BALANCING COVERAGE AND FINANCIAL SUSTAINABILITY IN PRO-POOR WATER SERVICE INITIATIVES: A CASE OF A UGANDA PROJECT

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Balancing Coverage And Financial Sustainability In Pro-Poor Water Service Initiatives: A Case Of A Uganda Project

Abstract: This paper examines the Affordable Basic Water Project implemented by Uganda's National Water and Sewerage Corporation (NWSC). Three alternatives to the NWSC service provision scenario are developed using a linear programming model, with the focus on different mixes of three service provision technologies: yard taps, public water points, and public water points with pre-paid meters. The alternative scenarios allow better service coverage and improved financial sustainability, compared to the design proposed by the NWSC. The scenarios demonstrate a tradeoff between social acceptability and operational feasibility / payment collection criteria.

Key Words: pro-poor, water provision, linear programming, service coverage, financial feasibility, developing countries

INTRODUCTION

Improving access to drinking water and sanitation services is a key to economic development in low-income countries. Lack of water and sanitation services is linked to socio-economic challenges ranging from water-related diseases to time allocation for low-income households to cope with long-distanced communal water points. Related issues also

include low school attendance by girls, rampant poverty, gender inequality, and a high "under-five child mortality rate" (U5CMR). Furthermore, it is acknowledged that better access to water and sanitation services for the urban poor offers a profound positive impact on environmental awareness and sustainability. In contrast, lack of water and sanitation services for the urban poor can be linked to water contamination, reduced water availability, and higher water treatment costs.

While the average for safe drinking water access in developing countries is 84 percent of the population, there is a tremendous variation among regions (United Nations Millennium Project 2008). More than one-third of those without access to an improved drinking water supply reside in Sub-Saharan Africa. In this region, only 58 percent of the population have access to an improved drinking water source, and only 31 percent utilize an improved sanitation facility (United Nations Millennium Project 2008). At the Fifth World Water Forum in 2009, *accelerating access to available water* was identified as "the key issue" for Sub-Saharan Africa (IISD Reporting Service 2009).

Economic development in low-income countries and regions did not catalyze private sector investment in water and sanitation services, especially in Sub-Saharan Africa which received less than 0.2 percent of the total global private sector investments in water and sanitation services in 2002 (United Nations Millennium Project 2003). The involvement of multi-national water operating companies in developing countries is declining worldwide. Many multi-national water companies in Europe and South Africa see their role as operators and managers of water projects, and not as investors (The first author was part of the delegation from Uganda that visited two multi-national companies in France, one in

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Deleted: about 42 percent of the population drinks untreated water. Rural-urban disparities are also significant. While in most developing regions, 70 percent of rural dwellers have access to improved drinking water sources and 31 percent to improved sanitation services, only 45 percent of rural dwellers in Sub-Saharan Africa have safe drinking water and 25 percent have improved sanitation services. Progress towards improved sanitation services has been very slow. An estimated 2.6 billion people are without improved sanitation facilities and services, and if the 1990-2002 trend holds true the sanitation millennium development target will not be achieved for 0.5 billion people worldwide.

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Germany and one in South Africa in March 2005). These companies are reluctant to invest equity outside their home markets, and they are extremely careful about investing in perceivably risky markets where the return on investment (ROI) is uncertain. Some of the perceived investment risks in Sub-Saharan water and sanitation services include small markets, customers' inability to pay, and regulatory requirements. In predominantly poor areas, returns on investment are further diminished by the high construction costs required to correct inadequate infrastructures, and high operation and maintenance costs.

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To balance the objective of service delivery for all with utility financial sustainability, some studies have suggested involving the community in service provisions and the maintenance of infrastructures (Kyessi 2005; Godfrey and Obika 2004). Community involvement entails examining the water tariffs and the willingness of the poor to pay for water services (Kayaga et al. 2003; Wittington et al. 1990; World Bank 1993). Kayaga and Franceys (2007) compare the incomes of poor households with the utility connection fees of the major water suppliers to emphasize the need for more affordable and customer-friendly water and sanitation services. Naidoo and Constantinides (2000) and Njiru et al. (2001) suggested that offering differentiated service options and flexible tariff structures could broaden the customer base while ensuring the utilities' financial strength. Akatch and Kasuku (2002) maintain that water and sanitation service provisions should be part of the housing policy for the poor and should be subsidized by taxing the rich. Mugabi et al. (2007) and Crook and Ayee (2006) address the advantages of focusing the utilities' management structures and performance evaluation procedures on improving customer relations.

