Technology transfer of hand pumps in rural communities of Swaziland: Towards sustainable project life cycle management

Yemane A. Baraki[a, b], Alan C. Brent[a]*

[a] Graduate School of Technology Management, Engineering II, University of Pretoria, Pretoria, 0002, South Africa.
E-mail: alan.brent@up.ac.za
Tel: +27 12 420 4605

[b] PO Box 139, Eveni, Mbabane, Swaziland.
E-mail: yabraham@irdglobal.org; yemabraham@gmail.org
Tel: +268 240 44 204

* Corresponding author

Abstract:
The research summarised in this paper explored the reasons behind the high failure rates of hand pumps from a technology transfer perspective, by examining the existing hand pump technology transfer practices and procedures in Swaziland where over 3,000 hand pumps were installed and about 60% are not working. The research determined that there is a lack of proper, structured and sustainable knowledge sharing practices among the main stakeholders, suppliers, providers, users, and the government. It was observed that operations and maintenance, knowledge management, and the integration of a project life cycle management approach were crucial elements for the sustainability of hand pump-based rural water supply projects. Users have little involvement throughout the project life cycle; they do not know where and how to access parts, the majority of the areas do not have trained technicians, and government does not have stock for parts. There is poor communication between the users and suppliers, which is critical for product improvement and product support. It is therefore necessary to have a balanced focus on resource allocation for a hard and soft technology transfer process. A maintenance model resulting from the study aims to provide for practical co-ordination involving all the major stakeholders. Its objective is to establish a sustainable institutional support system through a public/private partnership.

Keywords: Rural communities; Technology Transfer; Sustainable Technologies; Life Cycle Management.

1. Introduction

Hand pumps are mostly utilised to supply water in rural areas of Africa, and over 350,000 hand pumps have been installed for this purpose. However, the United Nations Children's Fund (UNICEF) data show that at least 40% (about 150,000) of these hand pumps are abandoned. In dry and remote areas the hand pump failure rate is over 80% [1]. In 2005 it was estimated that 35% of all rural water supplies in sub-Saharan Africa were not functioning [2]. In a survey conducted in 2009 by International Relief and Development (IRD), a Non-Governmental Organization (NGO), on 425 boreholes in southern Swaziland, 39% were not operational, while 19% were partially operational [3]. Statistics across the world, especially in developing countries, indicate that rural water supply facilities are falling out of use at an alarming rate [4]. This therefore requires a different approach to viewing the challenges affecting the sustainability of borehole pumps. A central aspect in the management of technology is the appropriate transfer of that technology to the users through a process known as technology transfer. In order to address the low sustainability of hand pumps in Swaziland, it was imperative to analyse the gaps in the process of transferring the technology from the manufacturers of the hand pumps to the user communities. The research explored the reasons behind the high failure rate of hand pumps in the context of technology transfer by examining the existing hand pump technology transfer practices and procedures in southern Swaziland, where hand-pump fitted boreholes are the main, if not the only, drinking water supply sources in most of the rural communities.

1.1 Technology transfer

Technology transfer is a process by which a technology supplier communicates and transmits the technology through multiple activities to the receiver, and this will ultimately enhance the technological capability of the receiver [5]. Technology transfer encompasses far more than equipment and other so-called "hard" technologies, for it also includes entire systems and their component parts, 'know-how', goods and services, equipment, and organizational and managerial procedures [6]. Technology transfer thus involves both 'hard' and 'soft' technology. Largely, the narrow definition in terms of hard technology transfer has been adopted in developing countries and hard technology has subsequently overshadowed training, institutional capacity and infrastructure; all of which are prerequisites for sustaining hard technology [7]. In the context of hand pump technology transfer, appropriate technology selection through suitable participation of users, knowledge management, maintenance and operation plans, technology improvement through feedback, and research and development (R&D) are all important factors for sustaining hard technology.

The sustainable use of hand pumps in rural communities has been hampered by factors from both the supply and demand side. There is little or no incentive for the private industry to invest in innovation, design, development and technology improvement of hand pumps due to the low return, since most of rural African communities do not have the capacity or means to purchase hand pumps on their own. From the demand side, contributing factors include: lack of adequate institutional support for operation and maintenance; lack of financing mechanisms, often being dependent on donor funding; inadequate provision of technical assistance for training in maintenance; and the lack of community participation ([8]; [9]; [10]; [11]; [12]; [13]). The lack of technology management plans and project management skills have also been detrimental to project success [7].

