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Perception from Uganda water area: Infrastructure advancement and execution evaluation

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Abstract

There are a number of infrastructure water utilities, especially in developing countries that have tended to use climatic change challenges as scapegoat for unreliable water supply to citizens. In this paper, we argue that there are significant gains that infrastructure managers can realise, in the short to medium term, while addressing water scarcity problems as the wider climatic change challenges are being globally tackled! We single out effective infrastructure optimization through high-impact change management plans and incorporating strong water loss management strategies. In addition, we pinpoint use of economic criteria for plant capacity expansion, raw water source protection and effective stakeholder coordination as key ingredients to infrastructure optimisation. Further, the paper investigates modes of infrastructure performance monitoring. Using a quantitative survey method and empirical data from 14 NWSC water utilities, the paper concludes that both process and output oriented monitoring approaches (measured by attitudinal indicators) are positively correlated with monitoring effectiveness and subsequently the technical efficiency change (catch-up) of infrastructure utilities. This study outlines an important issue that has not been adequately researched: the extent to which feedback and information flows from the principal to the agent could improve the capacity of the agent to conduct business.

Keywords: Infrastructure management, water scarcity, efficiency change, water loss management, source protection, monitoring.

INTRODUCTION

Many countries are faced with enormous challenges of water scarcity, which in turn affects the economic development activities of their citizens. There have been many schools of thoughts and insights into the causal factors and attempts have been made to alleviate the situation. One of such factors is climatic change that greatly affects availability of raw water sources. However, in most countries, climate change per se, is not the only factor affecting the availability of water to the citizens. In this paper we argue that, much as climate change might be an issue in most developing countries, lack of adequate focus on water infrastructure optimisation contributes significantly to water availability problems. Specifically, the paper brings out the question of efficiency and highlights the need to create water savings through continuous modify-cation and strengthening of infra-structure operational technologies and processes. Other than climatic change effects, which are largely outside the control of utility practitioners, we point out the need to network with immediate communities and local authorities to mitigate likely consequences on the raw water sources. The underlying motivation of the paper relates to the need to address the high levels of unaccounted for water (UFW) prevalent in most African water utilities. There are a good number of African water operations registering above 50% water wastage. Surely in such circumstances, debating the question of climatic change alone is missing the point! While the utility managers can contribute to the wider debate of conserving the environment, they must, primarily, address the issue of infrastructure optimisation. In order to ensure managerial effectiveness, the oversight bodies must carry out meaningful performance monitoring of the service providers. In this paper, we bring out a dimension of principal-agent interaction that works to ensure improved infrastructure efficiency. Water infrastructure optimization in this paper refers to the applicacation of suitable tools to generate greater efficiency in the way in which water is produced and used (Muhairwe and Mugisha, 2007). The water savings generated through optimization of water supply especially in water stressed situations can be used to meet the unsatisfied demand and delay unnecessary capacity expansion projects, releasing the much needed revenue for service expansion programmes. In countries facing uncontrolable climate change challenges, water optimization is even more apparent and calls for innovative copping mechanisms to address the water scarcity problems (ibid.)

This paper uses the case study of National Water and Sewerage Corporation (NWSC) of Uganda to demonstrate common challenges to water infrastructure optimization and how the corporation has approached them. NWSC is a government parastatal established in 1972 with the full mandate of providing water and sewerage services in the large urban centers on a self-sustainable basis, in Uganda. According to Muhairwe (2007), the corporation currently (2007) operates in 22 of the large urban towns with an estimated population of 2.1 million people. It has about 185,000 customer connections serving about 71 percent of the urban population in the designated service area.

The paper explores a number of water infrastructural management challenges affecting effective service delivery. Specifically, it singles out infrastructure optimization through high-impact change management plans and incorporating strong water loss management strategies. In addition, we pinpoint use of economic criteria for plant capacity expansion, raw water source protection and effective stakeholder coordination as key ingredients to infrastructure optimisation. Further, the paper investigates modes of infrastructure performance monitoring. Using a quantitative survey method and empirical data from 14 NWSC water utilities, the paper concludes that both process and output oriented monitoring approaches (measured by attitudinal indicators) are positively correlated with monitoring effectiveness and subsequently the technical efficiency change (catch-up) of infrastructure utilities.

Need for infrastructure optimization

Prior to 1998, the corporation with support from donor partners carried out heavy investments in infrastructure with the main objective of rehabilitating the existing system (Muhairwe and Mugisha, 2007). Unfortunately these investments were not matched with the necessary efficient commercial and financial management systems that were necessary to ensure the delivery of sustainable services in the medium to long-term. The corporation continued facing numerous challenges that compromised its ability to effectively deliver efficient services to its esteemed customers. Most of the problems faced were mainly as a result of low operational efficiencies that existed. The total number of customer connections was only 50,000 and only 48% of the population (1.2 million people) had access to piped water supply. Plant capacity utilization was only 55%, with 60% of the produced water lost as UFW. With this level of performance, the corporation could barely sustain the daily operation of the system. There were rampant water leakages and poor response rate to the few leakages that were reported. The uncontrollable and widespread vandalism of meters and other components of the water system not only increased the level of water losses but also increased the cost of delivering the services. Most of the existing customer and bulk meters were defective and registering inaccurate readings due to the poor maintenance culture and lack of a clear meter replacement policy. A big percentage of the customers were consuming water illegally and there was no clear mechanism of tracking such culprits leave alone measures to curb such practices. The distribution network did not have delineated hydraulic zones which made it difficult to balance the network and ensure effective management of water losses in the system. Due to the high losses in the system and poor operational practices, most of the towns experienced intermitted services ranging from 15-21 h. In this connection, there were no incentives for managers to focus on water supply optimization and demand management which partly explained the poor performance in most operating units (ibid.)