While most empirical studies have used qualitative approaches and examined social marketing, affordability, and governance, this paper combines qualitative stakeholder analysis and technology evaluation with the quantitative linear programming approach to analyze different scenarios for the pro-poor service provision. Our objective is to use a specific case study, the Affordable Basic Water Project by the National Water and Sewage Corporation (NWSC) of Uganda (NWSC and Aqua Consult 2003a, b), to examine the mechanisms and measures that can be used to enhance financial sustainability in pro-poor project planning and development. The next section presents the background for the Affordable Basic Water Project, followed by the methodology and empirical data used in the analysis, the results, and discussion.

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STUDY AREA AND PROJECT BACKGROUND

The population of Uganda's capital and largest city, Kampala, is 1.2 million; however, taking into account the city's transient population, the true population of Kampala is about 2.3 million (McGill University 2008). Many people from the villages migrate to cities in search of jobs, better economic prospects, and social opportunities. Kampala is located in the central district of Uganda, where the poverty rate is about 20 percent in the rural areas, and 6 to 12 percent in the urban areas (UBOS 2008). It is projected that the population of the poor urban residents in Kampala will more than double by 2015 (McGill University 2008, Humanitarian Care Uganda 2007). The majority of these will reside in informal settlements located in low-lying marshy areas within the city, with dwellings mostly made of mud and wattle (NWSC and Aqua Consult 2003b).

Deleted: The Affordable Basic Water Project was initiated in 2001. It focuses on the identification of the most effective strategies for water service provisions to the urban poor in Kampala, Uganda (Figure 1). According to the 2002 Census, the

Deleted: Thirty-nine percent of Kampala's population lives in absolute poverty and 43 percent are unemployed (Population and Housing Census 2002, cited by McGill University 2008).

In 2001, only 35 percent of the build-up area in Kampala's informal settlements had access to water services, mostly through public kiosks and public water points, with an estimated water use of 5 liters (1.3 gallon) per capita per day (NWSC and Aqua Consult 2003b). Local wells and springs were widely utilized by the local population as alternative water sources, but without a proper sanitation system, fecal contamination of the ground and surface water pose health risk to the residents relying on these alternative sources for drinking water (NWSC and Aqua Consult 2003b).

NWSC is the primary supplier of water and sanitation services for Kampala, withdrawing water from Lake Victoria, Earth's second-largest freshwater lake (NWSC 2010). It is a parastatal owned by the Uganda government. According to the NWSC Statute

(Statute No 7 of 1995), NWCS has a social mandate to provide water and sewerage services in areas entrusted to it. The primary functions of NWSC include the provision of water and sanitation services, and the development of water and sewage systems in urban centers (Muhairwe 2003).

In response to the inadequate provision of water and sanitation services in informal settlements, in 2001, a presidential directive ordered the installation of one hundred public water kiosks in the informal settlements under the direction of NWSC (NWSC and Aqua Consult 2003b). Furthermore, in 2002, the state government announced that it would provide an affordable basic water supply to the urban poor targeting the informal settlements of Kampala. The NWSC has the primary responsibility for implementing the initiative. Specifically, NWSC's "Affordable Basic Water Project" focuses on the identification of the most effective strategies for water service provisions to the urban poor in the informal settlements of Kampala.

As a part of the Affordable Basic Water Project, the NWSC sought extended stakeholder-input while developing the NWSC water service provision scenario. As a first step, the NWSC conducted an informal stakeholder analysis (Dani 2002; Kudat 2002; Brugha and Varvasovszky 2000), focusing on the barriers to water service provisions to the urban poor. Interviews with 24 key informants and 22 stakeholders in five focus group discussions, as well as two consultative workshops, were conducted. Information for the three stakeholder groups with the most significant influence on the project is summarized in the Stakeholder Analysis Matrix below (Table 1).

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The NWSC also collaborated with local stakeholders on evaluating alternative technologies for the water service provision. A semi-formal evaluation of four water service technologies was conducted: (1) rudimentary traditional systems (based on rainwater harvesting, protected springs and open wells), (2) public water points (with conventional mechanical meter or with pre-pay meter); (3) yard taps (with conventional mechanical or pre-pay meters), and (4) conventional house connection (with mechanical or pre-pay meter) (Table 2). Different water supply technologies were ranked based on the following five general criteria: (1) the level of service; (2) technical suitability, (3) social acceptability, (4) institutional suitability, and (5) environmental suitability. Prioritization showed that each of the service options presents tradeoffs among different criteria, and that none of the services can achieve all the priorities. The social acceptability criterion dominated the discussion, and yard taps were identified as the most preferable service provision technology, followed by public water points. However, prioritization was conducted informally without any formal scoring of the technologies, which involves assigning a weight to each decision criterion according to its importance and then computing scores for each decision alternative considered (Anderson, Sweeney, and Williams 2008).