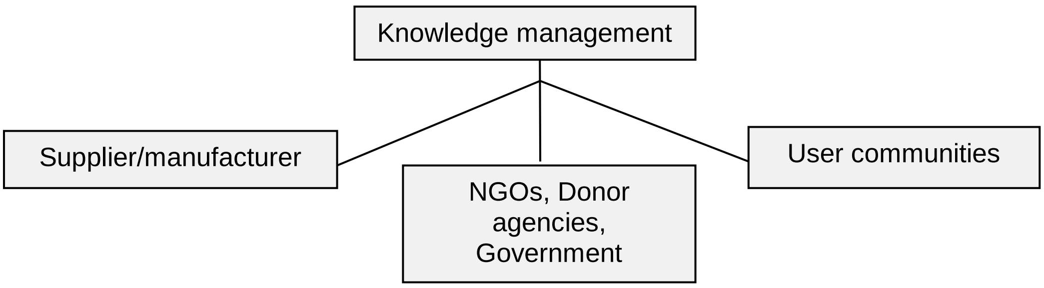

Figure 1. User–Supplier relationship in hand pump technology (Adapted from UNEP, 2003)

To improve the flow of credible information between technology developers, providers and users, information to support technology transfer should be demand driven and results oriented, supporting key activities in the transfer process, such as selecting a specific technology and making an investment decision [6]. The relationship and the interaction among stakeholders (see Figure 1) in the hand pump technology transfer are often not consistent. They are rather brief, with the relationship ending up with the closure, or completion, of the projects, which are usually short term in nature. There is often an unbalanced focus and resource allocation towards borehole drilling, supply and installation of hand pumps in rural communities and the aspect of its management, service, maintenance, and product improvement. While a great deal of attention is paid to the former, little or no support is given to the latter.

Since technology transfer is a process by which both the hard and the soft components of the technology are transferred from the supplier to the user, it requires a proper approach for the transfer to be successful. The life cycle management concept is one such approach.

1.2 Sustainable Life Cycle Management (LCM)

In current literature, sustainability is (typically) defined in three dimensions: *environmental*, *social,* and *economical.* Therefore, sustainability means to be able to keep human development in all these dimensions, which is often referred to as sustainable development [14]. Life Cycle Engineering approaches evaluate the environmental implication of a product, process or service in the design phase, while Life Cycle Management is an extension of the Life Cycle Engineering (LCE) concept, namely the life cycles of products, processes and services that are managed beyond the design phase [15]. Labuschagne and Brent further argue that a holistic LCM approach requires an effective integration of the three life cycles (projects, assets and products), for organisations.

1.3 Sustainability of hand pumps

Hand pump-equipped boreholes are one of the most common water supply technologies adopted in rural Africa, but often demonstrate low levels of sustainability. The primary reason for these high failure rates, and hence low sustainability, is insufficient attention to operation and maintenance of the pump [8]. Other reasons include poor financial management [9], a mismatch between the technology, the water environment, and the capacity of users to maintain the systems [11], and borehole failure [16]. There are a variety of rural water supply sustainability frameworks, approaches and initiatives in the literature. Montgomery et al. [12] proposed three foundational sustainability components: (1) effective community demand, (2) local financing and cost recovery, and (3) dynamic operation and maintenance. For each of these components, enabling factors along with the main obstacles and trouble-shooting approaches were presented.

Harvey and Reed [8] identify eight main sustainability factors. These factors (or building blocks) are: policy context, institutional arrangements, financial and economic issues, community and social aspects, technology and natural environment, spare parts supply, maintenance and monitoring. Each of these factors was extensively explored in relation to financing, effective demand, and management, along with guidance for addressing sustainability.

Given these observations and reflections in literature reviews, as well as the experiences of the authors in the field, rural water supply service failures are most attributable to two broad aspects:

Technical: These are failures related to the borehole's design and construction, the type and procedure for pump selection, and the lack of spare parts.

Managerial: These are failures related to poor community management (financial, operational and managerial) and inefficient support systems.

The causes of hand pump failure could thus be technical or managerial, or a combination of both. It is then necessary to analyse the problem of technology transfer from these perspectives.

1.4 Research objectives

The research aimed to establish the main problems associated with the transfer of hand pumps in rural areas of developing countries, and specifically Swaziland, by providing a conceptual framework in order to investigate and analyse the main causes for hand pump failures, and to provide recommended solutions that can assist in efforts to increase the sustainability of hand pumps. It also aimed to investigate and establish the existing buyer/supplier relationship in terms of knowledge sharing in the hand pump technology transfer, and provide recommended solutions to improve the knowledge transfer.

