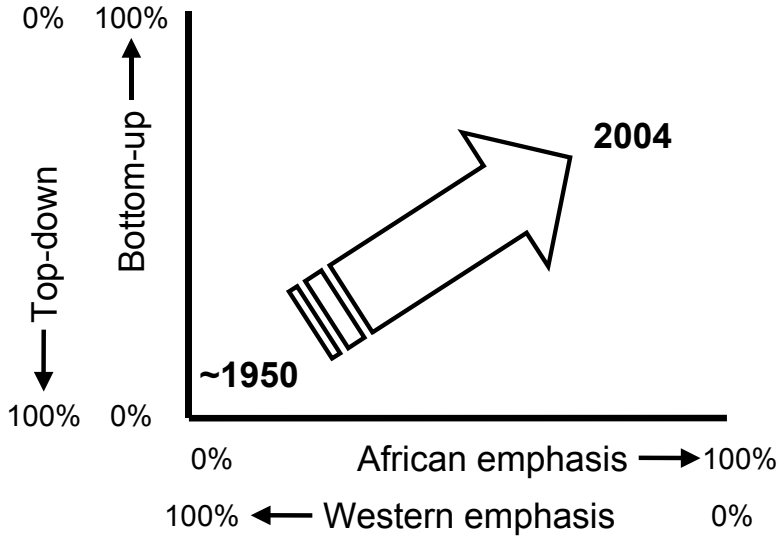


Figure 3.2. Illustration of progression from top-down to bottom-up and an increased African emphasis over the past five decades.

Although when the bottom-up approach is applied properly it has been shown to result in more successful (sustainable) developments, the difficult part is applying it properly. To do so, the two parties must understand one another's reference system.

3.3.2 Top-down and bottom-up

Seek first to understand, then to be understood

Habit No 5 "*The Seven Habits of Highly Effective People*". SR Covey. 1994

Of critical importance to the community is the reference system adopted by the supplier for technology transfer. Legislation decrees, and experience now dictates, that a bottom-up approach should take place. That is, the community's needs and preferences must be a primary driver of decision taking in developments. However, current attitudes remain in a state of transition from the previous top-down approach (in which developments took place with little or no community participation). The actual approach may therefore not be as extensively bottom-up as now considered necessary. There is therefore the danger of "mixed" (inconsistent) messages being given to communities.

The fact that transition is the order of the day in many aspects of service delivery by the Department of Water Affairs and Forestry (and other departments) means that it especially important that the community understands that nowadays a bottom-up approach is being adopted. The community's reference system relating to many previous developments, particularly the older ones, may be formulated around a top-down approach. Unless the community is clear about the supplier's new reference system, communication problems will inevitably arise.

Of particular importance to the bottom-up approach is the fact that the community must not merely be consulted. Rather their participation must be actively encouraged. Ideally, individuals and groups should be empowered where necessary to provide them with the ability to contribute meaningfully, articulate needs and be receptive to potential solutions. The community now has certain rights bestowed upon them. The community needs to understand these.

The bottom-up approach is also a relatively new reference system to suppliers of water services. Suppliers should use tried-and-tested approaches whenever appropriate but also be willing to test creative new approaches.

3.3.3 Western and African

3.3.3.1 Introduction

The following sections present a few ideas taken, often verbatim, from the book "The African Way" [Boon, 1998]. The ideas are not treated here exhaustively. (The reader is strongly encouraged to read the book for more detail.) However, the following sections do intend to illustrate certain different perspectives held by

Westerners and Africans. These in turn illustrate that the supplier and consumer knowledge (reference) systems in the water services provision context in South Africa, are often fundamentally different. These are the kinds of differences that need to be understood by the respective parties if truly effective communication is to occur.

These issues are important because, in many cases, the provision of water services to rural communities is being carried out by people with a Western emphasis while the consumers are typically traditional Africans.

A Westerner is regarded here as one who subscribes and aspires to a Western value system. An African is one who subscribes and aspires to a traditional African value system.

3.3.3.2 The concept of time

Typical Western view: Time is a linear concept. It progresses through the present, into a distant and potentially infinite future. The past is regarded as gone - let's rather look to the future. Planning and forecasting for the future can be all-consuming.

Typical African view: The African takes a circular view of time, in which the past is more important than the future. The African circles into the past, then the future, and back through the present to the past.