INSERT TABLE 2 HERE

Three pro-poor water service delivery technologies were selected for implementation: yard taps with conventional water meters (YTs), public water points (PWPs) with conventional meters, and PWPs with prepaid water meters. While one YT can serve several families, one PWP can be utilized by the whole neighborhood (SIGUS 2001). Furthermore, a PWP with conventional meter delivers service on credit, whereas a pre-paid meter requires communities or individuals to use tokens that can be recharged at the nearest vendor to meet their water requirements (Omurungi 2009). While the investment costs associated with the installation of PWPs with pre-paid meters are higher, they can potentially result in improved cost recovery as compared to PWPs with conventional meters that are associated with lower collection efficiencies.

Block maps of the target areas were prepared and the total numbers of standpipes, service points, and households were estimated. The targeted population (future customers) for the project was estimated to be 408 thousand people. Given that an average household size in Kampala is ten people (COWI 2007), it was estimated that a yard tap would serve on average 1.5 households, while a public water point (with or without a prepaid meter) would serve 15 households.

Finally, a specific service scenario (referred to as the “NWSC scenario”) was selected by the NWSC staff as follows: 19,067 YTs; 409 PWPs with conventional meters; and 409 PWPs with prepaid water meters. The NWSC scenario was selected using the trial-and-error process, based on the requirements of water provision to the target population and internal rate of return (IRR). The costs and returns of alternative service scenarios that could potentially achieve the same service provision coverage and IRR as the NWSC scenario were not examined. As opposed to selecting a scenario that merely satisfies the

minimum requirements of the project, we propose using an optimization model that can maximize a specific project outcome (in this case, net present value) while satisfying other requirements (such as service coverage and maximum investments).

MODEL

We use letter i to index alternative water service delivery technologies, with i=1 referring to YTs, i=2 denoting PWPs with conventional meters, and i=3 referring to PWPs with prepaid meters. The decision variable, X_i, is the number of service points for each water service delivery technology. We consider a ten-year time period (T=10), and assume that the project is implemented in year one (t=1). Total capital costs for the project is the sum of capital costs for each service option:

$$CCost = \sum_{i=1}^{3} c_i X_i \qquad (1)$$

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where c_i refers to capital costs per service point. Assuming that the operation and maintenance costs for each service point, w_i, NWCS's annual costs can be expressed as:

$$OMCost_t = \sum_{i=1}^{3} w_i X_i \quad \text{for } t = 2, 3, \ldots, 10. \qquad (2)$$

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Given the annual return from each service point, r_i, the NWCS's revenue can be expressed as a sum of returns from each service point and each service technology:

$$Revenue_t = \sum_{i=1}^{3} r_i X_i \qquad \text{for } t = 2, 3, \ldots, 10. \qquad (3)$$

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The objective of NWSC is to maximize the net present value (NPV) of water service provision:

$$\text{Maximise NPV} = \sum_{t=2}^{T}\left[\left(\mathrm{Re}\,venues_t - OMCost_t\right)\frac{1}{(1+z)^t}\right] - CCost\,\frac{1}{(1+z)} \qquad (4)$$

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where z refers to a discount rate.

Net present value (4) is maximized subject to constraints on the total investment costs and population served by the project, as well as non-negativity constraints. Given the total funding available to the NWCS, $\bar{C}$, the total investment cost constraint can be expressed as (Equation 5):

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$$\sum_{i=1}^{3} c_i X_i \le \bar{C}\,. \qquad (5)$$

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Denoting the targeted population for the project by $\bar{P}$ and targeted population served by each service point as p, the total population constraint is expressed as follows (Equation 6):

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$$\sum_{i=1}^{3} p_i X_i \ge \bar{P}, \qquad (6)$$

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The non-negativity constraints are presented in Equation (7):

$$X_i \ge 0 \text{ for } i = 1, 2, \text{ and } 3. \qquad (7)$$

MODELING SCENARIOS

The model (1)-(7) is used to examine the following three modeling scenarios. While the objective function (4) is the same for all three scenarios, scenario one, referred to as the

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"optimized service provision scenario", is developed to meet all the financial and the targeted population requirements. That is, the financial investment constraint (5) and stipulated population constraint (6) are met as equality, while maximizing NPV from the project. Next, for scenario two, referred to as the "service-oriented scenario", we relax the constraints (5) and (6) and allow the targeted population to exceed the baseline scenario target, while keeping investment costs less than the total funding available. Scenario three, referred to as the *cost-oriented scenario*, allows the investment cost to be less than or equal to the total funding available for the project, while requiring the population target (6) to be satisfied as equality. Finally, the results for the three modeling scenarios are compared with the NWSC scenario, and the effects on changes in the service technology mix on NPV, costs, and the targeted population served by the project are analyzed. The four scenarios were then examined using the Excel Solver add-in.