2. Hand pump technology transfer framework

The literature on rural water supply and sanitation in developing countries places much emphasis on sustainability, with more focus on the demand side. This research aimed to explore the sustainability issue of hand pumps from the technology transfer perspective, namely from both the supply and demand sides.

There is a lack of proper, structured and sustainable knowledge sharing practices among the main stakeholders, including suppliers, providers and users in the hand pump technology transfer process. Thus, a conceptual framework is introduced to investigate the inter-relationship among the three main stakeholders in the hand pump technology transfer process. The linkage between the product life cycle and the project life cycle is also explored. The project in this context entails the rural water supply project, which has a preference for using the product (hand pump) as a technology option. Generic life cycle phases are chosen for both the product and the project for the sake of simplicity. The method is illustrated in
Figure 2.

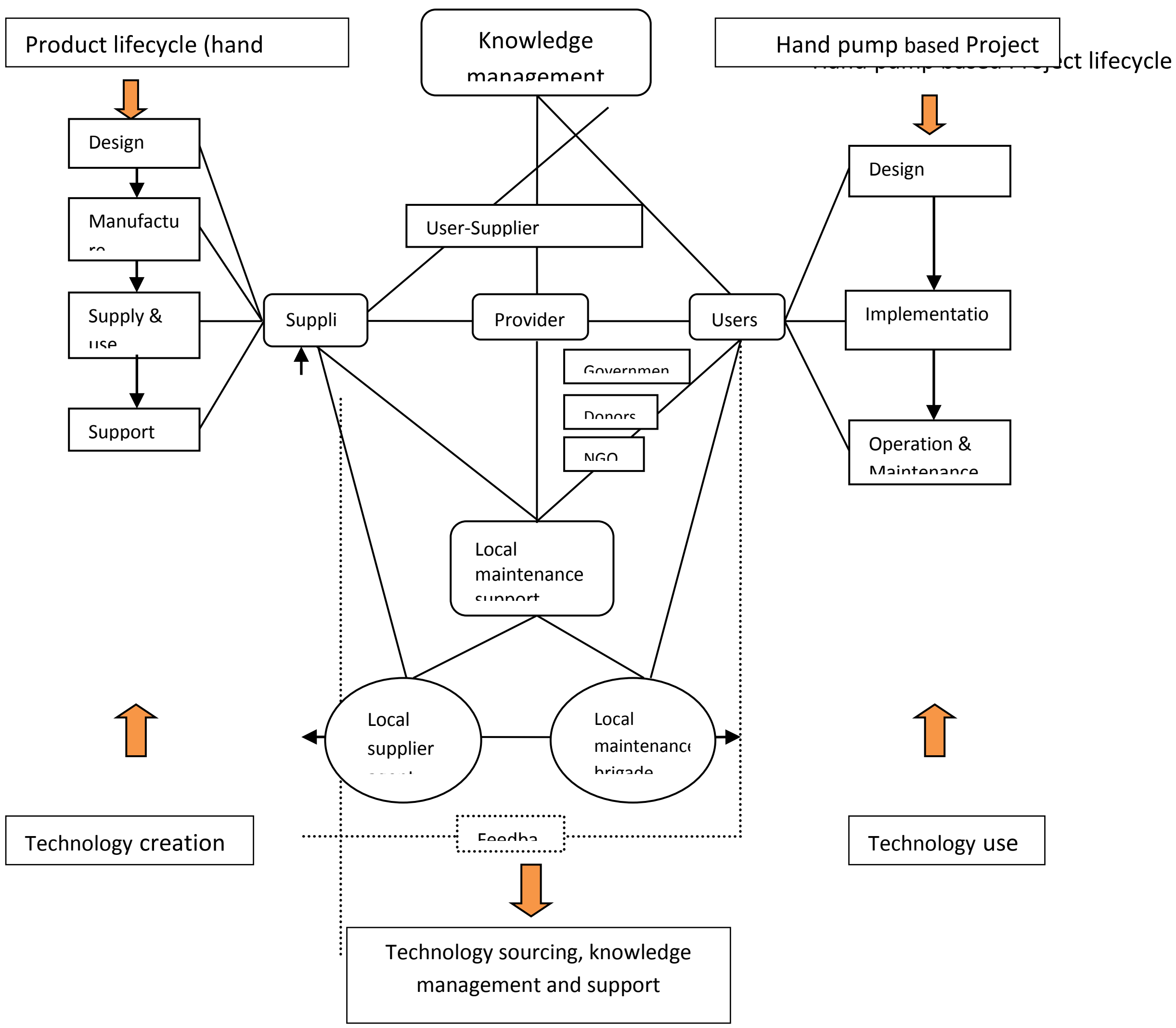

Figure 2. Proposed hand pump technology transfer framework

The knowledge management, including the information transfer and knowledge sharing, and technology improvement through feedback, R&D, operation and management procedures, are important elements for sustaining the hard technology. The insufficient attention to the operation and maintenance of hand pumps, which is regarded as the primary reason for high failure rates [8], cannot be treated in isolation since it is the major component in the technology transfer process. Technology transfer in the context of life cycle management is therefore a way forward to explore technological, technical and managerial processes and procedures of the product from “its cradle to its grave”.

3. Research approach

Due to the nature of this research – having multi-dimensional data sources – triangulation was used to negate or counterbalance the deficiency of a single data collection strategy, so as to increase the validity and improve the ability to interpret the findings. The research methodology therefore applied mixed methods, namely qualitative and quantitative methods of data collection and analysis. A mixed methods approach attempts to take advantage of the similarities and differences in qualitative and quantitative methods [17].

The project that was selected for the case is one funded by USAID[1] and implemented by International Relief and Development (IRD) in southern Swaziland. IRD is a humanitarian, non-profit organization engaged in rural water projects since 2007 in Swaziland. IRD repaired, rehabilitated and replaced over 200 hand pumps, and established community management systems.

For the hand pump users, from a sample of 400 borehole sites in IRD areas of operation, 24 boreholes were selected through multi-stage, systematic random sampling in four constituencies, so as to identify users obtaining water from the three main hand pump types: Afridev, Indian Mark II, and the Blue pump. A questionnaire was administered to 90 users sourcing water from the 24 boreholes; 71 % of them were regular members of the communities and 29 % were members of water committees. The selection of hand pump sites for the research was based on the relative distribution of the pump types in the Lowveld region of Swaziland. Information was collected from key informants from international Non-Governmental Organisations (NGOs), Government agencies, pump manufacturers and other stakeholders in the provision and use of hand pumps in Swaziland.

