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The practice of integrated asset management in Ugandan small towns

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ABSTRACT

Integrated asset management (IAM) has been promoted by international agencies and academics as a promising approach for water utilities in developing countries. These IAM frameworks present logical and linear approaches to managing a utility's infrastructure. In this article, we contrast these frameworks with the everyday practice of asset management in seven small towns in rural Uganda. In rural areas of Uganda, utility managers operating and managing assets need to maneuver between political demands, demands from the Head Office, inadequate resources, and limited capacity. As a result, the practice of asset management necessarily deviates considerably from the logical steps identified in many IAM frameworks. Without diminishing the relevance of the more conceptual IAM frameworks, the article suggests that for IAM to become more impactful for practitioners in rural areas and small towns in developing countries, these contextual factors need to be taken into account.

Key words: Asset management, Everyday practices, Small towns, Water supply

HIGHLIGHTS

- Practices of asset management in resource-constrained contexts are more complex than infrastructure asset management frameworks often suggest.
- The prioritization of extending service coverage to achieve SDGs may come at the cost of sustainably managing infrastructure assets.
- Asset stripping, in which existing assets are stripped to repair infrastructure failures, is a common practice in resource-constrained contexts.

INTRODUCTION

In Sub-Saharan Africa service coverage for basic water supply services is 87% in urban areas and 49% in rural areas (WHO/UNICEF, 2021). As concerning as these figures are, the actual service coverage figures are likely to be much lower due to challenges in the operation and maintenance of infrastructure assets (Hukka & Katko, 2015). Ageing infrastructure leads to high rates of physical leakage (Imonikhe & Moodley, 2014), which contributes to the high non-revenue water (NRW) for most African water service providers/utilities with reported figures ranging from 40 to 50% (Van den Berg & Danilenko, 2017; Macharia *et al.*, 2020). Illustrative of the state of water infrastructure is the fact that 30% of African water infrastructure needs immediate rehabilitation due to ageing and/or non-functionality (Briceño-Garmendia *et al.*, 2009).

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Infrastructure development and its management play a central role in the continuous improvement and provision of quality water services. However, balancing infrastructure development and management with the objective of achieving a desired service level acceptable to all stakeholders remains a challenge (Kalin *et al.*, 2019; Pathirana *et al.*, 2021; Shin *et al.*, 2022). Water utility managers must balance these asset goals while operating in a context of limited financial resources and capacity (personnel and technology) as well as inaccurate or non-existent data. These limitations make it difficult to assess asset risks, inform decisions on resource allocations, or identify gaps within the infrastructure systems (Burr *et al.*, 2013; Boulenouar, 2014; Kumasi *et al.*, 2019). These challenges are further exacerbated by the rising demand for drinking water from a growing population (UNDP, 2018).

In this context, many water utilities have embraced integrated asset management (IAM) as a prudent solution. IAM is presented as a coordinated approach to structure the decision-making for infrastructure maintenance (routine maintenance, rehabilitation, replacements, etc.) and management (resource allocation). The IAM frameworks usually follow a linear implementation approach to achieve coordinated management of assets (see next section). Fit-for-purpose IAM frameworks have gone further (Too, 2010; Pathirana *et al.*, 2018) to incorporate more local factors to render these frameworks useful in developing country contexts.

Although we appreciate such frameworks and the emphasis they place on the maintenance and management of infrastructure assets, relatively little research has been done to examine how the practice of asset management compares with such frameworks. In this article, we examine the practice of asset management for water providers operating in small towns. We show that the practice of asset management in such small towns deviates substantially from the linear, step-wise approaches stipulated by most IAM frameworks. This deviation is explained by several factors. First, the strategic objectives of a water utility may not align with the asset management objectives of a utility manager. Second, the limited resources available to a utility manager mean that the nature of asset management is determined more by the creativity and initiative of the individual manager, rather than the application of a linear framework. The arguments presented in this article are developed using the case study of seven small towns managed by the National Water and Sewerage Corporation (NWSC) in Uganda. Prior to analysing the practice of asset management in small towns in Uganda, the article first elaborates on IAM frameworks in the water services sector.