EMPIRICAL DATA

Project costs and returns data (Table 3) show that there is a tradeoff associated with each water service provision technology. PWPs with pre-paid meters are the most capital-intensive technology, but they also provide the highest returns for the NWCS. In turn, YTs are the least costly technology for the NWCS, but they are the most costly service option for the customers. Finally, PSPs with conventional meters provide a compromise between the costs for the NWSC and customers' expenses, and the most opportunities for dealing with low collection efficiencies from urban poor settlements.

INSERT TABLE 3 HERE

The discount rate, *z*, is 14 percent, which is approximately equal to the NWCS's cost of capital and to the IRR calculated for the NWCS scenario. Total capital investment threshold is 6,600 million UGX (4.0 million 2008 US dollars; note that this constraint does not cover the cost of infrastructure, which is common to all service technologies, 4,893 million UGX). A more detailed analysis of the costs and returns for the project can be found in Berg and Mugisha (2009).

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RESULTS

The results of optimization for the three scenarios are summarized in Table 4 along with estimates for the NWSC scenario. For the optimized service provision scenario (scenario one), the maximum net present value (NPV) is 2.5 billion UGX (1.2 million 2008USD), which is a significant improvement in comparison with the NWSC scenario. The optimum solution does not include the construction of any PWPs with conventional meters. Instead, the optimization process yields 9,542 YTs and 1,766 PWPs with pre-paid meters. These results are in sharp contrast with the NWSC scenario, which proposes YTs supplemented by a small number of PWPs with conventional and prepaid meters. A sensitivity analysis shows that the optimization result is robust with respect to the changes in revenues and costs per connection for each water service technology (Table 5). Based on the reduced cost value, the introduction of every PWP with conventional meter into the solution would reduce the NPV of the project by 6 million UGX (2.8 thousand 2008 USD).

The shadow price for the population constraint indicates that the NPV of the project would vary very slightly with the changes in the population target, as long as this target remains between about 345,000 and 453,000 people.

Optimization for the service-oriented scenario (scenario two) shows that the number of people served by the project can be increased significantly without violating the NWSC constraint on the total investment cost. In this scenario, the number of people served is almost four times larger than in the NWSC scenario, yielding an optimal net present value of 12,981 million UGX (7.9 million 2008 USD). The optimal solution includes only PWPs with conventional meters, which is driven by low investment costs associated with this service technology and the capacity to serve a significant number of poor people. The sensitivity analysis shows that any deviation from the optimal service provision scenario by increasing the number of yard taps or public water points with pre-paid meters will decrease NPV by one million UGX (0.6 thousand 2008 USD) for every yard tap and by three million UGX (1.8 thousand 2008 USD) for every public water point with pre-paid meter, respectively. In other words, the revenues collected from each service point for these service technologies would need to increase significantly before it would become beneficial to install them. Additional investment capital which would allow relaxing the capital cost constraint would increase the net present value of the project by 2.14 million UGX (1,301 2008 USD) for every additional million UGX (608 2008 USD).

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Finally, the results for the cost-oriented scenario (scenario three) show that it is possible to provide water service to the targeted population by investing 5.9 billion UGX, which is 10 percent less than the capital cost target set by the NWCS. The optimal technological mix includes only PSPs with prepaid meters, which would reduce the total

numbers of service points to only 2,720. High collection efficiency, which translates into higher returns associated with the PWP with prepaid meters is the main driver of optimality for this scenario. The optimal NPV is 4,708 million UGX. The sensitivity analysis shows that NPV would vary only slightly with the changes in the population served target. Changes in the optimal mix of service provision technologies (i.e., water provision through yard taps) would have a relatively minor effect on NPV, while the service provision through PWP with conventional meter would decrease NPS by 0.80 million UGX (488 2008 USD) for every PWP.