Besides the internal challenges highlighted above, tremendous external pressure from climate change was also affecting the quantity and quality of the water sources especially the lakes. The poor management of raw water catchments resulting from poor stakeholder coordination negatively impacted the availability and quailty of the raw water sources. This, not only increased the water scarcity problem, but also escalated the cost of service delivery. The rapidly growing population (4 - 5%) and urbanization in terms of geographical coverage for most of the urban centers where the corporation operated was putting excessive pressure on the already strained services and necessitated not only system expansion programmes but also strategic and innovative approaches for efficient and sustainable service delivery.

Optimization through strategic efficient management strategies

In response to the above challenges and with limited resources at its disposal, the NWSC devoted its efforts to strengthening water optimization through numerous innovative approaches. These included: effective change management, water loss (NRW) management, water resource protection and stakeholder coordination, and timely water production development.

Change management initiatives

NWSC opted to use short-term action oriented change management initiatives that emphasized efficient and optimum use of the available resources as a cornerstone to addressing the prevailing water supply challenges. The short term innovative changed management programmes. The first initiative was code-named 100-days programme that focused on reversing the operational and financial inefficiencies in the system by turning-around the working culture and thinking of the corporation staff. Following the latter was the Service and Revenue Enhancement programme (SEREP), which focused on restoring customer confidence in NWSC operations and creating a sense of ownership that was vital for sustainable service delivery. After this, a number of Area Performance Contracts (APCs) were initiated, emphasizing operational cost recovery of all areas through increased autonomy to the managers to take decisions and be accountable for actions. The APCs were supplemented by Stretch-Out programme that was aimed at empowering staff teams at all levels to take on-spot decisions and operate in bureaucracy free environment, with minimum external interference. However, the Stretch-Out programme was team-based, disregarding actions of individual staff. In order to address this shortfall, a One Minute management was introduced, focusing on individual accountability within the group and necessitating each staff to have individual visions, missions and one minute goals. Following in the series was the Internally Delegated Area Management Con-tracts (IDAMCs). These contracts, which are still running in the NWSC, focus on increased accountability and commitment to area operations through increased autonomy and apportionment of operating risk to the operating teams through performance-based pay mechanisms. In tandem with IDAMCs, there is a 'Checkers' system – a strong monitoring and evaluation tool that addresses both processes and outputs to ensure effective accountability of operating teams.

Emerging managerial tools and principles

Besides the above initiatives, an extensive computerization drive to network all its operating areas was undertaken in order to strengthen the communication mechanisms, which was vital for accurate decision making and planning purposes. Further, the tariff policies were reviewed and new measures instituted, including reduction of new connection and reconnection charges. At the same time, regular tariff indexation against inflation was introduced, which enhanced financial sustainability through improved revenue generation. In all these change management programmes, one may ask: 'what type of management best enhances water availability for citizens, especially in places of abundant fresh water sources? A number of emerging management tools (EMTs) can be distilled from NWSC case study. These include improving governance through a series of innovative performance contracts/programmes, use of performance based incentives and strong customer focus. Furthermore, empowerment and continuous staff development, efficient and well targeted investments to address scarcity, constructive dialogue with government and donors on how to best address water scarcity are also critical ingredients. Last but not least, utility managers MUST incorporate strong research and development to explore new ways and technologies of addressing water scarcity.

In respect to the principles, for all the implemented programmes in NWSC, the underlying considerations were proper identification of the driving forces for key performance areas and strategy formulation with clear prioritization of the activities. In all cases, well and strategically formulated monitoring and evaluation (M and E) framework were developed to ensure continuous improvement. The programmes adopted relevant PSP-like mentalities (that is, commercial orientation, customer care, and incentive based pay) and encouraged ownership, collective decision making and a balanced bottom-up and top-down management approach.

Water loss (UFW) management

A substantial amount of the water losses in the system was attributed to illegal use and other types of commercial losses. However, without well established hydraulic zones and demand management system, it was not possible to establish the percentage contribution of illegal use to the water losses. In an effort to curb down on the rampant illegal use in the system, dedicated and well facilitated illegal use management units were established in all operating areas with clear outputs that formed the basis for their remuneration. The units were responsible for identifying and taking proactive action on all illegal use cases in the respective areas. The organization structure of the operating units was also streamlined to emphasis leakage control activity and leakage management teams were established with delineated responsibilities and performance targets. The teams' activities are enhanced by a fully fledged call centre, which is the registration point of all reported leaks and bursts which are immediately routed to the responsible leak management teams. The call centre data base is also used to record all other actions in respect to faults that have been discovered by the teams themselves. This approach has significantly reduced the response time to leaks to within 2 h. Apart from physical leakage management, the meter management and replacement policies were reviewed leading into effective definition of procedures to ensure correct levels of maintenance for both customer and bulk meters. On the other hand, proactive strategic alliance

