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Parts of the system: supply chains and operation and maintenance (O&M) in Amhara, Ethiopia

Paper for the WASH systems symposium

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Many improved and community-managed water supply schemes in Amhara fail to provide services as designed. Two of the major problems are a weak spare parts supply chain, and poor operation and maintenance (O&M) practices. This paper summarises results of a study about the demand for rural water facility spares, the organisation of supply chains and the O&M systems in Amhara regional state across five zones; East Gojjam, South Gondar, North Gondar, South Wollo and North Shewa. It involved interviews with 357 water users, 104 woreda and zone experts, 127 kebele level water administration committee members and 30 private suppliers. Only 40% of the water schemes had a trained caretaker to undertake O&M and where present, only 10% conducted both preventive and corrective maintenance. There is a poorly organised spare parts supply chain throughout the region. There is very low demand from communities for spare parts due to shortages of trained caretakers, high inflation rates, poor supply and an absence of spare parts locally, poor quality of spare parts and consumer knowledge on water resources management. To reduce non-functionality of water points, recommendations are: to increase participation during project implementation and raise community cash contributions; to provide handouts for marketing with basic information on technological and management options; to prepare pricing guidelines; and to encourage the private sector to supply spare parts in order to create stronger incentives for sustainability.

Introduction

Access to safe drinking water supplies is increasing but at the same time the functionality of water schemes to the end of their design periods is a serious concern. In 1992, it was estimated that about 30-40% of constructed water points were non-functional in the developing world (Moriarty et al., 2013), while another study two years later estimated 45% of hand pumps were not working due to a lack of spare parts in sub-Saharan Africa (Montgomery et al., 2009). A more recent study estimated that 30-40% of the hand pumps in Africa are not working at any given time (Jiménez, A. and Pérez-Foguet, 2011). According to various studies, the major causes of non-functionality of rural water schemes are poor operation and maintenance (O&M), lack of spare parts, poor construction materials, lack of skilled manpower, poor community capacity to manage water schemes, poor involvement of the private sector and a lack of incentives for cooperative and government staffs (Chowns, 2014; Sharma, 2013, Kamruzzaman et al., 2013; Abebe and Denke, 2008). If current rates of dysfunctionality continue, attempts to increase water supply coverage will be hindered and many millions of rural communities will continue to lack access to safe water.

In Ethiopia, an estimated 29% of hand pumps and 33% of motorised boreholes in rural areas were found to be non-functional because of problems related to minor maintenance (Watkins, 2006). These findings were supported by the Ethiopian national water inventory in 2010/11, which found 25.5% of water points to be non-functional (Debela, 2013). The Amhara regional government planned to reduce the non-functionality rate to 10% in 2015 (Amhara Regional Water Resources Development Bureau, 2015). However, the national water inventory results and different studies have shown that construction of new water schemes is not a permanent solution unless the issue of the sustainability of these schemes is addressed (Abdi & Baumann, 2010). Water supply schemes fail in Amhara region for many reasons. Among the contributing factors are a lack of proper spare part demand and functioning supply chains. An inventory taken in eight woredas of South Gondar zone showed that 32% (of 3,612 water schemes) were non-functional at the time of assessment (Kebede, 2013).

Operation and maintenance are one of the key aspects requiring more consideration to improve water scheme functionality rates. There are two major types of maintenance activities that should be performed: preventive maintenance, protecting the water schemes from severe damage by replacing the spare parts based on the design period; and corrective maintenance, which is mainly concerned with correcting major problems of the water scheme after breakdowns. According to the Ethiopian rural water supply policy, preventive maintenance should be undertaken by the community themselves and the corrective maintenance should be undertaken with support from the local government (woreda) water office. However, there is little evidence on the current O&M practices in the region. To understand the situation and make recommendations to ensure sustainability, CARE Ethiopia in collaboration with the Amhara regional water resources development bureau, conducted an assessment of spare part demand and supply chains, and current O&M practices in the region. This assessment aimed to answer the following research questions:

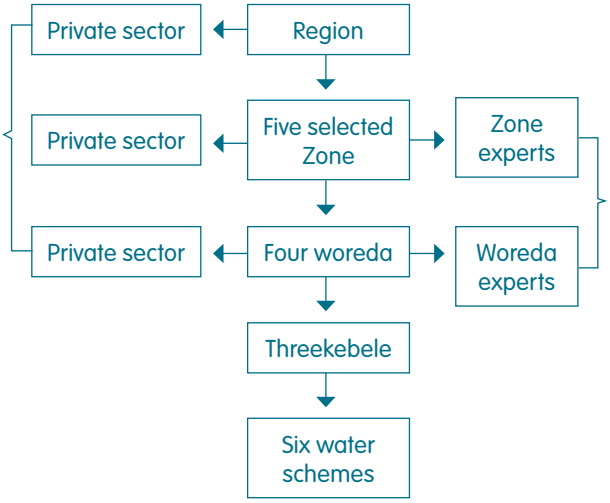
- Is there a demand for spare parts?
- Is there a spare part supply chain in the Amhara region?
- What are the potential barriers to an effective supply chain?
- What type of O&M management system exists?