INTEGRATED ASSET MANAGEMENT

Infrastructure assets for water supply provision concern the physical components of water service delivery systems (e.g. pipes, pumps, water meters, generators, storage tanks, valves, etc.) while their management refers to the processes and decisions that determine the operation and maintenance of these components (Boulenouar, 2014). IAM can be defined as a '*systematic and coordinated set of activities and practices through which an organisation optimally and sustainably manages its assets and asset systems, their associated performance, risks and expenditures over their life-cycles to achieve its organisational strategic plan*' (BSI 2008). On the one hand, IAM considers the existing state and nature of the infrastructure assets used for providing water services. On the other hand, it considers the desired level of service that the water utility seeks to deliver (Brown & Humphrey, 2005; Pathirana *et al.*, 2018).

The concept of IAM has existed for about 50 years with its initial conceptualization and implementation taking place in developed countries[1]. In this context where the existing water infrastructure already delivers the desired

[1] Asset management can be traced to as far back as the 1970s with its first conceptualisation and implementation provided by the UK oil and gas industry. In the water sector, however, it was not mobilised until the 1980s (Jones *et al.*, 2014).

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service level, asset management focuses on maintaining the value of infrastructure assets during their life span by prolonging their ability to provide optimum performance. In other words, asset management is geared to minimizing service interruptions due to asset breakdowns while extending the lifespan of the assets (Alegre *et al.*, 2013; Boulenouar & Schweitzer, 2015; Pathirana *et al.*, 2018).

Over the past decades, (international) development partners have presented IAM as an approach to address infrastructure management challenges in developing countries for two main reasons. The first is that most of these utilities are seeking to mimic the success that these frameworks have had in developed countries. These service providers are often desperate to turn their assets' performance around as they struggle to keep up with growing populations, service delivery inequalities, constrained budgets, and escalating asset management costs (Hutton & Varughese, 2016). The second is that utility managers can showcase to investors, donors, and development partners that their water utility is a good asset steward that adheres to internationally recognised asset management practices (Jones *et al.*, 2014; Humphreys & Schwartz, 2018). Showing adherence to such practices is important for water utilities in developing countries as it increases their chances of accessing pivotal capital investments.

Implementing IAM

There are essentially two levels of asset management implementation: operational and strategic. Operational IAM deals with the practical business of keeping the infrastructure in working condition. The strategic level involves the integration of the user needs, the environment, and the business functions of the organization (Too, 2006). In the past, many asset management approaches focussed on the operational aspect by simply monitoring asset condition and performance and using the data to plan for eventual reactive and corrective maintenance needs.

However, water utilities operate in complex institutional environments. Utility managers are tasked with achieving ensuring both universal service coverage and financial viability of the water utility while operating in a volatile political context (Schwartz *et al.*, 2017). These factors play an important role in determining resource allocation and decisions about water infrastructure. Decisions about water infrastructure are thus not limited to operational decisions, but also encompass economic, social, and environmental cost considerations associated with the design, construction, and operation of assets (Mootanah, 2005). It is the strategic form of IAM that has become popular in many developing countries (Too, 2006; Pathirana *et al.*, 2018).

The IAM framework

Although a variety of IAM frameworks exist[2], they often follow similar steps. Below the 'standard' steps in IAM frameworks are presented.

1. Establish an asset portfolio

The starting point of the IAM frameworks is obtaining data on the assets themselves, the service needs of the population to be served, as well as the environment within which the assets operate. Most utility asset registers normally include physical data like asset condition (age and operational capacity), specifications (design capacities), and non-physical data like the current market value and the asset's expected useful lives (Marlow *et al.*, 2014). The process of data collection during IAM is a repetitive process that ensures the information that is pertinent to the proceeding stages is always accurate and up-to-date.

2. Establish the demanded/agreed service level

[2] For additional IAM models see Alegre *et al.* (2013), Burr *et al.* (2013), and Mnguni (2018).

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Working towards an agreed level of service is the cornerstone of IAM. Utilities, therefore, must clearly define service level targets with agreed indicators and corresponding benchmarks. The service level can be defined by establishing the level of performance the system can deliver as well as the affordability of the service through tariff design. The service level often depends on the existing capacity of the assets and resources available (supply) in comparison to the current/future-projected number of consumers that require the service (demand). This determines the quantity, quality, and reliability of the service be expected. Monitoring of the service level, then, is usually done by assessing various indicators like the daily supply hours, water quality parameters, supply water pressure, and NRW (Boulenouar, 2014).

3. Understand asset failure mechanism to establish risks

In the third step, service levels are linked to possible risks that cause assets to fail. This risk assessment process relies on an understanding of how assets deteriorate and fail. In the water sector, common failure risks pertain to:

1. Pipelines – These assets deteriorate progressively over a long time through either scoring, calcification, or corrosion.
2. Electrical and mechanical assets – These assets are typified by abrupt failures due to the high risk and vulnerability of the system function when individual sub-components fail.
3. Civil structures – These assets also deteriorate progressively but unlike pipelines, they can be easily maintained through regular preventative maintenance (Boulenouar & Schweitzer, 2015).

