Life-cycle costs approach for WASH services that last

Life-Cycle Costs in Ghana

Briefing Note 11: Cost drivers of capital investment of small towns water schemes

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WASHCost project partners have developed a methodology for costing sustainable water, sanitation and hygiene (WASH) services by assessing life-cycle costs and comparing them against levels of service provided. The approach has been tested in Ghana, Burkina Faso, Mozambique and Andhra Pradesh (India). The aim of the life-cycle costs approach is to catalyse learning to improve the quality, targeting and cost effectiveness of service delivery.

IIn Ghana, Kwame Nkrumah University of Science and Technology (KNUST), International Water and Sanitation Centre (IRC), and Community Water and Sanitation Agency (CWSA) are using the WASHCost Life-Cycle Cost Approach to identify the true costs of providing sustainable Water, Sanitation and Hygiene costs in rural and peri-urban areas. This briefing note presents findings on cost drivers of capital investment of small towns piped water schemes and draws out the implications for policy and practice in Ghana's WASH sector.

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Front page photo
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WASHCost is a five year action research project investigating the cost of providing water, sanitation and hygiene services to rural and peri-urban communities in Ghana, Burkina-Faso, Mozambique and India (Andhra Pradesh). The objectives of collecting and disaggregating the cost data over the full life-cycle of WASH services are able to analyse cost per infrastructure and service level, and to better understand the cost drivers and through this understanding to enable more cost effective and equitable service delivery. WASHCost is focused on exploring and sharing an understanding of the true cost of sustainable services (see www.washcost.info).

Life cycle costs in Ghana:

Cost drivers of capital investment of small towns water schemes

Rural pipe water schemes, popularly known as small town water schemes, are associated with a wide range of capital expenditure and a limited understanding of what could be the key cost drivers of these systems. This briefing note, No. 11, focuses on identifying some of the major cost drivers of capital expenditure using 39 small towns pipe water schemes in Ghana. This series provide insight for better planning and predicting the cost of technology options, which is useful for planning.

Introduction

Ghana's National Community Water and Sanitation Programme (NCWSP), launched in 1994 has contributed to achieving the water target of the Millennium Development Goals (MDGs). The NCWSP has two main approaches for rural water service delivery, which are water point systems (i.e. boreholes fitted with hand pumps), and pipe water schemes. Pipe water schemes are used to accelerate rural water coverage for populations ranging from 2,000 to 50,000 inhabitants as a single village or multi village scheme. Single village piped scheme become more economical when population is greater than 2,000. The multi village piped water schemes are useful for clusters of communities or villages and towns (also peri-urban) when there is difficulty getting in a good and reliable water sources due to hydrogeological conditions.

The number of [1]small towns piped water schemes under the Community Water and Sanitation Agency (CWSA) stood at 451 in 2010 [2]. There is no doubt that to achieve universal coverage, more investment is required in new piped water schemes in Ghana. However, provision of pipe water schemes is confronted with some challenges like budget constraints because of high and wide variations in capital expenditure (CapEx), which is the cost of initial infrastructure provision. There is therefore the need to understand what drives the capital expenditure of piped water schemes. A "cost driver" [3] is a unit of an activity that causes a change of the activity cost. Cost drivers often interact to determine the cost of an activity and the interactions reinforce or counteract to reflect the relationships.

The WASHCost project has a focus on understanding the cost of sustainable water services. This briefing note, No. 11, series presents analysis of capital expenditure of pipe water schemes based on 39 small towns water schemes from Ashanti, Volta and Northern regions.

Data collection and analysis

The small town water schemes were selected from the Volta, Ashanti and Northern regions of Ghana. The criteria for the selection of regions were based on the hydro geological and hydro climatic conditions and presence of different development partners/donors (see Table 1 below).