Lesson in current context: The Western view of time is diametrically opposed to the African view. The Westerner will need to accept the critical importance of the past (history) to the African. The African will also need to grasp the critical importance of the future, punctuality and planning in business.

3.3.3.3 Locus of control

Typical Western view: There is an internal locus of control. To a considerable degree, one can determine one's own future.

Typical African view: There is an external locus of control. In other words, there are forces operating in every person's life over which he or she has absolutely no control.

Traditionally, the ancestors play an ongoing and complementary role in every aspect of life. (A Group Africa survey in 1995 in rural and urban areas covering 1 637 respondents revealed 66 percent believed in the ancestors.)

Lesson in current context: This issue is closely related to the respective concepts of time. The Westerner will need to accept the importance of ancestors to the African and that relationships with ancestors do not cease with death. The African will need to acknowledge the difficultly that the Westerner may have with such beliefs.

3.3.3.4 Ubuntu

Typical Western view: Ethics and values are based on a Greco-Roman philosophy entwined with Judaic and Christian religious beliefs. The latter is true even of atheists. "Thou shalt not kill" and "Thou shalt not steal" are definitive laws and values society adheres to irrespective of religious belief. "Love thy neighbour", however, becomes a subjective value assessment. However, it is not always clear how far this can go and what exactly it means. The Western family is one in which the individual is paramount. Individual competition is encouraged. Marriage is a contract between two individuals.

Typical African view: *Ubuntu* is morality, humaneness, compassion, care, understanding and empathy. *Ubuntu* is the ethic and interaction that occurs in the extended family. In Africa it draws in all people. In this "family" there is a community of shared values and equality. *Ubuntu* is captured in the following expression: A person is only a person because of other people. *Ubuntu* does not exist unless there is interaction between people in the community. It manifests through the actions of people, through truly good things that people unthinkingly do for other people and the community. The group is as important as the individual. Marriage is regarded as a contract between two families.

Lesson in current context: The Westerner will need to understand that the *ubuntu* ethic may be driving the decisions and behaviour of the community. The African will need to understand that the behaviour of certain Westerners (perhaps in a supplier organisation) may be occasionally driven by individualism (that is not necessarily destructive).

3.3.3.5 The way of the warrior

Typical Western view: The modern Western warrior can be seen in the boardroom. There is always a clearly perceived hierarchy that need not be stated. Over the years the board will have been tested. There will have been skirmishes between members as the pecking order was established. There will have been fights between this board and other groups. The junior board members slowly learn the skills required and begin to position for power. The individuals compete with one another and are part of a team.

Typical Eastern view: The ancient warrior traditions of the Samurai have represented the honour and institutionalised morality in Japan. There is discipline and gentleness in those who have great physical and mental power. There is clear control and order, and with that comes respect. This culture has been harnessed to form the basis of one of the most powerful economies in the world. Every citizen is warrior-like in his discipline, loyalty and respect.

Typical African view: The warrior ethic is strongly rooted in African traditions. There are clear categories in the development of a male *e.g.* boy, senior boy, adolescent warrior, warrior. However, this is followed by a period of "taming of the warrior hero" as the warrior becomes a homestead head and then senior head. Boon (1998) quotes Johnny Clegg as saying "a man spends much of his life creating himself as a warrior, only to spend the rest of his life trying to tame the warrior that he created". Opponents are treated with respect and dignity. Even though the warrior seems extremely individualistic, there is no conflict with the community.

Lesson in current context: There are a number of similarities in the warrior-like traditions that pervade Western, Eastern and African societies. If properly harnessed, they can be a powerful force for good. However, each side should make the effort to better understand the details of the other's traditions.

3.4 EFFECTIVE INFORMATION FLOW - PROCESS MODEL

3.4.1 Introduction

The systems models suggest that effective information flow between supplier and consumer is one particularly critical issue. Accordingly, this section describes a simple process model that addresses this only.

It has been noted that the Havelock (1986) model is a useful model that can illustrate both technology-driven and demand-driven technology transfer approaches. The emphasis of supplier-consumer interactions in the systems models is clearly on a demand-driven approach. The process model developed here is based on this.