Table 1. NWSC performance improvements**.**

Performance Indicator	1998	2007
Service coverage	48%	71%
Total connections	50,826	185,000
New connections per year	3,317	25,000
Staff per 1000 connections	36	7
Coll. Efficiency	60%	93%
Unaccounted water	51%	32%
Proportion metered accounts	65%	99.6%
Annual turnover	USH21.9BN	USH68.4bN
Profit /(loss) After Depreciation	Loss: (USH2.0Bn)	Profits: USH6.5Bn

Source: Muhairwe and Mugisha (2007)

with security agencies and communities played a vital role in addressing the challenges of meter vandalism in the system.

Water resource protection and stakeholder coordination

NWSC has experienced a number of external factors, arising from climate changes, affecting service delivery in respect to the quantity and quality of raw water in most areas. A continuum of approaches was adopted to respond to these challenges. Among these approaches was the enforcement of compliance with abstraction permit conditions, including, among others, the need for the utility to restrict raw water abstraction within allowed limits. In this regard, emphasis was put on ‘optimization of every drop’ abstracted to ensure reliable supply especially during times of short raw water supply. The NWSC managers also increased vigilance in the surveillance of the source and coordination with the environmental protection agencies and the communities where measures were undertaken to protect the source and minimize devastating human impact. The recent (2004 -2006) drop in the water levels especially in Lake Victoria necessitated innovative approaches that required modification of the intake system to extend the abstraction point further into the lake to guarantee reliable abstraction in terms of both quantity and quality.

Timely water production capacity development

The heavy investments carried out prior to 1998 resulted in excessive idle plant capacity for most infrastructure systems. Consequently, as at 1998, the overall plant capacity utilization for all NWSC plants was 55%. The excessive idle plant capacity gave rise to uneconomical depreciation costs, increasing operating costs due to the over sized system. This inefficient investment activity also meant that funds had been tied and there was not enough to carry out network expansion programmes. However, arising from the free new connection policy, the expansion in the customer base and improvement in the service delivery has significantly reduced the idle capacity of the system to about 75% as at 2007. In this respect, a plant capacity utilization of 85-90% is considered a sufficient inflection/trigger point for capacity upgrading. Further more, in NWSC’s case, majority of the heavy investments in the system are implemented through grant financing to avoid negative tariff effects given the limitations in implementing full cost recovery. In order to ensure long term sustainability of the investments, all capital projects are implemented taking into full account of accompanying institutional and operational and maintenance managerial implications.

NWSC benefits from the management strategies

The implementation of the above management strategies has resulted in significant efficiency gains (see Table 1 below) for the corporation for the period 1999- 2007. Specifically, service coverage has increased from 48 to 71% and the level of UFW has reduced from 51 to 32% - with all towns, other than Kampala, registering UFW levels between 15 - 18%. The corporation registered a financial surplus after depreciation in 2007, which is a reflection of the positive impact on financial sustainability. Most importantly the change management initiatives lifted the spirits of all staff in the corporation and enhanced performance through increased accountability, increased customer focus, prompt decision making increased autonomy and initiative taking. The programmes also allowed for rational allocation of operating and commercial risks through well structured performance incentives.

Approaches to infrastructure monitoring: Rethinking the principal/agent relationship

This paper identifies two approaches to infrastructure performance monitoring; input versus output orientations. In this paper, input/process monitoring orientation is the perceived measure (through a number of attitudinal indicators) of whether the performance monitor carries out his/her roles by helping and supporting the agent through advising on how to improve performance. In involves regularly looking at the operators' management systems and advising on possible improvements. The performance monitor also regularly carries out field visits/audits and gives technical advice on how to overcome problems. The orientation is keen at advising the operator on aspects of operations where efforts could be put to achieve performance targets. In addition performance monitoring involves carrying out deliberate activeties aimed at disclosing how the other operators do it to succeed and how they fail in some aspects to encourage learning from each other.

On the other hand, output monitoring orientation is the perceived measure (through a number of attitudinal indicators) of the non-interference attitude of the performance monitor and only getting concerned with output delivery (Output Orientation) . In this case, the performance monitor is concerned with achievement of performance standards in the contract and not how the operator does it. There is extreme keenness not to engage in the operator's operational strategies and management. Furthermore, comparison of the operators' performance to other utilities is only based on achievement of performance outputs and not the processes involved (only performance standards count).

There are a number of arguments against input/process orientation, in respect to performance monitoring. Graham (2002) points out that the performance monitors/regulators should not get involved in the operating firm's business, as this would verge on micro-management. In the same tone, Berg (2002) also posits that, as long as there are good performance measures and commensurate incentives (rewards and penalties), there is no need for extensive monitoring oversight of the performance delivery process. Emery (2002) also supports emphasis on output orientation. He suggests that there should be minimum intervention by the performance monitor in the management of operating utility's operations. Warrick (2002) observes that monitoring inputs or processes rather than outputs or outcomes will reduce the firm's incentives to search for and apply lower cost ways of achieving the result. These arguments clearly show that an output orientation to monitoring, as opposed to an input orientation, limits micro-management and therefore gives maximum discretion to the operating firm in deciding how to deliver ultimate performance improvement.