Methodology

Description of study area: the study was conducted in five selected zones of Amhara regional state: South Gondar, North Gondar, East Gojjam, South Wollo and North Shewa. In these zones, with more than 11 million people, there are 54,600 water schemes constructed both by the government and non-government organisations.

Data collection: a cross sectional study was conducted collecting both secondary and primary data from 20 woredas (districts) across the five zones. A total of 360 water systems were identified for the study using a cluster sampling technique. All 360 water schemes were equally distributed across the five zones, with four woredas selected per zone, three kebeles selected per woreda, and six water points selected per kebele. Three schemes were later excluded due to poor data quality (Fig 1).

Figure 1: sampling techniques



Data type and analysis

- Primary data: Quantitative and qualitative data were collected from 360 water schemes (WASHCO committee), 104 woreda and zone experts, and 30 private suppliers. The WASH committees of five to seven people completed the questionnaire as a group.
- Secondary data: unit cost prices for 2003 and 2008 were collected from CMP (community managed project) reports and the total number of hand dug wells was accessed from the Amhara regional water bureau.
- Data analysis: both descriptive and analytical research methods were used to investigate and describe the existing spare part supply chain of rural water supply schemes. Descriptive statistics, ANOVA (analysis of variance), SPSS and Excel tools were used to analyses the data.

Results and discussion

(A) Rural water scheme spare part demand

Out of 357 surveyed water schemes, 68% are fitted with Afridev hand pumps whereas the remaining 30% and 2% are springs with gravity systems and rope washer pumps respectively.

Community participation in the implementation of water schemes: among the surveyed schemes 91% reported that the community was involved at different stages of project cycle management (Table 1). However, the level of engagement in the project cycle varies. The level of community participation is higher during construction, which mainly occurs through the provision of local construction material, labour and cash contributions. The results of community participation are in agreement with other similar research findings from Amhara region. This study shows that community participation is on an upward trend from the 76% as reported by Menegsha et al. (2003.

Table 1: Level of community participation in water development projects

Question	Yes	No
Did the community participate at the initial phase of the project? (N=357)	60%	40%
Did the community participate in source selection? (N=357)	54%	46%
Have you been informed about the budget source? (N=357)	24%	76%
Did you participate in providing labour, cash or local material supply? (N=357)	91%	7%

Community contribution of operation and maintenance: less than 47% of the WASH committees have a budget for minor maintenance (Table 2). Based on the opinion of woreda and zone experts, just 13% of water schemes have a sufficient amount of money for maintenance. Moreover, 91% of water schemes have a maintenance budget of less than 1000 Birr (Table 3).

Table 2: Community contribution for operation and maintenance budget

Question	Yes	No	Respondents
Have a maintenance budget (N=357)	47%	53%	WASHCO
Have a maintenance budget (N=104)	45%	45%	Woreda and zone
Is the maintenance budget enough? (N=47)	13%	87%	Woreda and zone
Did contributed on monthly bases for operation and maintenance (N=168)	53%	47%	WASHCO

Table 3: Amount of maintenance budget contribution

Amount	Number of schemes (357)	% of schemes
No budget	189	53%
500-1000	153	43%
1001-2000	12	3%
2001-3500	3	Less than 1%