In addition to these system risks, assets may also fail because of external forces. Natural calamities that cause physical damage to assets may also be considered risks for the infrastructure assets.

4. Prescribe pragmatic maintenance methods

Various maintenance approaches can be identified in managing infrastructure assets. These include 'do nothing', light renewals, rehabilitation, and (partial) replacement (see Boulenouar & Schweitzer, 2015:5). Most water infrastructure systems will adhere to a combination of maintenance approaches. Upon understanding the modes of failure and the desired service level, the utility manager decides on a combination of maintenance approaches that the manager considers appropriate and affordable given the available resources.

5. Develop a long-term financial plan

Upon completing the previous steps, a practical plan to finance the actual implementation of the different maintenance activities is to be designed. Such a finance plan essentially has two components. Firstly, it requires an in-depth understanding of all the costs of the asset system and/or its individual components over their full life-cycle[3]. Secondly, the utility manager needs to plan asset management on the basis of a realistic revenue stream as this income needs to cover the asset management expenditures that the water utility envisages (Burr *et al.*, 2013).

6. Evaluate the IAM process and reiterate

After implementation of the IAM framework, the cycle is completed by an assessment of the utility's asset performance, its attained versus desired service level, and the achievement of its asset management financial plan. This is followed by an analysis to determine whether the data that the system relies upon are changing (natural environmental conditions like climate, political factors, demographic changes, service level alterations) which would mean the targets would also need to change accordingly (Marlow *et al.*, 2014). This

[3] For a detailed account of all assets' costs during its lifetime, see Fonseca *et al.* (2011).

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process also allows for new technologies or methods to be introduced if they allow IAM to be implemented more efficiently and/or effectively. Once this evaluation is completed, the IAM cycle starts again from step 1.

METHODS

Primary data were collected through 38 semi-structured interviews which were held between November 2021 and February 2022. Interviews were held with the NWSC small-town strategic and tactical asset management staff (19), management of the NWSC Head Office (7), Kampala Water Operations (6), Kampala asset management-departmental staff (4), as well as key external informants (2) working in the Ugandan water services sector. The data obtained through the interviews were triangulated with other data sources. These other sources include secondary data sources like Uganda's water sectoral and NWSC policy documents and reports as well as field observations at various stages of the IAM implementation process in the small towns.

Case study: small towns in Uganda

The selection of the NWSC as the case study was based on its ambition to implement IAM in all its service areas. The utility is also one of the biggest and most decorated water utilities in the developing world (Tutusaus & Schwartz, 2020). Moreover, since 2013, the NWSC has been taking over the management of water services in Uganda's small towns. Small towns often have a more challenging market to serve (Tutusaus & Schwartz, 2020) with relatively elaborate infrastructure assets to service a small population.

In Uganda, three categories of small towns are distinguished. These towns are primarily categorized based on their population size, economic potential, as well as the nature of WASH infrastructure. Category one small towns have fewer than 1,000 water connections with most averaging around three to five hundred. These towns are usually located further from other larger towns and are relatively isolated. Category two towns usually have a total of more than 1,000 water connections but often less than 2,000. These towns are more strategically located and often host the major administrative headquarters as well as regional offices for major private-sector entities like commercial banks and telecommunication companies in their districts. Category three towns have more than two thousand connections but less than six thousand. These towns are often located closer to larger cities and can be viewed as satellite towns for these urban centres.

To understand the practice of asset management, seven small towns in two NWSC service areas (Table 1) in Eastern Uganda were selected based on the size and characteristics of the towns.

Table 1 | Overview of Case Study of Small Towns.