Overall, results for these three scenarios show that NPV of the NWSC scenario can be significantly improved by changing the number of service points of the water provision technologies. Furthermore, the optimum selection of the technological mix would allow the NWSC to increase the number of poor customers served without violating the investment cost constraints. The optimal technology mix would allow the NWSC to combine the economic (revenue) and public service provision objectives. In all three optimization scenarios, NPV is positive, while the target for the total number of poor customers served is achieved or exceeded.

DISCUSSION

The informal prioritization of service technologies conducted by the NWSC (Table 2) offers several criteria to examine the results for the three modeling scenarios. Service quality and social acceptability are the most important criteria for selecting a service

technology mix (NWSC and Aqua Consult 2004b). For these criteria, PWPs are inferior to YTs (Table 6), since PWPs are seen by most communities as an interim solution and most communities aspire to higher levels of services. The PWP technology is also associated with a high risk of illegal water connections and a moderate to high level of vandalism. Hence, from the social acceptability standpoint, the optimized service provision scenario (scenario 1), which allows for almost 10,000 YTs, is the preferred scenario developed in this paper. The optimized service provision scenario also includes more PWPs with pre-paid meters as compared to the NWSC scenario, which partially addresses the non-payment problem associated with service provision through yard taps.

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The NWSC offered a set of sub-categories to characterize the service technologies from both the management and operational perspectives (Table 7). Because the total number of employees working in the Kampala area is limited (NWSC and Aqua Consult 2004a), the scenario with the smallest total number of service points may be preferable. From this perspective, all the modeling scenarios proposed in this paper allow an improvement in water and sanitation services when compared to the NWSC scenario, since the total number of service points in these proposed scenarios is relatively small, but the cost-oriented scenario (scenario 3) is the most preferred scenario because it accounts for 86 percent fewer service points as compared to the NWSC scenario. But even this scenario implies installing about 3,000 new service points in the informal settlement. Hence, for any of the scenarios considered, the NWCS's "management approaches and operational routines have to improve tremendously in order to satisfy the additional management load" (NWSC and Aqua Consult 2004a).

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The cost-oriented scenario (scenario 3) is also the most preferred from the payment collection perspective, which is an important target for utilities in developing countries (Berg and Mugisha 2009). Non-payment for services is a big problem because many households in the informal settlements earn income on a day-to-day basis and are often very transient, which makes it difficult for paying the monthly water bills or even the up-front costs for the yard tap connection (NWSC and Aqua Consult 2004a). The cost-oriented scenario relies solely on PWPs with pre-paid meters, and "where services are pre-paid the risk of consumers disappearing with water revenues is eliminated" (NWSC and Aqua Consult 2004b).

CONCLUSIONS

This paper examines three alternative water provision scenarios for the Affordable Basic Water Project for the urban poor in Kampala, Uganda. The methodology employed by the NWSC for the Affordable Basic Water Project integrates the main components of social research (Nichols 1991; Dani 2002; Kudat 2002), combines field investigations with stakeholder consultations, and prioritizes different water supply technologies. However, the NWSC did not formally examine how the changes in the number of service points for the water supply technologies would influence the socio-economic outcomes of the project. A certain combination of technologies was selected and tested against the rate of return criterion internal rate of return (IRR). In this study we found that the financial performance of the project (measured in NPV) can be improved by adjusting the mix of service provision technologies through a simple optimization technique.

We used a linear programming model to generate three alternative water service provision scenarios that meet the NWSC's criteria for the capital investment and population served by the project. These scenarios differ by the number of service points for the three water provision technologies considered: YTs, PWP with conventional meters, and PWPs with pre-paid meters. In addition, the scenarios maximize the net present value (NPV) of the project, while allowing for reduced capital investments and more customers in comparison with the NWSC scenario. Analysis shows that the targeted population served by the project can be significantly increased without affecting the financial characteristics of the project.

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Next, the stakeholders' feedback received by the NWSC (NWSC and Aqua Consult 2003b) was used to examine the three alternative scenarios of water service delivery to the urban poor in Kampala, based on technical, managerial, and social acceptability criteria. From the social acceptability standpoint, the optimized service provision scenario (scenario 1), which allows for almost 10,000 YTs, is the most preferable among the three scenarios developed in this paper. In turn, the cost-oriented scenario (scenario 3), which relies solely on PWPs with pre-paid meters, is the most advantageous of all three modeling scenarios from the perspective of managerial suitability. This scenario allows meeting the population served target with 86 percent fewer service points as compared to the NWSC scenario, and is the least expensive from the cash collection efficiency perspective.