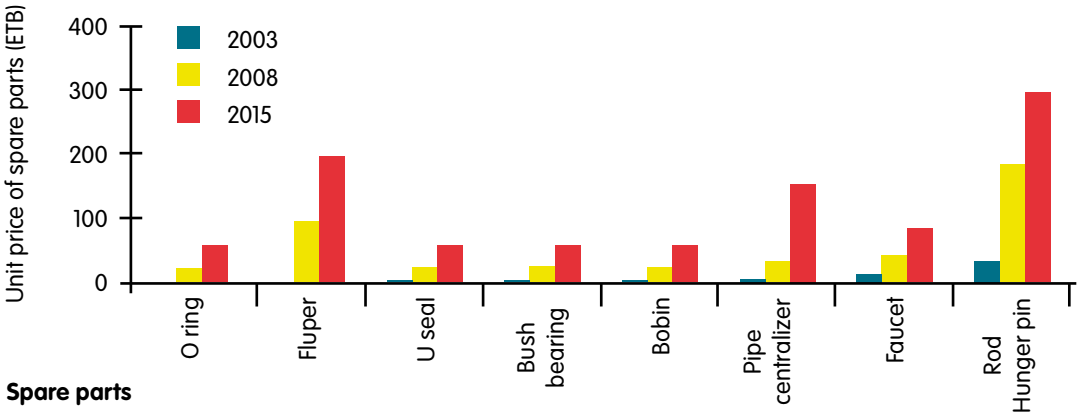
Because of the high inflation rates of spare parts and/or suppliers' inability to satisfy demand for quality parts, 64% of the local communities prefer to wait for new schemes rather than maintain existing facilities (Table 4). Similar results are reported by woreda and zone experts - about 33% agreed that the current costs of the spare parts were very expensive (Table 5). Moreover, the cost of spare parts has risen significantly ($p<0.05$) in the previous 13-year period. The average cost of spare parts increased by 84% in the years 2003 to 2008, and the average cost increased by 48% 2015 from 2008. In nominal terms, the price variation for 13 years varies from 2.6 to 197 times of the base year, 2003 (base year) where the variation is significant among different parts (Fig 2 and 3).

The water management committee from one non-functional scheme in Simada woreda in kebele 16 explained that, 'we cannot access spare parts in the nearby locality. We have to travel to Bahir Dar to purchase even a very small spare part. It is very costly to travel such long distances for a very minor spare part. We spend up to 290 birrs while the cost of the spare part (u-seal for instance) is only 50 birr. The extra cost of 240 birr is related to per diem and transportation.'

Table 4: Costs related with available spare parts and community interest to renovate

Questions	Number	Percentage
What did you/will do when your water schemes are malfunctional? (N=357)		
Replace with new water schemes	228	64%
Rehabilitated	129	36%
Is the cost of spare parts expensive? (N = 104)		
Yes	34	33%
No	70	67%

Figure 2 : Change in unit price for selected spare parts in three periods



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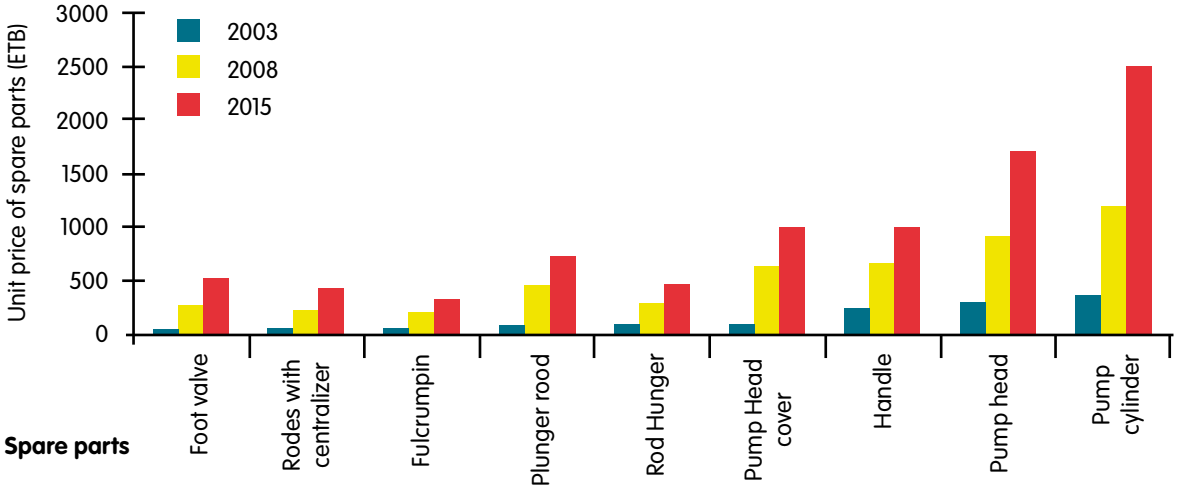

Operation and maintenance capacity: Communities prefer pumps and fittings that can easily be installed, operated and maintained within their own capacities. For example, hand pumps are easy for the community to conduct O&M, and will also improve spare part demand at local level, but springs are difficult to conduct even minor maintenance upon. According to this research, 58% of the respondents from the community and 64% of the woreda and zone experts agreed that Afridev hand pumps are easily maintained by the local community (Table 5). Pumps are maintained by scheme caretakers who are either few in number or do not have the skills to maintain the pump. From the surveyed water schemes fitted with Afridev hand pumps only 40% of them have trained caretakers and out of that only 10% of the trained caretakers undertake preventive and minor maintenance on a regular basis (Table 5). Low levels of involvement of trained caretakers may be attributed to poor initial training and/or follow-up and support by government and WASH committees.