In addition, Sansom et al. (2003) recommend that, as far as possible, outputs should be specified in water utility contracts, rather than inputs and processes. They assert that an output-focussed specification can be more flexible, requires less administrative effort and provides greater value for money for the contracting utility than one focussed on inputs and processes. They further observe that the output specification gives contractors more room for innovation that may enhance efficiency and effectiveness. If a good performance-based contract is prepared, then the client representatives can concentrate on checking that the operator is meeting its agreed performance requirements, rather than becoming involved in the day-to-day management of operations (Sansom et al., 2003). This argument assumes that the operator knows it all in respect to production maximisation possibilities. From experience, this is not necessarily the case in low-income country utilities. It is less a case of a clear-cut choice between input- or output-based monitoring orientations than of a need for a hybrid of the two. There is limited empirical investigation, however, to inform the selection of appropriate and relevant performance monitoring approaches in utilities located in low-income countries like Uganda.

There are arguments in support of input/process orientation. Memon (2002) (Ali Memon has had a lot of regulatory experience, having worked at the World Bank and as CEO of a regulatory commission in Pakistan, a country with typical low- income utility characteristics) suggests that one way a regulator can create a good enabling environment for the operating firm to deliver improved performance is to adapt an enabling/facilitative orientation through:

Education programmes aimed at capacity building.

Technical workshops where ideas about improving operations are discussed. Regular monitoring, including visits to the operating firms. Being different from a "regular performance judge" by working in co-operation with the operating firm. Working with and guiding utilities as opposed to being adversarial.

Not waiting for deadlines but being proactive and problem-solving oriented.

In support of the input/process monitoring orientation, Bullin (1996) also suggests that there is need for the principal and agent to participate meaningfully for strategies to take shape. She asserts that the role of an effecttive monitor is to be an advisor and consultant who coordinates work and serves as a resource to the agent. She adds that the effective monitor shares information openly, recognises achievements, explains rules and coaches the agent, if necessary, in improving skills. The unanswered question of course is how far the monitor can go with this approach without verging on interference in the operator’s conduct of business?

The input/process monitoring orientation is also emphasized by the features of an effective Performance Management System (PMS) suggested by Bevan and Thompson (1991). Their PMS pinpoints teamwork between the principal and the agent as a key factor for success. It also emphasizes "shared vision" of purpose and the mission statement as critical improvement factors for organizational performance. The PMS principle suggests that the process of delivering performance should not just be a preserve of the operating firm but rather should encourage partnership with the performance monitor. Furthermore, research by Fletcher and Williams (1992) suggests a practical model that is significantly premised on principles similar to Bevan and Thompson's model, one that emphasises shared corporate vision and values and togetherness in performance delivery between the operating firm and the performance monitor. Frunzi and Halloran (1991) give a balanced view to monitoring approaches. They argue that effective monitoring and control means knowing how the agent operates. While this might sound supportive of the input orientation, they add that the intrinsic motivation of the agent springs heavily from recognition of a job well done, as well as from real decision-making power regarding how the job is done. Thus this approach is also associated with output monitoring orientation. Chandan (1987) also suggests a balanced approach to monitoring. He points out that performance monitoring is a dynamic process, requiring deliberate and purposeful actions to ensure compliance with the plans and policies previously developed. Chandan maintains that performance monitoring maintains equilibrium between the means and the end or between efforts and outputs. Accordingly, a well-designed monitoring system should be capable of identifying potential problem areas before they arise so that corrective action can be taken before the problem becomes serious and unmanageable. In support of the output orientation, monitoring should focus on results. The ultimate aim of monitoring is to attain objectives. It should not only indicate deviations but should also lead to corrective action. The system should also disclose where the problem areas are and what factors are responsible for them so that immediate actions can be taken quickly.

The above arguments are concerned with both approaches of performance monitoring – input/process and output orientations – and their perspectives. This research study goes further to consider aspects and dimensions of performance monitoring and regulation that are directly relevant to water utility performance enhancement, for which research gaps still exist, especially for African water utilities. Even when the issue is not the choice between output orientation and input/process orientation, the remaining question is what the monitor/regulator has to do when using either orienttation. Most water regulators, especially Ofwat (UK), use metrics benchmarking to encourage competition among peer water utilities. This is a clear case of output monitoring orientation. Indeed, benchmarking is increasingly a key instrument for generation of performance improvement incentives, given a number of water utilities. Berg (2003) underlines this fact when he says….
“I am convinced more than ever that benchmarking is one of the tools that can make a difference for the future.” He argues that benchmarking represents an important tool for documenting past performance, establishing baselines for gauging improvements, and making comparesons across service providers. The monitoring/regulatory role identified by Berg in respect to benchmarking involves the review of studies and creation of performance incentives to achieve policy objectives. The latter is a generic role that incorporates both the output and process orientations to performance monitoring. Armstrong (2000) suggests that performance monitoring should emphasise a supportive approach to the contractor rather than a directive one. He observes that performance monitoring should not just be another means of obtaining compliance with the achievement of objectives that have been cascaded down from some remote height by the principal. He suggests that performance monitoring ought to be seen as a joint process that requires both the principal and the agent to identify, in discussion with each other, what support the operating agent needs to work effectively.