4. Research results and discussion

The conceptual framework that was introduced (see Figure 2) to show the linkages between technology sourcing, knowledge management and maintenance support systems was used as the basis for the investigation, and guides the discussion of the results.

4.1 Usability and efficiency of hand pumps in Swaziland

It was observed that 59% of the pumps had experienced a problem in the 12 months preceding the research, with 45% of the pumps not functioning for the whole 12 months and 29% only functioning for up to 5 months. The majority of the pumps breaking down during the mentioned periods were Afridev pumps (85%). This indicated that there are differences in the usability and efficiency of the different brands of the pumps. The major reasons attributed to the pumps not being functional were the breakdown of the pumps (27%) and the boreholes not having sufficient water (20%). The breakdown of the pumps is directly related to the design, operational and maintenance problems. This finding is supported by other researchers and scholars, for example, Harvey and Reed [8]” *the primary reason for hand pumps failure is insufficient attention to the operation and maintenance*”.

[1] USAID: United States Agency for International Development

4.2 Sources of hand pumps in Swaziland

The main sources of hand pumps were Holland for the Blue Pump and India for the India Mark 2 and the Afridev pumps. The Afridev and the Indian Mark 2 pumps were introduced in Swaziland in the mid-eighties. Recently the Blue Pump was introduced through an IRD/USAID funded program in 2009 and was found to be efficient at depths of up to 100m.

The appropriate selection of hand pump type is an important element for hand pump sustainability. Table 1 summarizes advantages and disadvantages of the major pumps in Swaziland, based on the information obtained from key informants.

Table 1. Comparison of main hand pumps in Swaziland based on key informants' assessments

Pump Type	Advantage	Disadvantage
Afridev	• Easy to install and repair • Cost relatively cheaper ($2,500)* • Suitable for shallow wells	• Not suitable for deep wells • Frequent maintenance requirement • Difficult to maintain a specific quality standard as it is a public domain pump
Indian Mark II	• Suitable for deep wells • Moderate cost ($3,000)	• Installation and repair requires specialised crew
Blue Pump (Afri pump)	• Suitable for both shallow and deep wells • Very low maintenance requirement • Easy to install	• Cost relatively high ($4,200)

***** Pump costs were estimated based on suppliers estimates and recent imports to Swaziland

4.3 Technology transfer

Product improvement: The research highlighted that there is neither allocation of funds for R&D by donors and governments, nor feedback between suppliers and users. Despite the presence of water point committees (83%), the interaction between the users and the service providers, suppliers, and manufacturers is still very poor; thereby limiting the information flow that can be used to improve the product through research and design.