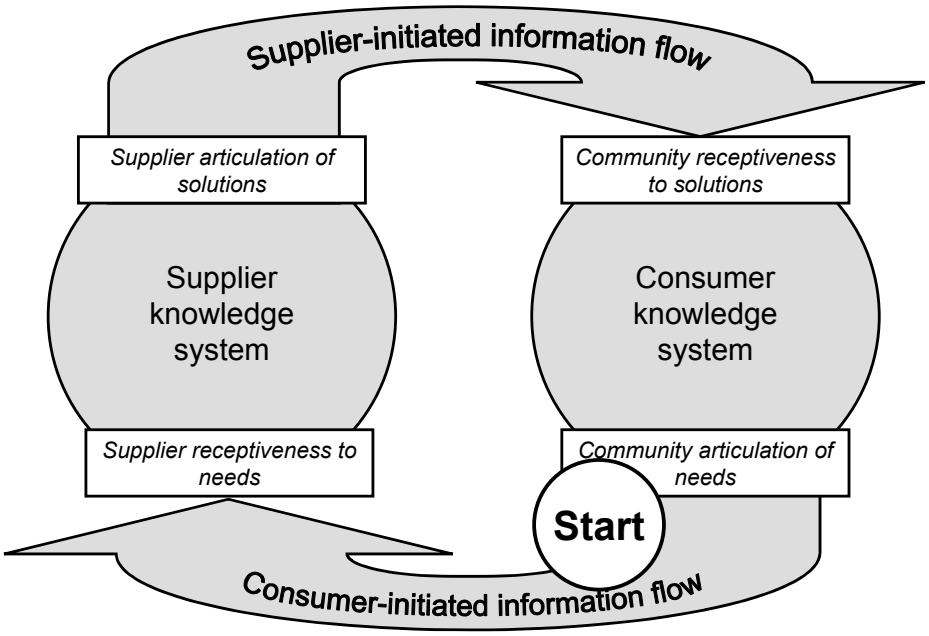


Figure 3.3. Information flow model used as basis for the process model.

3.4.2 Model description

The supplier should initiate engagement.
The community should initiate information flow.

The process model is presented from the supplier's perspective. The starting point is assumed to be the articulation of needs by the community (see above figure). The supplier will inevitably initiate engagement with the community. However, the

community must initiate the overall information flow (in the form of their articulated needs). The supplier will need to explain why the engagement has been initiated. However, explicit articulation of potential solutions to community needs perceived by the supplier should be avoided at this time. The supplier should use this opportunity to begin to understand the community's knowledge system, particularly related to water, with the ultimate intention of enabling the community to express its needs.

The backbone of this process model is a series of questions. The first questions (relating to desire and ability to articulate needs) will be particularly relevant in the earliest planning phase of the overall development. As the relationship develops between supplier and community, and potential solutions are being developed, the remaining questions become more relevant.

The model can be referred to during any development phase. The user is encouraged, at any time, to scan through the questions, in the order given, confirming that all can be answered in the affirmative until the user comes to the question most relevant to the current phase and situation. If a negative answer is more appropriate, the model then suggests, in broad terms, what actions should be taken and, in particular, what issues should be focussed on.

It should be emphasised that these questions can be referred to *at any time in any development phase*. For example, community needs are not static. It is important that as circumstances change, even during the operation & maintenance phase, the desire and ability to articulate new needs must still exist. The community's buy-in must be sustained. Communication mechanisms must remain in place. It is in this sense that the questions remain important.

The model is captured in two consecutive figures.

3.5 CONCLUSION

3.5.1 Ease of process model development

An important aspect of the relationship between systems models (the issues) and process models (the actions) is that once the important issues have been identified and their inter-relationships with other issues understood, the focus of the optimum process model is often self-evident.

The current model demonstrates how a process model can be derived relatively straightforwardly once the important issues (focussed in this case on effective information flow) have been identified in a systems model. A more detailed description of relevant actions at each stage is obviously possible. However, since the current work is demonstrating an approach, this is not done. References to issues dealt with in more detail in the Systems Models chapter are relatively obvious.

3.5.2 Consistency with empowerment and capacity building

Each action in the process model exists because there is an issue that it is addressing. The emphasis given to understanding the issues (and capturing this understanding in a systems model) creates considerable confidence in any associated process. One now understands clearly *why* certain things need to be done. One does not have to take this for granted and simply hope that the action you are about to take actually has some useful purpose.

Having an associated systems model can therefore be very useful when trying to convince others to adopt a particular process (*i.e.* to do what you want them to do). It is not always effective simply to give instructions and hope that they will be carried out (*i.e.* adopt a "command and control" approach). If one can convey clearly why an action is important, then the instruction is more likely to be carried out. It also shows a degree of respect for those you are trying to convince.