The above discussion surely illustrates that there are two perspectives regarding how the performance monitor may create managerial incentives for the operator: (1) by using an output oriented monitoring specification and (2) through meaningful input oriented monitoring specification. The question is, should the choice be one or the other or a hybrid of both? From the above discussion, it appears that both approaches may have positive effects on monitoring effectiveness. Therefore, the debate is still inconclusive and warrants further investigation to provide a better understanding of this principal-agent relational dilemma. Consequently, this study investigates the following proposition:

“Both process and output oriented monitoring approaches (measured by attitudinal indicators) are positively correlated with effectiveness of the performance monitor/regulator (principal) and subsequently the technical efficiency change (catch-up) of operating utilities (agents).“

EMPIRICAL FINDINGS

Methodological approach

The study (The survey was carried out in 2004 as part of the collaborative research to map out effective modes of performance monitoring in low-income countries) utilised a qualitative approach to develop a survey instrument (see Appendix) and later applied a quantitative methodology during the main study. The rationale for using a quantitative method, which is based on the positivist’s para-

paradigm, was based on a number of reasons. First, the study design involved correlations between efficiency change and perceptions of modes of performance monitoring, which calls for use of statistical methods that can best be applied when a Likert-type scale is applied. Second, most of the targeted respondents, through previous research work, were conversant with response choices. Third, the methodology easily allows for mailed questionnaire administration and self assessment, without a lot of interface, which ensures more unbiased responses. Fourth, funds for rigorous qualitative investigation were not readily available.

The study was carried out in 14 out of 15 towns of NWSC (exempting Kampala). The rationale behind the selection of the 14 utilities was that all of them were running under the same management arrangements namely performance incentive con-tracts and later internally delegated area management contracts (IDAMCs). These contracts had a characteristic public-public setting, whereby the contracting parties are Head Office (publicly owned) on one side and the operating utility (publicly owned) on the other side. It is the interface between the parties that was clearly defined by structured operating contracts, whereby each party had clear roles and responsibilities. The operating arrangement in Kampala (the 15th utility) was, however, different in that the operator was a private company with a slightly different operating manage-ment contract. The properties of the contracts were, nonetheless, principally the same in both cases. Under the above management arrangements, each of the 14 utilities has a management team. The team is comprised of the Area Manager (Lead Partner) and other Partners consisting of the persons in charge of finance and accounts, technical operations, commercial operations and zones (if any). The number of Partners depends on the size of the Area. The Lead Partner and the other Partners routinely interact with performance monitors from Head Office in respect to matters concerning the running of operating contracts. Because of this attribute, the study considered the partners as the most suitable respondents to the survey questionnaire, which was dealing with questions directly relating to the monitor-monitored interface.

The study utilised a cross-sectional survey to collect data from partners that routinely interact with Head Office in matters of contract management/regulation. A cross-sectional survey was preferred mainly because of its advantages over the other data collection methods in respect to economy of the design, the rapid turn-around in data collection, and ability to identify attributes of a population from a sample (Babbie, 1973; Creswell, 1994). The survey used a self-administered questionnaire for collecting data on three variables: process (input) monitoring orientation (PROCESS), output monitoring orientation (OUTPUT) and monitoring effectiveness (ME). Two approaches to questionnaire administration were used: (1) unsupervised administration for respondents who were literate and informed the research assistants that they understood all the contents of the questionnaire (2) semi-supervised administration for respondents who informed the research assistants that they needed guidance in the interpretation of some of the contents of the questionnaire. Self administered questionnaires were preferred because according to Babbie (1973) and Neuman (1997); (i) there are comparatively lower costs associated with their administration; (ii) they allow for wider geographical coverage; and (iii) self-administered questionnaires are easier to implement than other kinds of questionnaire. In addition the study utilised a purposive sampling design. The choice of this sampling design was premised on the fact that a unique group of respondents, who routinely interact with Head Office in respect to contract monitoring and who would, therefore, be informative was needed. It is clear in this regard that the sample did not include respondents at Head Office since their activities were the ones being assessed. As was pointed out above, the target population included all the Lead Partners and other Partners in the 14 utilities under study. Because this was relatively small population, the target sample taken as the entire population size of 61 utility managers (100% sampling ratio).

The survey instrument was designed following the procedures for the development of a measurement instrument recommended by several scholars (Babbie, 1973; Spector, 1992; Kervin, 1992; Oppenheim, 1992). The instrument was pre-tested, piloted and purified for the main study. In this connection, Likert scales or summated rating scales were chosen for the questionnaire because they: (i) have better validity and reliability; (ii) are cheaper and easier to develop; (iii) are usually quicker and easier to fill in by respondents (ibid.). Additionally, multi- item scales have been found to communicate interval properties to respondents, and, therefore, produce interval-scaled data (Oppenheim, 1992). Five to nine choices are normally considered optimal, depending on the measurement sensitivity of respondents (Nunnally, 1978; Kayaga, 2001; Spector, 1992). In designing the number of choices, consideration was made for conditions prevailing in the study setting. Experience from previous research in NWSC by the author had shown that most managers prefer a limited range of choices. The five-step scale was, therefore, chosen to avoid confusion in differentiation of scale intensity. The five steps used for perception statements were “5: Strongly Agree”; “4: Agree”; “3: Not Decided”; “2: Disagree”; and “1: Strongly Disagree” as recommended by Babbie (1973) and Oppenheim (1992).