Knowledge transfer: The research indicated that the attention provided to the knowledge transfer, particularly the soft technology, is insufficient. Inadequate time is provided to the users during training. A one-day training session is usually provided to water point committee members during pump installation, and it usually involves the "How" part of operation and management, and less emphasis is placed on the "Why". There are no user-friendly hard-back manuals left behind with the users, to which they can refer during the operation of the hand pumps.

Appropriate technology/pump selection: The majority of the pumps breaking down were Afridev pumps (85%) which are the most common pump types (76%) in Swaziland [3]. The survey also indicated that the average borehole depth is 72 meters, which is beyond the capacity of Afridev pumps. These pumps are generally ineffective below a depth of 40 meters and are subject to frequent breakdowns below this depth. In these cases it is not the hand pump technology itself, but it is the improper pump selection that greatly contributed to the operational failure.

The research also identified barriers to technology transfer that include:

- Most hand pumps are foreign and suppliers and agents are not accessible to the direct users.
- There is a high turnover in the water point committees due to the impact of HIV/AIDS in Swaziland, which is resulting in loss of valuable information at community level.
- There is still a general feeling among the communities that water points are a responsibility of the Government and NGOs that installed them.

- Inadequate information is provided to the users, regarding the pump type, pump expected lifespan, and the basic operation and maintenance requirement.

4.4 Life cycle management

Neither the hand pump suppliers, nor the project implementers properly practiced the life cycle management approach, particularly in relation to operation and maintenance (O&M). From the manufacturers/suppliers perspective, the product support system, including operational training, spare parts supply and feedback, is provided through their local agents. In practice, this approach proved to be less effective, since user communities never had a direct communication with the suppliers or their agents. Implementing agencies indicated that they involve user communities in all the stages of the project life cycle. However, 80% of the respondents stated that hand pump project implementers had not involved them from the project planning stage to the closeout stage.

The choice of technology is entirely selected by implementers, so only a single technology choice is given to the users, namely hand pumps. The type of hand pump selection is done only by the implementing agencies. Training on O&M for the representatives of the communities is provided using the supplier's manual, which is not adequate in itself. In the current arrangement, the responsibility for O&M lies on the user communities for minor repairs and the rural water supply branch of the Government for major repairs. However, all NGOs that were interviewed agree that the current hand pump O&M practice is unsatisfactory. It appears that the product support, knowledge management and O&M issues have not been given the required attention by both suppliers and implementing agencies. This applies to any phase of the product or project life cycle, which has immensely contributed to hand pump failures.

4.5 Hand pump standardization

It was observed that there is no standardization of hand pumps in the country. Suppliers are free to bring in hand pumps of their choice, because there are no legal requirements, which force suppliers or other service providers to meet a minimum performance or quality standard. To date, there are many pumps that have been imported into the country, but in the last ten years the most common ones include Indian Mark 2, Afridev and Blue Pump. In comparison with countries like Zimbabwe, where it is a policy to use a specific type of pump that is tested and approved by the Government, pump suppliers here have the free will to decide what to put on to the market. This creates a challenge when it comes to availability of spare parts and product support. If the Government does not standardize pump types, manufacturers and suppliers will be reluctant to bring product support to the people as it will be a business risk.

4.6 Operation and maintenance of hand pumps

Despite the presence of community-based management structures, there is still a high failure rate and longer down time; 45% of the broken pumps were not functional for over 12 months. It was noted that community representatives hardly received training on operation and maintenance; 81% (of the regular members of communities) and 92% (of members of water committees) respectively said the project implementer had not trained their representatives on operational and financial management whereas 85% had not received maintenance tool kits. Of the respondents, 82% indicated that they did not have a plan for replacing the pump when damaged. The focus of the implementing agencies and Government was on the formation of WASH[2] committees without providing them the necessary training in operational, financial and maintenance management. Without a proper training/knowledge transfer, communities may not be expected to perform efficiently. The responsibility of the committee should also be clearly spelled out.