NWSC AREA	Towns/Branches	Number of water connections	Average daily supply (h)	Average failure downtime (h)	NRW (%)
MBALE	Nkoma	4,373	17	3–5	40
	Bugema	5,693	22	3–5	50
	Sironko	1,449	19.5	7–30	33
	Budadiri	1,053	22	8–30	54
	Butebo	398	7	4–48	32
BUKEDEA	Kachumbala	563	14	2–30	32
	Bukedea	1,001	17	4–48	40

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IAM AT THE NWSC

The Ministry of Finance, Planning, and Economic Development adopted a policy entitled '*GoU Asset Management Framework and Guidelines (AMFG)*'. The policy outlines the various roles and responsibilities of critical asset-managing officials in government entities under the different ministries (Accountant General's Office, 2020:15–20). In the water sector, asset management is indirectly organized (without a formalized policy document) through two relevant policies. The first is the National Water and Sewerage Corporation Act of 1995 the roles and responsibilities of various levels of asset managers from the staff to the Board of Directors (BoD). It also specifies the regulations of how the NWSC has to handle its finances and structure its corporate plans in conjunction with other legislations like the Public Finance Management Regulations 2016 and The Public Procurement and Disposal of Public Assets (PPDA) Act 2003. The second is the National Water Policy of 1999 gives the NWSC the power to set tariffs with provisions for tariff indexation that would allow for cross-subsidization in WASH service provisioning (Mugisha & Berg, 2007, 2008). It also discusses the operation and maintenance of water/sewerage supply in small towns. It provides guidelines for private-sector participation and also reinforces all previous water policies and statutes.

The introduction of IAM at NWSC dates back to 2010[4]. Introduction stemmed from the desire to reduce the high NRW that had stagnated at 37%. Previously, planned preventive maintenance had rarely been done with reactive/breakdown maintenance being the predominant maintenance approach (Echelai, 2013:7). Additionally, the corporation was struggling with the high costs of asset management and development due to urbanization and population growth within existing service areas[5]. At that time, NWSC had 27 urban towns and was in a process of acquiring more towns (Mugisha & Berg, 2008: 306). As a result, its asset portfolio was rapidly growing as NWSC became responsible for servicing these towns[6]. This situation led NWSC to identify IAM as a key strategy for achieving the targets of its corporation plan of 2012–2015[7]. The choice for IAM was based on three factors. The first was that the international water community promoted IAM as the best-practice to asset management. This was reinforced by the development partners that the NWSC had turned to for funding and expertise support like the World Bank, who also promoted IAM as the best strategic solution for NWSC[8]. In addition to these external factors, also NWSC staff that received training related to IAM in developed countries championed the introduction of IAM at the NWSC[9].

Initially, the NWSC had little to no expertise regarding IAM and so it needed to gain capacity[10]. As explained by a senior NWSC staff member: '*The corporation was really interested in asset management, but there was no one with the expertise and proper knowledge of what it is… My supervisor was also learning to know what asset management is, so we began to read and check out what this thing called asset management is. So, we took about a year of just studying, checking out, and benchmarking from elsewhere [partner water utilities & development partners] what happens in the asset management field…*'[11].

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[4] Interviewees AM1, AM2, MB1, MB7.

[5] Uganda's estimated urbanisation was at an average annual rate of 5.5%, with a population of 34.1 million people with approximately 1.7 million living in Kampala (Echelai, 2013:2).

[6] Interviewees AM1 and AM2.

[7] Echelai (2013), Interviewee AM2.

[8] Echelai (2013), Interviewees AM1 and AM2.

[9] Echelai (2013), Interviewee AM1, AM2.

[10] Interviewee AM2.

[11] Interviewee AM2.

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The procedure for rolling out IAM in the NWSC consisted of establishing an asset management strategy, developing an asset management plan, and then a policy that was to lead to a change in the existing asset management culture. This corporate policy was intended to be implemented in all of NWSC's service areas. The implementation of the corporate policy proved to be problematic, however. NWSC's financial and other capacity limitations meant that it could not guarantee that asset data could be registered nationwide. An additional limitation was that 90% of the utility's staff had no idea what IAM was[12]. The NWSC also had to deal with resistance from the existing 'rule-of-thumb' practices. Staff were familiar with this rule-of-thumb approach, which was arguably also faster and cheaper in the short term[13].

Faced with these challenges, the NWSC top management decided in 2012 to pilot IAM in only one of the service areas. For this pilot it selected Kampala, as it had the most infrastructure assets and where expertly trained staff were available to coordinate its implementation[14]. Following this pilot, the NWSC began introducing the IAM systems/practices that were working well in Kampala to the other service areas including the small towns that were being added yearly from 2013. While the IAM policy had not been formalized through a binding document, it was informally implemented through action plans, infrastructure management programs, and information-based decision systems[15].

With time, however, the politically driven ambition to expand water services to small-town populations began to compete for the same resources as those designated for the management of existing assets. The allocation of resources to services expansion left the implementation of IAM unsupported and local actors predominantly resorted to the 'rule-of-thumb' practices they knew could be executed with fewer resources[16]. During this time, NWSC's service coverage and the number of connections grew by over 107 and 60%, respectively, in 4 years. As a result, until early 2018, implementation of the IAM policy outside Kampala was limited[17].