After the changes were made as a result of the pilot study, the format of the questionnaire was improved with the intention of enhancing the response rate. In accordance with recommenddations to provide “ventilation” questions (Bourque and Fielder, 1995), space was made available at the end of the questionnaire, and respondents were invited to make suggestions and/or specific comments about improvement of performance monitoring to improve the operator’s service delivery initiatives. Respondents were also encouraged to make specific complaints, as a method of establishing construct validity of the measurement instrument (Spector, 1992; Parasuraman et al., 1991). Newly recruited engineers in the NWSC who were seen to be impartial and could therefore act as independent research assistants, were trained on the contents of the questionnaire and used to go around the Areas, facilitating questionnaire answering, where needed. As in the pilot study, the main survey questionnaires were placed in A4 envelopes, and addressed with the following identification information: water supply area (WSA), questionnaire reference number (QRN) and physical address (PA). C5 return envelopes were enclosed in the A4 parcel envelopes. The processed questionnaires were sorted according to the Water Supply Areas and put in parcels. The parcels were then put in the respective letter “pigeon holes” of the Water Supply Areas at Head Office. The questionnaire administration design was such that the independent research assistants could continue facilitating collection from respondents for another week if the respondents so wished. Those questionnaires which would be ready would then be collected by the independent research assistants if the respondents so wished. The respondents were free to send the questionnaire on their own through a given address, to be sure of anonymity and hence reduce bias.

Analytical methods

The study utilised a number of statistical analytical methods, namely: Pearson and Rank correlation methods, ANOVA, non-parametric methods and correlation techniques. In addition the study utilised econometric methods involving input distance sto-chastic frontier (SFA) methods to get efficiency change indices.

Item/reliability analysis

To check for internal consistency of the research instrument, a

Table 2. Krustal-Wallis Test Values vs. critical Chi-square values (Main Study).

Sno.	Variable	H_a	Chi-square Index, χ^2 (at 1% level)
	Process Benchmarking Orientation	12.4	16.8
	Output Benchmarking Orientation	8.1	9.2
	Monitoring Effectiveness	18.8	21.7

Table 3. Average Attitudinal Scores for the Period 2003-04.

Sno	Utility	EC*	ME	PROCESS	OUTPUT
1	Jinja	1.00	3.66	3.57	**3.39**
2	Entebbe	1.12	4.07	3.89	**3.50**
3	Mbale	0.93	4.13	3.91	**4.30**
4	Mbarara	1.56	4.76	4.51	**3.10**
5	Masaka	1.03	3.84	3.60	**2.70**
6	Tororo	1.22	4.48	4.43	**4.08**
7	Lira	1.08	3.93	3.74	**3.15**
8	Gulu	1.11	3.32	3.50	**3.88**
9	Fort Portal	1.00	4.27	4.32	**3.56**
10	Kasese	0.90	3.82	3.76	**3.25**
11	Kabale	1.49	4.33	4.23	**4.60**
12	Arua	1.03	3.80	3.93	**3.75**
13	Bushenyi	1.30	4.42	4.62	**4.08**
14	**Soroti**	**0.97**	**3.05**	**2.71**	**2.88**

ME = Perceived Effectiveness Score; PROCESS = Process monitoring orientation; OUTPUT = Output (Metrics) monitoring orientation. EC (performance improvement) is the main dependent variable because the main modulator variable (ME) relates to performance change. In addition, the study aims at detecting the effects of monitoring modes (measured by attitudinal indicators) on performance improvements.

non-parametric Krustal-Wallis one-way ANOVA was carried out on all the sub- items of the survey (principal- agent) variables. Table 2 shows that purification of the pilot study instrument improved the internal consistency of the main study research instrument. This is seen from the H_a values, which are less than the chi-square critical values for all variables. These results clearly show that all sub-items under each variable load on the same underlying composite variable.

RESULTS AND DISCUSSIONS

Table 3 shows the mean utility attitudinal scores for each principal-agent dimension. The outliers in each utility score were eliminated by deleting scores more than 0.5 points away from the group mean. The remaining scores were then re-averaged to obtain the scores indicated under each variable in the table.

EC represents technical efficiency change analysed by looking at model specification in Table 4 and log-linear frontier distance function (1) for all utilities in question (Mugisha, 2007).

$$-\ln(x_{Kit}) = \alpha_0 + \sum_{m=1}^{M} \alpha_m \ln y_{mit} + \sum_{k=1}^{K-1} \beta_k \ln x_{kit}^{*} + \phi_1 t + \phi_2 t^2 - u_{it} + v_{it} \qquad (1)$$

(i = 1, 2…N; t=1, 2 ….T) and $x_k^{*} = x_k / x_K$

Where t represents time (t = 1, 2 …T), the Greek-coefficients are unknown technological parameters to be estimated and (i = 1, 2…N = number of firms), y_S and x_S are outputs and inputs respectively. The model is applied on data from 15 NWSC Utilities, whose summary statistics are presented in Table 5 (Mugisha, 2007).