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The above results suggest two important lessons for utility managers and policy-makers in developing countries. First, the use of even simple optimization techniques can significantly enhance financial performance and service coverage of pro-poor water service projects, compared to the trial and error approach. In this case study, NWSC was able to

meet or exceed the target for the population served by the pro-poor water project in informal settlements in Kampala, while also meeting or outperforming the capital cost target. In this study, a simple linear programming approach was used; however, other techniques can allow the selection of a water service provision scenario that satisfies the multiple objectives of the project stakeholders and utility managers (Abrishamchi et al. 2005; Duckstain and Opricovic 1980).

The second lesson is that pro-poor water service projects should incorporate the preferences and concerns of the project stakeholders. An effective stakeholder involvement in decision-making process ensures that the project meets public interests and allocates resources efficiently (Berg and Mugisha 2009; Hope 2005). In this study, NWSC used multiple methods for the stakeholder engagement in the selection of service provision scenarios. Stakeholder involvement allowed the identification of a unique set of criteria to evaluate alternative service provision technologies and to examine trade-offs between the water utility managers' objectives (such as fee collection rate, risk of illegal connections, and managerial suitability) and the stakeholders' goals (including service quality and social acceptability). Overall, stakeholder involvement in the identification of a pro-poor water service scenario can build trust between the utility management and water service customers, establish stakeholder support for the final service provision decisions, and strengthens communities' capabilities to manage water services (Tetra Tech 2003; Kudat 2002). Stakeholder involvement facilitates social development and enhances public accountability of water supply projects (Kudat 2002), and should be utilized by utility managers and decision makers in developing (and developed) countries.

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Figure 1. Uganda and Sub-Saharan Region

Source: UNESCO 2006.

Table 1. Stakeholder analysis matrix for affordable basic water project for urban poor.

Stakeholder Group	Interest in Project	Effect of Project on Stakeholders' Interest	Importance of Stakeholders for Success of Project	Degree of Influence of Stakeholders over Project
Water and sewage service providers: NWSC and Kampala City Council (KCC)	- Mandated to provide water and sewage services to urban poor - Concerned about the cost recovery of service provision to informal settlements - Regard informal settlements as temporarily; concerned about possible non-payments for services - Subject to contradictory state and local regulations	- The project is a risky investment that can potentially result in losses for NWSC and KCC - NWSC has the flexibility to select the project design option that leads to positive expected profits. - If successful, service provision to poor has the potential to significantly increase NWSC's customer base, and hence, returns. - Successful provision of services to urban poor will earn country and regional recognition for NWSC and KCC, and will help collaboration with foreign donors	Very important (NWSC and KCC are implementing the project)	Significant
Mailo landowners*	- Legal owners of the land occupied by informal settlements - Unable to develop their lands occupied by the informal settlements - Lack formal means to regulate the extent of informal settlements or evict the settlers - Consider restriction of the water and sewer services as an informal instrument to influence the informal settlements	- The project will improve living conditions of the residents of informal settlements, and hence, reduce the abilities of mailo landowner to vacate the settlers and develop their lands	Stakeholders lack the legal means to influence the project result. However, the stakeholders can influence the project through informal relationships with influential city officials	Potentially significant

Stakeholder Group	Interest in Project	Effect of Project on Stakeholders' Interest	Importance of Stakeholders for Success of Project	Degree of Influence of Stakeholders over Project
Residents of the informal settlements	- Diverse group with diverse interests - Suffer health effects from the lack of access to safe drinking water and sanitation - Hold false believe that the alternative water source – spring – is safe - Lack legal standing to demand municipal services - Lack understanding of procedure to apply for municipal services - Concerned about the cost and reliability of municipal service	The project will result in health benefits, improved access to safe drinking water and hygiene services. However, the stakeholders needs to be educated about expected benefits of the project	Success of the project depends on selection of the project design option acceptable to the residents of informal settlements.	Potentially significant

Source: Based on National Water and Sewerage Corporation (NWSC) and AquaConsult 2003a, b.

* Mailo land tenure accounts for 65% of Kampala area and about 80% of the area in the city covered by informal settlements (NWSC and AquaConsult 2003b). The specificity of mailo land tenure facilitated the growth of informal settlements and prevented effective water and sewerage provision to such settlements. Mailo tenure originated in early 1900s and was used by colonialists as a way to indulge local elite. The individuals receiving this land often lacked the means to till the area so they settled tenants. In 1975, all land in Uganda was declared to be the property of the state, and mailo landowners were converted into lessees of the state for the period of 99 years. The Decree also gave the former mailo landowners the right to evict tenants after issuing a six-month notice and compensating tenants for any land improvements. However, mailo landowners have not have any mechanisms of controlling the nature and extent of illegal settlements and they rarely take the steps to evict tenants (Place and Otsuka 2002).