Table 1: Selected study regions

Region	Hydrogeology/hydro climatic conditions	Dominant donor partners
Northern	Characterized by difficult and low successful drillings; northern belt and savannah	CIDA, EU and AfD
Ashanti	Generally successful drillings and good quality; middle belt and forest zone	IDA, EU, AfD, GTZ
Volta	Relatively successful drillings but saline; southern belt and coastal	DANIDA

[1] Also known as small town water schemes which may serve between 2000 and 50,000 people as a single or multi village pipe water supply option or peri-urban communities under CWSA jurisdiction.
[2] CWSA (2010). Revised Design Guidelines for Small Towns Water Systems. Community Water and Sanitation Policy Guidelines, Ministry of Water Resources, Works and Housing, pp 4-6.
[3] Shank and Govindarajan (1993). Strategic Cost Management: the New Tool for Competitive Advantage, New York: The Free Press

Data sources include interviews with key informants (30 interviewees) and review of completed project reports and other documents. The interviews focused on the major cost drivers which were used for the analysis: population size, population density, hydrogeological condition, contract packaging, and technology options. The capital expenditure of water systems was adjusted to the base year, 2010, using the inflation estimator Prime Building Cost Index (PBCI) from the Ghana Statistical Service. Regression analysis was used to identify the relationship between factors and capital expenditure of the water schemes.

Magnitude of CapEx of water schemes

The capital expenditure of the 39 small town water schemes has a wide range, US$ 56,000 and US$ 740,000 (year 2010) across regions. The range of capital expenditure (CapEx) per person of water schemes are shown in Table 2 below.

Table 2: CapEx per capita of water schemes

Region	Range of CapEx per capita (US$;2010)	Mean CapEx per capita (US$;2010)	Median CapEx per capita (US$; 2010)	Standard deviation
Volta (N=11)	2 –36	19	18	± 10
Ashanti (N=15)	13 – 247	82	63	± 64
Northern (N=13)	55 – 148	100	89	±36

The wide range of cost suggests that the median is more indicative of the general cost of schemes than the average cost. The disaggregated CapEx showed that pipeworks and storage tanks are the key cost items. However, Northern region schemes also show power supply or energy source as a significant cost component in addition to the two already mentioned.

Cost drivers

Simple regression analysis revealed little correlation between population size and CapEx per person. This means there are other significant factors influencing or driving the capital expenditure. This also means that any economies of scale due to population are less noticed. However, the pipe-length per capita (or person) that was used as proxy for population density shows a strong and positive linear correlation with the capital expenditure, explaining 76% of cost variability. Thus the water schemes with high pipe-length per capita (i.e. low population density) cost more per person. Generally, smaller and scattered communities tend to have low population density and may require extensive pipe laying to serve more users.

The role of hydrogeological conditions were assessed using yields, and number of boreholes (used as water source); and transmission pipe length. Water schemes in Volta had the highest average yield (336 m3 per day) and an average of one borehole per water scheme. Both the Northern and Ashanti regions schemes are within the [4]Voltaian formation characterized by low yielding boreholes. As a result the average borehole per water scheme is two and three for Northern and Ashanti respectively. However, there is no marked relationship in the cost per capita of transmission pipes and number of boreholes. Though hydrogeology plays a role, the results suggest that other more important factors are affecting the CapEx. This explains the low contribution of boreholes (between 3% and 9%) to capital expenditure in the piped water schemes.

The main energy sources used are the national electricity grid and solar panels. Water schemes with solar energy sources cost close to three times that of systems connected to the national grid. In the northern region about 50% of schemes were based on solar. The cost of energy source development in northern region was 21% of the total capital expenditure. This expenditure covered the installations of solar modules and accessories such as invertors. Table 4 shows the capital expenditure for two main energy sources.

[4] Darko, 2001. Transmissivity Anomalies and Prospects for Groundwater Exploration in Hard Rock Aquifers of Ghana. Ghana J. Sci. 45 (2005), pp 9-17.

Table 3 Capital expenditure per capita for different power sources

Group	System with power source	Average CapEx per capita (US$; 2010)	Median (US$; 2010)	Standard deviation
All (N=34)	Mechanized borehole with national electricity grid as source of energy	59	54	43
All (N=5)	Mechanized borehole with solar as source of energy	164	146	47
Ashanti region	Mechanized borehole with national electricity grid as source of energy, N=14	76	63	47
	Mechanized borehole with solar as source of energy , N=1	247	Na	na
Volta region	Mechanized borehole with national electricity grid as source of energy, N=11	20	20	10
	Mechanized borehole with solar as source of energy, N=0	Na	Na	na
Northern region	Mechanized borehole with national electricity grid as source of energy, N= 9	83	75	25
	Mechanized borehole with solar as source of energy, N= 4	143	144	6