This approach is entirely consistent with empowerment and capacity building. The latter not only trains but enables problem solving. This is closely related to empowerment. Those being "empowered" are necessarily given a deeper understanding. This means they should be able to understand *why* an action is important.

This lesson can apply within the supplier institution. Instead of simply saying to individuals that they should be "consumer-oriented", rather explain why consumer buy-in important. And explain why it is not only important to the consumer, but why it is important to them as individuals and to the overall sustainability of the development. This can done by (a) emphasising the potential problems if buy-in is not achieved and (b) by emphasising the positive effects (like promoting cost recovery).

In essence, understanding is the basis of genuine empowerment and capacity building. Systems models create understanding. They also have the added advantages of (a) enabling highly focused process development and (b) facilitating communication of that process to others.

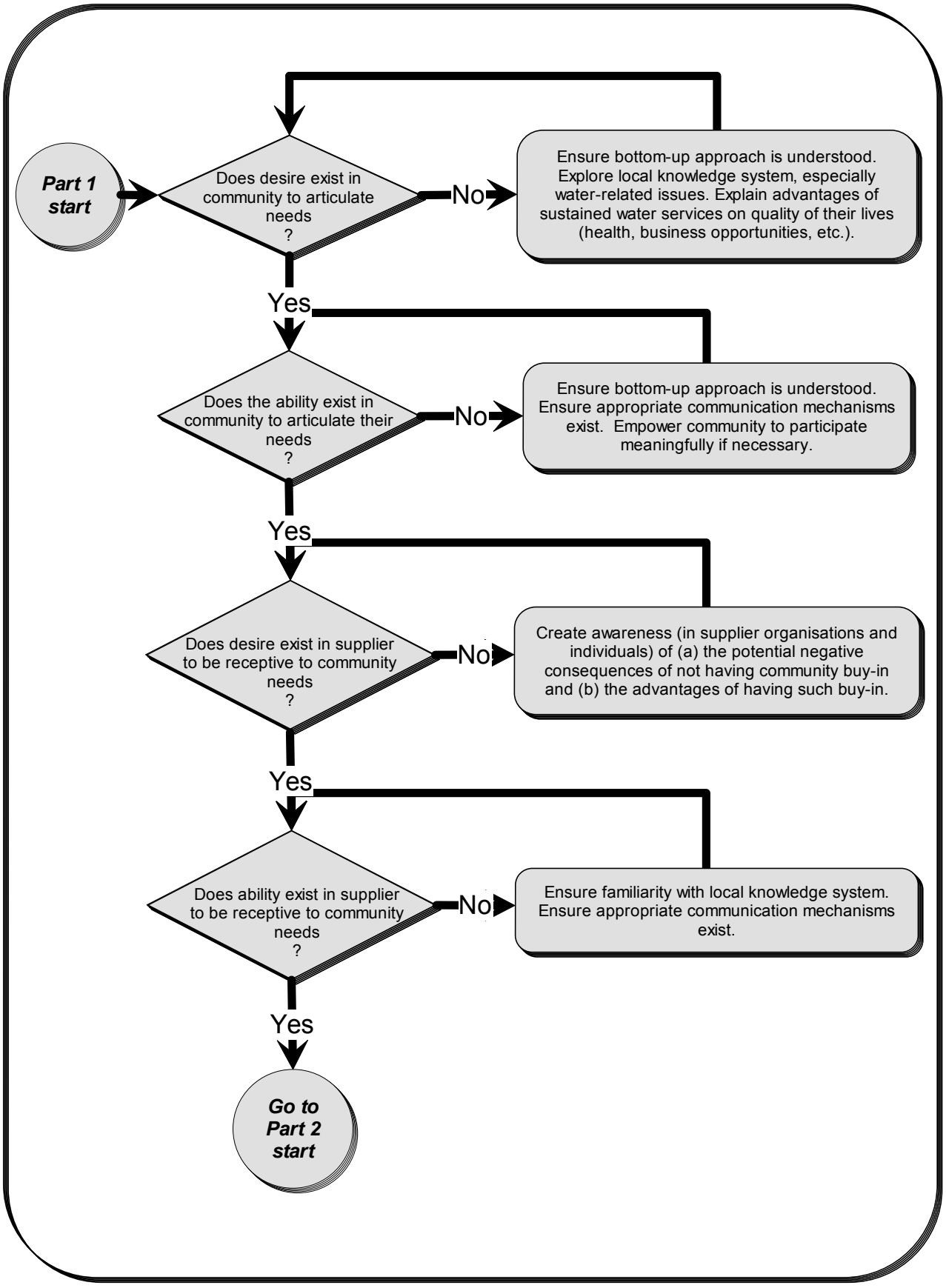


Figure 3.4. Part one of process model for effective information flow.