Table 2. Prioritization of service technologies.

Service Level / Prioritization Criteria	Service Quality	Technical Suitability	Social Acceptability	Managerial Suitability	Environmental Impact
Rudimentary traditional systems	Risk of contamination is high; water quantity available is relatively small; distance to the water source can be large.	Service reliability is mostly low. However, this option requires minimum operation and maintenance.	Generally viewed as inferior.	Can be administered by a community organization or water committee; no formal operator is needed	Direct environmental impact is low
Public water points (with conventional or pre-paid meters)	Water quality is moderate; water source located closer to the customers; water quantity varies.	Moderate service reliability; maintenance complexity varies with scheme size	Viewed as an interim solution; most communities aspire to higher level of services; willingness to pay is low; risk of illegal connections and vandalism is high.	Can be managed by a community organization or water committee; training in operation and maintenance is needed	Direct environmental impact is low;
Yard tap	Risk of water contamination at residents' houses is moderate or large. Water source located close to residencies.	Reliable technology; moderate level of maintenance is required for high pressure pipes and shut-off valves	Yard tap is perceived inferior to house connection; overall acceptability is moderate or good with proper awareness of advantages; volume-based billing improves willingness to pay; risk of illegal connections is reduced; risk of vandalism is low	Can be administered by a community organization or a water committee; can be operated by customers; training of customers in water awareness is needed	Direct environmental impact is low
House connection	Water contamination is possible at the point of use; water source located close to residencies;	Technical efficiency is moderate (higher leaks due to high pressure); reliability is moderate or low; maintenance is high	Social perception and acceptability are good; affordability is low; willingness to pay is moderate to low (poor control); risk of illegal connections is high; risk of vandalism is low	Billing system requires community support; requires significant training of staff; mentoring and water awareness is critical since there is no other control; cost recovery is moderate to low	Environmental impact is moderate to high (effluent management is needed)

Source: Based on National Water and Sewerage Corporation (NWSC) and AquaConsult 2004b.

Table 3. Expenditures and returns for various service options.*

	Yard Taps (YTs)	PWPs with Conventional Meters	PWPs with Prepaid Meters
Capital Cost, Total, million UGX (2008 USD) Including:	0.287 ($174)	0.632 ($383)	2.186 ($1,325)
Basic Connection (materials, 50 meters)	0.145 ($88)	0.145 ($88)	0.145 ($88)
Manual Labor (trenching, 50 meters)	0.050 ($30)	0.050 ($30)	0.050 ($30)
Skilled Labor (plumbing and project management)	0.013 ($8)	0.013 ($8)	0.013 ($8)
Road Reinstatement	0.007 ($4)	0.007 ($4)	0.007 ($4)
Bit Tap	0.015 ($9)	0.045 ($27)	0.045 ($27)
Water Meter (1/2 inch)	0.057 ($35)		
Water Meter (3/4 inch)		0.063 ($38)	0.063 ($38)
Concrete casing, platform and drain		0.272 ($165)	0.272 ($165)
Additional cost for 1-inch piping		0.037 ($22)	0.037 ($22)
Prepaid meter additional cost			0.805 ($488)
Additional construction and reinforcement cost			0.750 ($455)
Operating expenditure per connection per year (including all supply chain operation and maintenance costs associated with delivery of water at a supply point), based on the existing data for similar projects, million UGX (2008 USD)	0.103 ($63)	0.103 ($63)	0.103 ($63)
NWSC consumption tariffs, UGX/cubic meter (2008 USD)	1064 ($0.6)	688 ($0.4)	688 ($0.4)
Collection ratios	85%	60%	100%
Return per connection per year, million UGX (2008 USD)	0.119 ($72)	0.466 ($283)	0.777 ($472)

* Exchange rate as of July 31, 2008 (Yahoo! Finance 2009)
Source: COWI (2007).

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Table 4. Service provision scenarios.