Table 5: Operation and maintenance capacity

Questions	Water schemes/ WASHCO (N=357)		Woreda and zone experts (N=104)	
	Yes	No	Yes	No
Are the fitted pumps (Afridev pumps) easy to operate?	100%	0	100%	0
Are the fitted pumps (Afridev pump) easy to maintain?	58%	42%	64%	36%
Is there a trained caretaker?	40%	60%		
Does the caretaker have the skills to maintain the pump?	10%	90%		
Do you have information on where to get spare parts?	75%	25%		

The research revealed that communities which got sufficient product information (such as how and where to acquire, special qualities and benefits) have greater demand on spare parts. 75% of the surveyed water management committees have information from where they can get the spares. The majority of spare parts are available in woreda, zone and regional cities.

(B) O&M of rural water schemes in Amhara region

According to Anthony Oyo, 2002, at least two people per scheme should be selected for a meaningful role in developing an O&M plan at scheme level. However from the surveyed schemes only 40% have at least one trained caretaker/pump attendant and only 34% of the schemes have more than one trained caretaker for O&M of the water schemes. The study shows that only 10% of the caretakers (n=143) did preventive/corrective maintenance and at only 9% (n=337) of the schemes are maintenance hand tools available. At 22% of the water schemes, the communities believe that the trained caretaker can manage preventive and corrective maintenance, as per their designated responsibility. In discussions with woreda and zone level officials, major maintenance activities should be undertaken by the government either through artisans or pump attendants. When major maintenance support is needed, 82% of the water scheme WASH committees know the channel of communication with their respective higher level administration structure (woreda) (Table 6).

Woreda and zone water resources development experts responded that the major causes for the high dysfunctionality of water supply schemes are a lack of spare parts, lack of maintenance budget and a lack of skills for the caretaker to undertake repairs. This study is in line with the findings from Seifu et al., 2012.

Sixty-five percent of the woreda and zone expert respondents agreed that there are well organised operation and maintenance systems established at the woreda and zone level. However, there are at least two pump attendants per woreda that supports the community upon demand and requested by the WASH committee. The major challenges for the government staff to establish O&M systems at woreda level are skill gaps, lack of spare parts, lack of maintenance budget at community and a lack of interest of the private sector to engage on the business. In addition to the above gaps, the lack of enough budget for monitoring by government bodies also plays a role. Efficient maintenance of water schemes requires capacity building as one of the major tasks to be undertaken at the woreda and zone level. 62% of the woreda and zone experts agreed that the training provide to caretakers is not adequate to undertake preventive and corrective maintenance.

Table 6: Operation and maintenance management of water schemes and woreda and zone experts' response

Water scheme level WASH committee	Yes	No
Have a trained caretaker/pump attendant (n=357)	40%	60%
Have more than one trained caretaker (n=357)	34%	66%
Does the trained caretaker conduct either preventive/corrective maintenance? (n=143)	10%	32%
Do you have maintenance hand tools? (n=357)	9%	91%
Will the caretakers maintain the system when water schemes break? (n=357)	22%	78%
Do you have the information of who to inform in case the breakage is beyond the caretaker? (n=357)	82%	18%
Woreda and zone experts		
Does the caretaker training have a training manual? (n=104)	22%	78%
Is the training for the caretaker enough to provide the required skills? (n=104)	38%	62%

(C) Spare parts supply of rural water supply systems in Amhara region

The result show that 73% of WASHCOs have information about how and where to access spare parts for the constructed water schemes (Table 7). However, , only 3% of the water schemes have access to spare parts near their locality (Table 7). The remaining 97% of water schemes have to travel up to 150 kms to access spare parts at either the zone or regional capital city.