Specifically, the model is represented by dependent and regressor data which is computed as shown in Table 6 (ibid.). We use Frontier 4.1 (Coelli, 1996) to estimate efficiency measures for each sub-utility for the period 200-2006. We then exclude Kampala (since it is not being considered in the survey) and calculate efficiency change for each utility for a time shift 2003 - 2004, a pe-riod of our survey. In this case, efficiency change for each utility is computed as model efficiency (2004) divided by model efficiency (2003).

The relationship between the managerial perceptions of monitoring effectiveness and the actual technical efficiency change for the year 2003/2004 is first investigated

Table 4. Input distance function specification.

Variable	**Indicator**
Inputs	Pipe Network Length
	Operating expenses (including depreciation)
	Staff (labour)
Outputs	Water billed/Water Delivered (%)
	Connections
Efficiency Parameter	Maximum earnable utility specific incentive /Employee Basic Pay (%)

Table 5. NWSC Summary Statistics 2000-2006.

Variable	**Mean**	**Standard Dev.**	**Minimum**	**Maximum**
Inputs				
Network Length	164	245	31	1,149
Staff (No.)	72	128	15	548
Opex. (Ushs/year)	2,301,289	5,285,632	198,315	24,351,848
Outputs				
Water Billed/Water del. (%)	77	11	49	95
Connections	7,165	16,012	597	93,929
Eff. Parameter				
Max. earnable incentive /Employee basic pay (%)	31.49	30.99	1.20	111.02

Table 6. Model dependent variable and regressors.

Variable		**Computation**	**Symbol**
Dependent variable		-log(net. length)	-x3
Regressors (ind. variables)	Output	log(water billed/water del.*100)	y1
		log(connections)	y2
	Normalised input	log(staff)-log(net. length)	x1-x3
		log(opex)-log(net. length)	x2-x3
	t-trend	Time	t
		time-squared	t^2
Efficiency explanatory variable		Max. earnable Incentive/basic pay*100	z1

[1] The computations are carried out based on deviations from sample means e.g. y1 = ln(y1) – ln($y1_m$), $y1_m$ is the sample mean of y1s; x1-x3 = (ln(x1)-ln($x1_m$))-(ln(x3)-ln($x3_m$)) where the notation m again refers to the sample mean.

because the questionnaire final survey results are applicable in that period, by design. A Pearson correlation analysis for the EC and ME scores gives a significant relationship coefficient of 0.652 ($c_{critical}$ = 0.532, at the 5% level) . This means that the agents' perceptions that actions of the performance monitor enhance their production processes are positively associated with technical efficiency change. The associations between the other two principal-agent dimensions (PROCESS and OUTPUT) and perceived monitoring effectiveness are now investigated. Since all the scales in this case are ordinal, the Spearman's rank correlation analysis (Thorne, 1989, p. 305- 06) is used. The analysis gives the following coefficients (Table 7).

From this analysis it can be seen that all the relationships are positive, and the relationship between perceived monitoring effectiveness and the process monitoring orientation is statistically significant. These results suggest that the NWSC Head Office uses all the orientations in implementing monitoring activities, which are all positively associated with perceived monitoring effectiveness and technical efficiency change. Given that the

Table 7. Spearman's correlation matrix.

	Process	Output
ME	.094*	0.37
EC	0.61*	0.31

*Significant at 5 percent level.

Table 8. Descriptive statistics.

	Process	Output
Mean Score	86	3.59
Proportion above 3.00	93	3.91

the mean technical efficiency change (from Table 3) is 1.13, all the orientations are associated with technical efficiency improvement (movement toward the frontier). Computing the mean score values we derive the following results (Table 8).

The mean scores, given a Likert scale of 1 = Strong Disagreement sliding to 5 = Strong Agreement, suggest that the monitor is viewed by the agency utilities as having applied all the orientations. This result is further supported by the large proportion of individual utility scores (which are above 3.00), that is calculated to be more than 85%. A comparative analysis of the Spearman's rank correlation coefficient analysis for all 59 attitudinal scores is carried out to check the stability of the associative relationships above since the process of averaging the 59 respondent scores into utility scores could have changed the perception scenario. The analysis gives coefficients of 0.661 and 0.153 for the associations of ME versus PROCESS and OUTPUT perception scores, respectively. The coefficient relating to PROCESS scores is significant at the 5 percent level. Also the coefficient for OUTPUT scores still exhibits a positive relationship although its significance is much less.

CONCLUSIONS AND POLICY IMPLICATIONS

Players in the water sector especially in Africa need not use climate change as cover and scapegoat for water stress problems. The approaches implemented by NWSC clearly show that water scarcity problems, even where there are residual climate change challenges, can be addressed through use of innovative and home-grown management strategies. The NWSC experience underscores the importance of effective demand management and resource optimization with innovative efficient management programmes, tailor-made water loss reduction activities, use of economic criteria for plant expansion and raw water source protection and effective stake-holder coordination. A number of emerging infrastructure management lessons can be distilled from NWSC case study. These include improving performance through a series of innovative performance contracts/programmes, use of performance based incentives and strong custommer focus.