	NWCS-Scenario	Optimized Service Provision Scenario	Service-Oriented Scenario	Cost-Oriented Scenario
YTs	19,067	9,542	0	0
PWP with conventional meters	409	0	10,444	0
PWP with pre-paid meters	409	1,766	0	2,720
Total number of service points	19,885	11,308	10,444	2,720
Total capital investment cost, million UGX (million 2008 USD)	6,600 ($4.0)	6,600 ($4.0)	6,600 ($4.0)	5,947 ($3.6)
Population served	408,000	408,000	1,566,580	408,000
Net Present Value, million UGX (million 2008 USD)	8 (~$0)	2,515 ($1.5)	12,981 ($7.9)	4,708 ($2.9)

Table 5. Selected results of the sensitivity analysis for the service provision scenarios.*

	Optimized Service Provision Scenario	**Service-Oriented Scenario**	**Cost-Oriented Scenario**
Yard Taps			
Changes in YT net returns* for which the optimal technology mix remains unchanged, million UGX (2008 USD)	Unrestricted decrease / increase by 1,893%	Unrestricted decrease / increase by 4,493%	Unrestricted decrease / increase by 1,643%
Reduced cost: changes in the Net Present Value if a YT is included in the service provision scenario, million UGX (2008 USD)	Not Applicable	-1.00 (-$608)	~0
PWPs with conventional meters			
Changes in PWP net returns* for which the optimal technology mix remains unchanged, million UGX (2008 USD)	Unrestricted decrease / increase by 446%	Reduction by 54% / unrestricted increase	Unrestricted decrease / increase by 59%
Reduced cost: changes in the Net Present Value if a PWP is included in the service provision scenario, million UGX (2008 USD)	-6.02 (-$3,660)	Not Applicable	-0.80 (-$488)
PWPs with pre-paid meters			
Changes in PWP net returns* for which the optimal technology mix remains unchanged, million UGX (2008 USD)	Reduction by 85% / unrestricted increase	Unrestricted decrease / increase by 117%	Reduction by 37% / unrestricted increase
Reduced cost: changes in the Net Present Value if a PWP is included in the service provision scenario, million UGX (2008 USD)	Not Applicable	-3.00 (-$1,824)	Not Applicable
Constraints			
Shadow price: changes in Net Present Value with a unit increase in the population served	0.06 ($38)	Not Applicable (population constraint is not binding)	0.01 ($9)
Shadow price: changes in Net Present Value with a unit increase in the capital cost limit	-3.36 (-$2,039)	2.14 ($1,301)	Not Applicable (capital cost constraint is not binding)

* Net returns for each technology are defined here as returns, r_i, reduced by operation and maintenance costs, w_i, and investment cost, c_i, estimated over the life span of the project

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Table 6. Social acceptability of YT and PWP water provision technologies.

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	Public Perception	Public Acceptability	Affordability	Willingness-to-Pay	Pay-in-Kind	Illegal Connections	Vandalism
YTs	Mixed (inferior to house connections)	Moderate to good (given proper awareness of advantages and up-grade options)	Moderate to good (most households can afford the service if investment costs are covered by a grant)	Good (especially for volume-based billing)	Good (suited for own excavation and laying of yard connection and servicing)	Low	Low
PWPs (with conventional or pre-paid meters)	Mixed (viewed as an interim solution)	Low (most communities aspire to higher level of service)	Moderate (most households can afford the service if investment costs are covered by a grant)	Low (since water should still be carried manually from a PWP to home)	Low	High	Moderate / high

Source: Based on National Water and Sewerage Corporation (NWSC) and AquaConsult 2003b.

Table 7. Technical and managerial suitability of YT and PWP water provision technologies.

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	Administrative Capacity	Operating Skill	Training Needed	Payment Collection	Maintenance Needed	Technical Support Needed
YTs	Moderate (can be operated by a community organization)	Moderate	Training of customers in water awareness	Good (given no illegal connections and honest meter reading)	Moderate (maintenance of high pressure pipes and occasional servicing of shut-off valves in nodes)	Low
PWPs with conventional meters	Moderate (can be operated by a community organization)	Moderate	Training of customers in operation and maintenance	Very low due to limited control over water usage and payment	Moderate (varies with scheme size)	Moderate / low (varies with scheme size and density)
PWPs with pre-paid meters	Moderate / high (require frequent loading of cards or replenishing tokens, and deploying of many vendors)	Moderate, but frequent contacts with NWSC are needed; large schemes need dedicated operator	Training of customers in operation and maintenance	High, but can potentially be reduced with shrinking of water usage by customers	Moderate (varies with scheme size; special maintenance of pre-paid meters)	Moderate / high (special maintenance of pre-paid meters)

Source: Based on National Water and Sewerage Corporation (NWSC) and AquaConsult 2003b.

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Capital Cost, million UGX (2008 US$)	0.287 ($174)	0.632 ($383)	2.186 ($1,325)