Other parameters for spare parts supply chain is the affordability to the purchasers. This research shows that 69% of the water schemes' WASHCOs have information about the cost of spare parts (Table 7). About 68% of WASHCOs agreed that the cost of spare parts is expensive and increasing alarmingly (Table 7). In two zones there is still support for the community managed project (CMP) for access to spare parts through the government office. The revolving funds established are still functioning in East Gojjam and North Gondar zone with no profit to the government office. When accessed from these government offices the spare parts are less expensive than private suppliers. Moreover, the cost of spare parts is escalating which makes access difficult for the local community.

Several WASH implementing partners and NGOs follow different implementation modality which may have impacted the spare part supply chain differently in different woredas and zones. For example, in North Gondar and East Gojjam zones, the government offices are responsible for managing spare parts supply through government finance institutions.

In North Gondar and East Gojjam zones, the woreda water resources and development office submits their annual spare parts demand to the finance section. Some zones that includes North Gondar, East Gojjam and South Gondar have the experience of engaging the private sector on the spare parts supply chain through the help of CMP programme support. As a result, six private spare parts supply shops are found in Gondar town. However, the shops do not receive technical advice and training from zone WASH organisations (Ferede, 2013). Similarly, there are three private shops in Debre Marqos town that supply spare parts to WASHCOs based on demand, and also revolving funds for spare parts supply in each woreda for water schemes, including Machekel, Enemay and Dejen woredas (Ferede, 2013). However, in South Gondar, the private sector is interested in supplying spare parts in bulk to organisations instead of retail sales to the community. The woreda and zone experts explained the reason for little interest from the private sector could be due to limited demand from the community, subsidy from government and non-government organisations which do not attract adequate profits for the private sector.

To evaluate the level of private sector engagement on the spare part supply chain, 30 private suppliers were interviewed. From the surveyed suppliers, none of them have a specific trade licence for the supply of spare parts. As a result, they did not invest their full time in supplying spare parts because of the low demand from the community. All spare part suppliers view the sale of spare parts as a part-time job. Those shops are mainly involved in the sale of construction material like corrugated iron sheet, cement, iron bars, nails etc. From a profit point of view only 3% of spare part shop owners receive a profit (Table 7). 83% of the respondents said that there is no demand for spare parts from the community because of the frequent support by the non-government and government office (Table 7). The study shows that all suppliers received the spare parts from Addis Ababa.

Table 7: Water scheme level and private sector spare parts supply chain

Water scheme level WASH committee	Yes	No
Do you have information about where you get spare parts? (n=357)	73%	27%
Is the spare parts supplier accessible within 50km of your locality? (n=357)	3%	97%
Do you have information on the cost of spare parts? (n= 357)	67%	33%
Is the cost of spare parts expensive? (n= 246)	68%	32%
Private sector		
Do you have a license for spare parts supply? (n=30)	0%	100%
Do the spare parts make a profit like your other business?	3%	97%
Is there a demand for spare parts from the community?	17%	83%

Conclusion

Communities are highly involved in the construction phase of water supply projects, mainly through the provision of free labour, local construction material and cash contribution. Community funds for O&M are insufficient, and needs strategic focus by government and stakeholders to raise community awareness. High costs possibly contributed to a lower demand for spare parts and therefore contributed to the community's preference for the construction of new schemes over rehabilitation. Also, there is low demand for spare parts due to limited maintenance skills at community level, accessibility, limited spare parts supply, ever increasing costs and quality issues.

This study shows that there is high water scheme dysfunctionality due to the lack of spare parts. The hidden/untapped demand for those spare parts is very high in the region but it can be addressed by a coordinated effort from the government, private sector and donors. This issue requires thorough rethinking to create the demand at community level and engage the private sector as a partner. Several water supply schemes became dysfunctional due to the skill gap for maintenance, lack of information about spare part supply and location. Moreover, weak institutional support, inadequate community engagement on how to operate the water points, lack of maintenance hand tools, lack of spare parts and a lack of maintenance budgets have profound influence on the rate of schemes dysfunctionality in Amhara regional state. The private sector can potentially

provide a more flexible and innovative supply chain than the public sector or NGOs. An effective supply chain can be built through social marketing and networking. However, the public sector and NGO sectors have important roles to play in capacity building (Robinson and Paul, 2000). The study found that all private sectors supplying spare parts do not have a trade licence and did not receive training in any capacity building activities by the government and non-government organisations.

To improve the spare parts supply chain, the paper recommends the active engagement of potential partners in the chain, the facilitation and coordination of capacity building work for the private sector, community engagement to rehabilitate water schemes by themselves, a reduction in government and non-government subsidies, provision of the right incentives and the creation of a collaborative planning environment for concerned stakeholders.

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