The two main water storage facility materials in use are steel and concrete. Generally, the steel storage tanks are significantly more costly, about twice the cost of equivalent capacity of concrete tanks in all cases in this study. The steel tanks are imported from Europe with extra cost burden from high and unstable exchange rates. In the Northern region, hot pressed steel tanks are mostly used instead of concrete tanks. This practice is based on the belief that concrete tanks are not suitable because of the high temperatures in those areas. The use of steel tanks contributes about 28% to the CapEx of water schemes in the Northern region.

The water schemes are financed by different Donor agencies using two main types of contracting. The contracting type was either International Competitive Bidding (ICB) or National Competitive Bidding (NCB) and each can also influence the capital expenditure.

Table 4 below shows the capital expenditures of water schemes with international and national/local competitive bidding contracts.

Table 4: Capital expenditure per capita and contract packaging

Group	Description	Average (US$; 2010)	Median (US$; 2010)	Standard deviation (US$; 2010)
All regions,	International competitive bidding N=20	111	98	52
	National competitive bidding, N=19	32	30	19
Ashanti region	International competitive bidding N=7	130	104	73
	National competitive bidding, N=8	49	45	13
Northern region	International competitive bidding N=13	100	89	36
Volta region	National competitive bidding, N=11	20	20	10

Water schemes provided under international competitive bidding (ICB) are more expensive compared to the national competitive bidding. Unlike national competitive bidding (NCB), the ICB contracts are associated with higher overheads, non-flexible contract terms to accomodate price fluctuations and variations, foreign exchange rates effects, etc. The NCB is highly competitive, open to more bidders (local ones with low overheads) and has adjustment factors to address variations and fluctuations. However, quality level of engineering services from both ICB and NCB contracts were not considered as part of this study.

Conclusions and emerging questions

There is a wide range of cost for the small towns or rural pipe water schemes across the three regions with quartile range of US$ 30 – 95 per capita. The wide cost range is attributed to the three major cost drivers: population density that shows the extent of dispersion of users of the water schemes, types of technology for water storage and energy, and contract packaging.

The capital expenditure of water schemes has a stronger relationship with pipe length per capita, a proxy for population density, than it does with just the population. Schemes with low population density(as pipe length per capita) require extensive pipe networks to serve the users which increases total capital investment. Technology type, with respect to energy sources and storage facilities also influences the cost of water schemes. Water schemes with solar energy, as a power source and steel storage facilities are more expensive than those with national grid power connections and concrete storage facilities. Furthermore, water schemes awarded under international competitive bidding (ICB), are more costly (about three times more) than those awarded under the national/local competitive bid. This is purely based on the cost and not considering the quality and speed of construction services rendered.

However, the hydrogeology of the area was not identified to be a key cost driver. There is no marked relationship between the cost of the water schemes and the number of boreholes used as water source.

Recommendations for policy and practice

The findings from this study based on 39 small towns water scheme from three regions are indicative, considering the total available number of CWSA small towns water schemes across the country. However, some key policy implications can be made notwithstanding the need for further study with more schemes.

On technology options, first of all, there is the need to examine the perception that concrete tanks or storage facilities may not work in the northern part of Ghana. Looking at the financial difficulties of providing piped water schemes across the nation, some savings could be made if concrete tanks would work. The call to examine the potential for concrete storage tanks in the northern part of Ghana is reasonable because Burkina Faso, a neighbouring country with a comparatively high average temperature, uses concrete tanks.

Secondly, a study is needed on the life cycle cost of the energy sources, whether national electricity grid or solar energy. This is because, though water schemes with solar panel are more costly than those on the national grid, there could be trade offs in operational life of facilities. The solar powered schemes are cheaper to operate in terms of energy cost, however, there could also be several operational challenges like consistent poor weather, especially in the wet/rainy seasons, security in case of accident (like children playing around with stones resulting in breakage of several panels – an experience known in some parts of Ghana) etc.

Finally, a study on the relationship between cost of construction and the quality of the water schemes will provide further insights on the difference in cost arising from the contracting arrangement.

WASHCost briefing note series

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