[2] WASH: Water Sanitation and Hygiene

One major reason for the high failure rate is the availability of the necessary funding to support the on-going operation and maintenance; and the eventual replacement. The establishment of appropriate funding mechanisms is then required that is managed by the communities themselves. For the sustainability of the system the importance of user payment for the service has been highlighted [7]. However, water, as a basic human necessity, cannot be withheld. And seasonal variations in water availability also mean that the economic ability of communities to pay for the service changes over time. The funding mechanisms thus need to incorporate flexi-payment schemes that are agreed to by community members, and managed through the WASH committees.

4.7 Research and development on hand pumps

The users also highlight the need for hand pump technology improvement; 66% of respondents believe that the product should be improved. The absence of significant improvement or very slow progress in the hand pump technology is an indication of lack of funding for research and development (R&D) activities, as highlighted by BOODE[3]. The manufacturers indicated that they never received any form of assistance from Government, donors or research institutions on R&D, but highlighted that they would have improved their product had that been the case.

According to data obtained from comparative studies in Zambia and Swaziland on the provision of hand pumps, donors and Governments have either subsidized or supplied spare parts freely. For example, UNICEF has subsidized spare parts for Indian Mark II hand pumps in Zambia and Afridev pumps in Swaziland. USAID, through IRD, has invested in the repair and replacement of broken hand pumps in Swaziland and Mozambique since 2008. While there is funding available for the purchase, repair and replacement of pumps and parts, there is no such funding for research and development.

5. Conclusions and Recommendations

5.1 Hand pump technology improvement

With the current level of technological advancement, one can assume that it is possible to manufacture a hand pump which is simple to transport and install, easy to operate, affordable and has low maintenance requirements. What it takes to achieve this is the will and allocation of funds for R&D by donors and Governments. The design improvements made by BOODE on the Blue Pumps certainly supports this possibility. Donors and Governments have invested large amounts of money on pump purchases, repairs and spare parts supply. By shifting investment into R&D, it is possible to manufacture a better quality and user-friendly hand pump. The investment in the design improvement can help reduce the pump cost and will contribute significantly to reducing the maintenance requirements. This is the critical component in hand pump sustainability as it also minimizes the down time.

Manufacturers and suppliers need to be incentivised to improve their products and provide maintenance support. Such incentives include:

- Standardizing hand pumps in order to allow a healthy competition among suppliers and avail spare parts supply;
- Setting up a set standard for pump specification by governments and donors;
- Establishing a dealership office as a prerequisite for pump importation; and
- Awarding suppliers and manufacturers contracts based on their product performance evaluation.

5.2 Functionality problems of hand pumps through the application of technology transfer and LCM models

The LCM approach helps ensure that important issues like operation and maintenance are purposefully considered at the project planning and design stage, and sequentially followed

[3] BOODE: Blue Pump Manufacturer based in the Netherlands.

throughout the life cycle of the project. LCM enables project implementers to proactively plan and make decisions at the right time. Figure 3 lists major activities that need to be considered in each phase of the life cycle for a hand pump based rural water supply project.