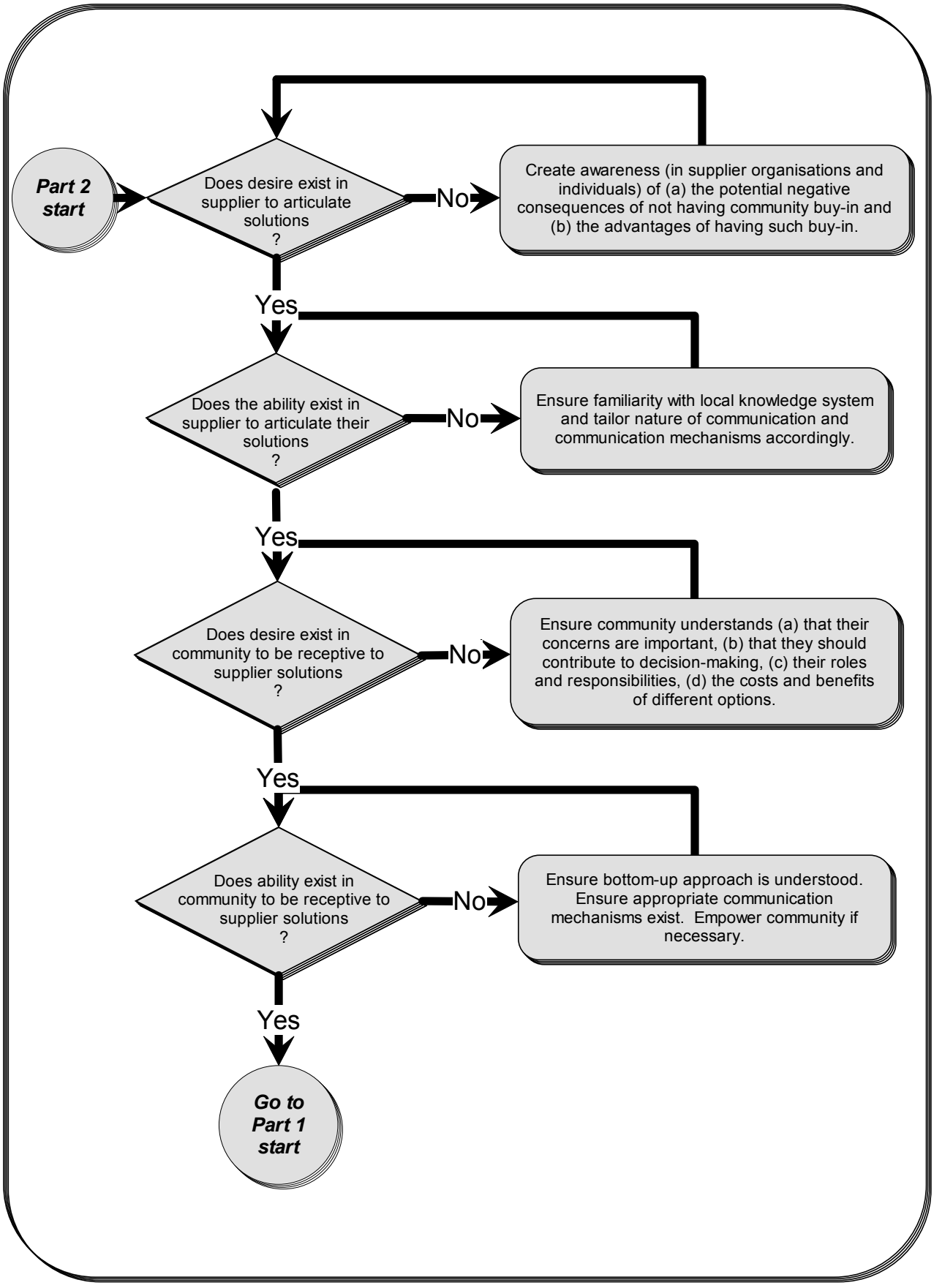


Figure 3.5. Part two of process model for effective information flow.