In order to ensure effective infrastructure optimisation, the study underlines the role of performance monitoring. The empirical evidence from NWSC cross-section survey data (2003-04) suggests that both process and output monitoring orientations (measured by attitudinal indicators) are positively correlated with perceived monitoring effectiveness of the performance monitor/regulator (principal) and subsequently effeciency change of operating utilities (agents). This result contributes to infrastructure management literature and policy debates in a number of ways. First, traditional models separate the monitoring activity of the principal from the production processes of the agent. The recent thinking is that the information sets available to both the principal and the agents differ, and the design of optimal incentives has been at the heart of economics research in this area for over two decades. This study outlines an important issue that has not been adequately researched: the extent to which feedback and information flows from the principal to the agent could improve the capacity of the agent to conduct business. The emphasis has been only on performance outcomes rather than on how meaningful synergies could develop from both the "outcomes" and the requisite "inputs and technologies". Such interactions have not been emphasised in theoretical literature; hence this research helps to direct attention to this important issue. Second, the study findings contribute to the ongoing debate as to what performance monitoring approach works in varied operating environments, given that cultural differences may produce differences in enforcement styles (Baldwin and Cave, 1999). Given the result that interactions are essential, as the NWSC case has revealed, the findings send significant signals to policymakers involved in designing ways to monitor units/departments operating under incentive contracts. In African water utilities, the variety of staff capacities that may be necessary to carry out an effective monitoring/regulatory activity can be a limiting factor.

The result that both performance outcomes and inputs/technologies are important monitoring elements posts significant implications for infrastructure management practice. Specifically, the result suggests varied propositions for the monitoring/regulatory policy in situations where local operating capacities have started evolving and international operators face significant market entry risks, and hence cannot enter at affordable prices. In this case the monitoring/regulatory framework design must take the principal-agent feedback/interaction issue earnestly, if the design is to be effective and practical. A design derived from developing countries, whose operating contexts are different, will probably remain theoretical in the face of "hands -on" utility managers in low-income countries and may be resented and shelved. Feedback/

APPENDIX:

QUESTIONNAIRE ELEMENTS

SECTION I: Output Monitoring Orientation

There are different methods of monitoring to achieve agreed performance objectives. The methods vary from performance monitor to performance monitor. Please tick the choice that best describes your experience with the key decision making performance monitors in the last 12 months.

Item	While trying to ensure that you meet agreed performance, the performance monitors: (Read below)	**Strongly Agree**	**Agree**	**Not Decided**	**Disagree**	**Strongly Disagree**
		5	4	3	2	1
1	Are concerned with achievement of performance standards in the contract and not how the operator does it					
2	Are very keen not to engage in the operator's operational strategies and management					
3	Comparison of the operators performance to other utilities is only based on achievement of performance outputs and not the processes involved (only performance standards count)					
4	Performance comparisons with other operators are only based on quantitative performance outputs					

SECTION II: Input/Process Monitoring Orientation

As stated above, there are different methods of monitoring to achieve agreed performance objectives. The methods vary from performance monitor to performance monitor. Please tick the choice that best describes your experience in the last 12 months.

Item	And/or, while trying to ensure that you meet agreed performance, the key decision making performance monitors: (Read below)	**Strongly Agree**	**Agree**	**Not Decided**	**Disagree**	**Strongly Disagree**
		5	4	3	2	1
1	Regularly look at the operators management systems and advise on possible improvements					
2	Regularly carry out field visits/audits and give technical advice on how to overcome problems					
3	Get interested in knowing the practical problems hindering the operator's efforts to improve performance.					
4	Are keen at advising the operator on aspects of operations where efforts could be put to achieve performance targets					
5	Regularly ask the operator how things are going before receiving a report on performance for that period					
6	Are always interested in knowing how the operator plans to improve performance					
7	Carry out deliberate activities aimed at disclosing how the other operators do it to succeed and how they failed in some aspects to encourage learning					

SECTION III: **Monitoring Effectiveness**

As you are aware, the performance monitors are supposed to help you deliver agreed performance levels.

Item	To what extent, do you think the key performance monitors' efforts (talking to you, taking decisions, monitoring the contract etc) contributed, in any way to the improvement of performance in the following areas in the last 12 months?	**Very greatly**	**Greatly**	**Undecided**	**Very little**	**None**
		5	4	3	2	1
1	Reduction of water losses in the distribution network					
2	Increase of water production					
3	Reduction of water losses in the water treatment plant					
4	Optimal use of staff to improve operations					
5	Increase of water connections through marketing					
6	Construction of new water extensions to serve new customers					
7	Application of the right tariff to maximise billing					
8	Extending services to high water-consuming customers					
9	Reduction of time taken to process and install new connections					
10	Reduction of under-billing errors					

Do you have any other specific comments or suggestions that could be useful in improvement of performance monitoring to improve the operator's service delivery initiatives? This could be a specific compliant.
……
……………………………
I WORK IN …………………………………………………AREA
Thank you for the time and effort you have spent in answering the questions. We are grateful for your support and co-operation.

/interaction is particularly important in designing suitable process- benchmarking platforms, as part of managerial capacity enhancement initiatives in African WSS utilities. The research study evidence suggests that such platforms can be significant performance drivers, especially in settings where the agent (whether private of public) may have significant operational capacity gaps.

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