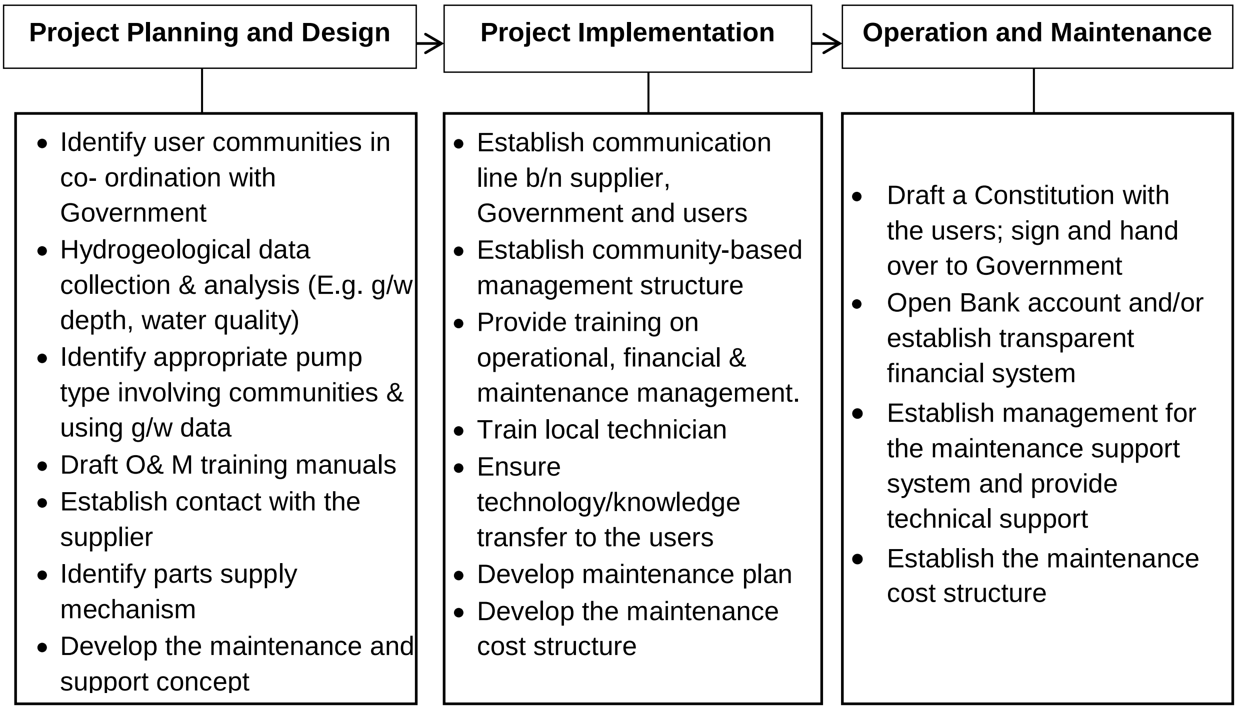

Figure 3. Proposed project life cycle phases for a hand pump based rural water supply project

It is essential to emphasise that crucial activities, including appropriate pump selection, maintenance, support and training plans, must be designed at an early stage of the project. Implementers must ensure that user communities are provided with the necessary training and that management systems are established. They also must ensure that maintenance support systems are in place so that users are aware of how to maintain their pumps, and where to access parts. In all phases of the project, the co-ordination of stakeholders involved in the project is important. It is also necessary to define, upfront, their roles and responsibilities so that they can be prepared with the necessary capabilities.

5.3 Proposed service and maintenance model

The proposed framework aims to identify and analyse the challenges and possible solutions to the gaps in technology transfer and sustainability of hand pumps in rural communities of Swaziland. It highlighted the critical elements for sustainability of such water supply projects: knowledge management, a life cycle approach, and operation and maintenance systems. The proposed maintenance model aims to assist implementers to plan, design and implement a support system through responsible co-ordination, resource allocation and knowledge sharing among stakeholders. A specific concern that the model also addresses, is that of appropriate funding mechanisms, which allow for flexi-payment schemes that are agreed to by community members, and managed through community committees. The model is therefore to be utilised by all stakeholders to assist in the development and provision of hand pump services to the rural communities.

The design of the proposed support system is based on consultations with key informants amongst the stakeholders, whose roles and responsibilities, with respect to the proposed maintenance support system, are discussed (as shown in Figure 4).

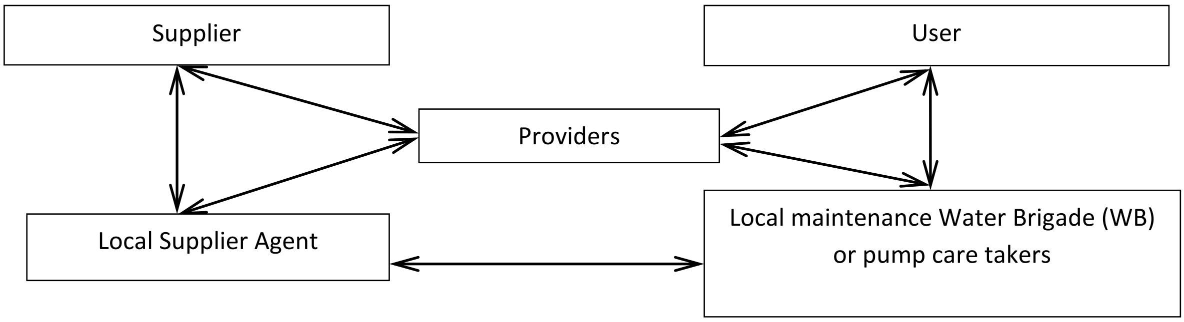

Figure 4. Proposed hand pump maintenance support system

Roles and responsibilities:

Local maintenance Water Brigade (WB) or pump care-takers:

The Water Brigade (WB) is a locally-based private company that will undertake the responsibility of providing operational and maintenance support to the user communities. The idea is that communities will enter into a lease agreement with the local maintenance provider (WB) in order to have maintenance support in a sustainable fashion. Implementing agencies would facilitate the lease agreement to be signed between the WBs and the communities. Government will provide support in overseeing the functionality of the system. User communities would pay a fixed amount annually from their maintenance fund to the WBs – about 20% of the contribution would go to WBs and the remaining 80% would go to replacement fund. Depending on the level of training provided, the responsibilities of the WBs include, but are not limited to:

- The installation of new pumps;
- Providing support for preventative (organizational level) maintenance;
- Corrective maintenance (Intermediate level); and
- Pump overhaulling.

The other alternative to WBs is to train and capacitate pump caretakers. The caretakers will be in charge of the supervision and monitoring of the operation and conduct preventative maintenance (see Table 2). Users would pay the caretaker from their monthly contribution. Users would continue to raise maintenance funds until they accumulate enough money for the overhaul or partial replacement. BOODE estimates the replacement amount to be 300 to 400 US$ for the Blue Pump after a service of at least five years.

Table 2. Proposed levels of support and levels of repair

Support Levels	Levels of Repair	Typical Activity
Organizational	1st line: Operator/User	• Functionality Inspections • Ensure proper operation(PM) • Ensure proper fencing and sanitary condition
Intermediate	2nd line: Mobile technician (WB)	• Support 1st line • Periodic preventive maintenance tasks • Minor/medium repair and replacements (CM)
	3rd line: Dealer technician	• Support 1st and 2nd lines • Corrective maintenance • Store, supply and replenish spares • Pump overhaul as required
Depot	4th line: Depot technician	• Support 1st,2nd & 3rd lines • Major preventive maintenance • Store, supply and replenish spares

Suppliers:
Suppliers should take responsibility for establishing a support system, and should provide a maintenance plan for their product (hand pump). They should also collect data on the hand pump's operation in order to use the information for product improvement.

Local Supplier Agent:
The agent should have a stock of hand pumps and parts at all times. The agent should establish a communication system with all stakeholders. It should also provide assistance to the local maintenance providers (WB) or pump caretakers.

Providers:
These are project implementers including Government and NGOs, and to a lesser extent, donors. These institutions should play a greater role in establishing the maintenance support system. Once established, new projects simply fit into the system. The maintenance support system can better be established through the WASH cluster, which is a forum established to co-ordinate rural water supply activities in the country. Many African countries, including Swaziland, have these WASH stakeholder forums.

Users:
The responsibility for operation and maintenance (preventative) lies with the user communities. They need to be sensitized, trained and organized in order to undertake their responsibilities.

5.4 Critical factors that promote and contribute to the functional sustainability of hand pumps

Appropriate pump selection:

- A flexible hand pump standardization policy is required. The introduction and adoption of Blue Pumps in Swaziland is the correct option, since its maintenance requirements are minimal.
- Replacement of broken Afridev pumps from deep boreholes and replacing them with Blue Pumps is a practice that needs to be extended.

- The broken Afridev pumps also need to be repaired, reassembled and reinstalled in shallow boreholes.

Proper technology transfer process:

- It is necessary to have a balanced focus and resource allocation for the hard and soft technology transfer processes. The current and past practice emphasis is on the hard technology (hand pump) transfer. Sufficient attention should be given to the soft technology transfer throughout the life cycle of the project.
- It is necessary for the Government to clearly define the hand pump technology transfer process.

Recommended solutions that can assist in efforts to increase the sustainability of hand pumps

- Hand pump manufacturers and suppliers should bear the responsibility of improving their products by involving users through feedback loops. They should also work with local Governments and implementing agencies to establish product support systems.
- Hand pump standardization should be enforced, as it is essential for spare parts supply, but it should be flexible.
- Appropriate pump selection should be carried out based on borehole/groundwater depth, availability and affordability of parts, and quality of the pump; this helps to reduce maintenance costs and down time, improve customer satisfaction and contribute significantly towards sustainability.
- The formation of WASH committees is not a solution by itself, but rather a step towards the solution. Sufficient attention should be given to technology (and knowledge) transfer through training on operational management, financial management and maintenance procedures, in order to empower communities and improve sustainability.
- Appropriate funding mechanisms need to be established, managed by the WASH communities, which incorporate flexi-payment schemes to allow community members to contribute to the funding of the operation and maintenance of the service in a sustainable manner, and within their specific means.

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