CHAPTER 4: MODEL VALIDATION

4.1 INTRODUCTION

An important component of any kind of model development is testing whether the model adequately reflects the important aspects of the real world it is associated with. The specific model of relevance here is the process model. If this could be shown to be adequate (at least for those aspects it specifically addresses), then, by implication, so would the systems model be adequate since the process model is based on the systems model.

The limited nature of this particular study did not allow the process model to be formally released to practitioners in the field for testing. Nor indeed was this the original objective. (The aim was to test and assess an approach, not necessarily develop a tool for use.) Furthermore, the process only addresses one particular aspect identified as important in the systems model, namely information flow (or, equivalently, effective communication).

Accordingly, the following case studies were considered in a rather superficial and subjective manner. First, an attempt was made to assess the degree to which each gave attention to the questions appearing in the process model. Secondly, an assessment was made of the degree to which the development was successful. If the two assessments corresponded, the model was considered validated.

4.2 CASE STUDIES

Three case studies where chosen. The extent to which each desire and ability (of the process model) was addressed was subjectively assessed by the project team. In each case people intimately involved in each development were consulted. The degree to which each question was addressed was rated on a scale of 1 to 2 (1=intermediate degree, 2=significant degree).

4.2.1 KwaNyuswa (Kwazulu Natal)

This water treatment plant was part of a broader water supply scheme. It is regarded as only having been ***partially successful***. The main reason for this is that one

component of the water treatment plant was eventually not operated (it was bypassed) according to original design specifications. Although the community still received water, it was inevitably of lower quality than that designed for. Occasionally specific complaints were received about turbid water. This was specifically caused by the inappropriate operation of the plant.

Table 4.1. Case Study A: Assessment of communication issues.

Issue	Rating	Comments
Desire of community to articulate needs	2	Initial request came from community for water closer to households.
Ability of community to articulate needs	1	Limited public participation during meetings
Desire of supplier to be receptive to expressed needs	2	Initial intentions were good.
Ability of supplier to be receptive to expressed needs	1	Supplier did not fully appreciate what was required to achieve maximum participation.
Desire of supplier to articulate solutions	2	Multiple options and there implications (employment, costs, etc.) were presented
Ability of supplier to articulate solutions	1	Presentation of broad options effective but communication of detail, especially with respect to sustainability, was questionable.
Desire of community to be receptive to proposed solutions	2	Community were enthusiastic about considering options.
Ability of community to be receptive to proposed solutions	1	Communication mechanisms restricted to written report (only readable by few) and hand drawn diagrams on flipchart.
Overall rating (max=16)	12	

Assessment of validity of model: The ratings suggest that, although the desire apparently always existed to overcome the potential communication barriers, the abilities to do so fell somewhat short of optimum levels in every case. It is not unreasonable to suggest that this model would have predicted some difficulties.

4.2.2 Ga-mogkgwathi (Northern Province)

This rural community was provided with a single water desalination plant to improve the quality of brackish borehole water. Only one borehole was treated. Other boreholes were also used by the community although these were all of better, though not good, quality. The study was only a pilot study with possibly less than 10% of the population (total approximately 10,000) benefiting directly from the plant. The purpose of the study was to (1) provide good quality water and (2) train a water committee to manage the water supply. This training focussed on the following typical aspects:

- How to communicate the needs of the people.

- How to conduct meetings.
- How to collect payments (for scheme).

It was the intention that maintenance costs (excluding plant operator salaries, which were paid for by the Department of Water Affairs and Forestry) would be paid for by the community. This involved the whole community, even though a small percentage were actually benefiting directly.

After two initial meetings the plant was installed. Thereafter training proceeded. However, a rift developed when water committee members became dissatisfied with proposed payments to them for performing a local economic survey. This was intended to establish the degree to which the community could afford to pay for services.

This project (albeit a pilot project) is considered a ***failure***. The main reason cited was inadequate cost recovery. The plant was formally shutdown about two years after initial installation.

Table 4.2. Case Study B: Assessment of communication issues.

Issue	Rating	Comments
Desire of community to articulate needs	1	Initially readily communicated their broad needs (electricity, etc.). After installation and water committee dissatisfaction, low attendance at meetings suggested lessened desire to articulate needs.
Ability of community to articulate needs	1	Only two meetings held before plant installation. Thereafter water committee was trained and acted as main mechanism for articulation of needs.
Desire of supplier to be receptive to expressed needs	2	A genuine desire apparently existed.
Ability of supplier to be receptive to expressed needs	1	Ability restricted to mechanism created by the water committee.
Desire of supplier to articulate solutions	1	Only one water treatment option existed (desalination). However, articulation of solution initially restricted to verbal communication only.
Ability of supplier to articulate solutions	1	Initial meetings restricted entirely to verbal communication. After installation, on-site demonstration of plant capabilities (*e.g.* water tasting) carried out (considered successful).
Desire of community to be receptive to proposed solutions	1	Initially receptiveness apparently high. After installation and water committee dissatisfaction, much less receptive. Asked "why should we pay?" especially in context of "free basic water".
Ability of community to be receptive to proposed solutions	1	Sometimes information given to the water committee did not filter through to the community.
Overall rating (max=16)	9	

Assessment of validity of model: The average ratings in all cases except one strongly suggests that this model would predict significant problems. Although inadequate costs recovery was the technical reason for shutdown, this could be explained by the generally inadequate consumer buy-in (see systems model, Figure 2.1). If greater attention had been given to improved communication at all times, this level of buy-in may have been improved. This may have improved the level of cost recovery.

Although examined extremely superficially, this case study seems to provide further validation of the process model.

4.2.3 Isidumbini (Kwazulu Natal)

This water treatment plant is part of a broader water supply scheme. It is regarded as having been ***successful***. The main reason for this is that the water treatment

plant has been continuously in use as an integral part of the water supply scheme for a number of years. Certain components of the water treatment plant have been modified due to technical shortcomings, but this has not resulted in the treatment plant being by-passed. The community has become very aware of water quality issues, and report problems on a regular basis when these occur.

Table 4.3. Case Study C: Assessment of communication issues.

Issue	Rating	Comments
Desire of community to articulate needs	2	The community initiated the water supply project and established the structures needed to represent all members of the community in meetings.
Ability of community to articulate needs	1	The community representatives were able to show and discuss their needs to some extent, but without the background of possible options and only in verbal form.
Desire of supplier to be receptive to expressed needs	2	The supplier has been working in a participative way with communities for at least 10 years and fully understands the approach of community participation
Ability of supplier to be receptive to expressed needs	1	Although the desire to be receptive was high, the supplier representative at the first meeting was not Zulu speaking and may not have had an in-depth understanding of the local culture.
Desire of supplier to articulate solutions	2	There was a significant desire to ensure that the community made the choice of solution that they would then take ownership of.
Ability of supplier to articulate solutions	1½	Feasibility report compiled and various options were proposed, but not necessarily at a level that community members could fully grasp.
Desire of community to be receptive to proposed solutions	2	There was a high level of commitment and interest in the project that has been maintained throughout the life of the project.
Ability of community to be receptive to proposed solutions	2	The community did fully understand the option they selected, and have remained committed to it on an ongoing basis.
Overall rating (max=16)	13½	

Assessment of validity of model: The ratings suggest that, with the high level of experience and desire on both sides, although some minor misunderstandings may have existed in the early stages, the result has been a successful project overall. It is not unreasonable to suggest that this model would have predicted this level of success.

4.3 CONCLUSION

Bearing in mind that the process model only directly addressed issues relating to information flow between supplier and consumer (and not the multitude of other possible issues), the degree to which this simple model seems to correlate with the actual outcome is remarkable.

Taking this at face value, it not only suggests that the process model is addressing critically important issues. Since the "avoiding the pitfalls" systems model (Figure 2.4) makes it abundantly clear that many other specific issues exist (like cost recovery, political will, etc.), it also suggests that the communication issues may be more fundamental than these other issues. Indeed, this is what the systems model suggests. For example, cost recovery and political will (and other issues) are driven by consumer-related buy-in which is promoted by expectations being met, understanding of roles, etc. These, in turn, are driven by effective information flow. In other words, although a development may apparently fail because of inadequate cost recovery (for example), the model is suggesting that this is not the root cause. The root cause may be ineffective information flow.

Nevertheless, although this simple model validation exercise is encouraging, it does remain a *simple* validation exercise. It would be entirely inappropriate to assume that this rounds off the current study to an extent that its findings should be made available for broad application. A number of critically important issues identified in the systems model remain to be more fully investigated by this systems thinking approach.

An interesting final observation is that in most cases the *desire* to address each issue was present (except in the case of Ga-mogkgwathi in some instances). However, apparently in many cases the *ability* to do so fell short. In other words, sometimes abilities do not match the usually good intentions.

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