THE PRACTICE OF IAM IN SMALL TOWNS

In analysing the practices of implementing IAM in the seven selected small towns of the NWSC, this article examines three dimensions namely: (a) the people that make decisions, plan and execute maintenance actions, (b) the money to financial asset management, and (c) the systems that are relied upon to provide data on infrastructure assets.

The people: IAM actors

Three levels of actors are relevant in the practice of implementing asset management: (a) the NWSC top management at the Head Office, (b) small-town system managers and technicians, and (c) the asset operators like attendants and operators who actually physically operate and maintain the assets.

Top management at the NWSC Head Office makes decisions about NWSC's financial, human, and technical resources allocation. This includes determining and approving capital and operational expenditure budgets for each area based the areas' annual billing and collection figures[18]. The emergency operational budget, used for unplanned works, is also allocated at this level. It is also at this level that each area and small town's KPIs are

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[12] Interviewee MB7, AM2, HO1.

[13] Interviewee HO2, HO6, MB1, MB3.

[14] Interviewees HO1.

[15] Interviewees all HOs, MBs, BKs, SPs, and KWs.

[16] Interview AM1, AM2, MB1, MB2, MB3, HO2.

[17] Interview AM1, AM2, HO1, HO2, ES1.

[18] Interviewees MB1, MB2.

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set and monitored each financial year with rewards given to the best performers and penalties given to the worst performers[19]. In setting the capital and operational expenditure budgets, the Head Office largely fixes the boundaries within which lower levels managers will need to operate and manoeuvre.

Below top management, the local strategic management represented by small-town managers and technical specialists are responsible for allocating/planning resources for maintenance. They directly supervise the work of operators and determine performance levels for the individual systems. At this level, decisions are made by senior officers like engineers, accountants, procurement officers, and (branch/area) managers[20]. This level largely represents the linchpin between the Head Office in Kampala and the everyday asset management practices on the ground in the small towns.

Finally, the asset operators are the ones who have daily interaction with the assets. As the everyday operators, they are critical to the performance of the infrastructure assets[21]. Most of the information concerning the assets is 'stored in their heads' which has been gained through experience or through discussions with other asset operators. These operators ultimately decide how assets are managed. While their agency is limited by the resources that are availed to them, they decide what to report, prioritize how the assets are to be operated, and which maintenance activities to undertake. Based on the everyday challenges they contend with, they interpret and modify the IAM corporate policy so that they can deliver water services as quickly as possible within the envelope of available resources.

In addition to these three levels of actors, external actors also have a bearing on what happens in the IAM process. For example, the power and influence of local councillors, members of parliament and mayors in small towns often put pressure on small-town managers to use water infrastructure assets in a particular way or to prioritize certain maintenance activities. In doing so they also influence how available resources for asset management are used and allocated. Areas that have leaders with higher bargaining power will often be allocated more money for maintenance and management of assets. Both small-town managers and the Head Office in Kampala, need to maintain good relationships with these political leaders who are instrumental in approving the NWSC programs and budgets from the national to the local levels[22]. These external actors can also work to the benefit of small-town managers and operators. These political leaders may influence decision-makers at the NWSC Head Office to ensure the town's asset management needs are given the highest priority during the budget review process. As explained by a senior small-town manger: *'The pressure [from our politicians] means that Head Office is always willing to help us with most of our challenges since they also want to make these big shots happy'*[23]. There is also a down-side to this, however. Small towns without such politically powerful leaders will receive less resources for asset management as the resources that would have been used for them are diverted to politically more powerful areas.

The money: financing IAM

Contrary to many IAM frameworks which start with the existing state of the infrastructure in relation to a desired level of service provision, NWSC's small towns start with resources that are made available by the Head Office. The resources available for capital and operational expenditures are predetermined by the financial department at the Head Office. These budgets are determined on the basis of different factors. First, the historical budgetary

[19] Interviewees HO2, HO4.

[20] Interviewees MB1, MB2.

[21] Interviewees MB3, MB11.

[22] Interviewees MB4, BK1.

[23] Interviewee BK1.

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allocations from previous years form the basis for setting up future ones. Second, the level and improvement of revenue billing and collection in the previous financial year(s) influences the budget allocation for asset management. In other words, the higher the billing and collection level of a small town, the bigger its budget allocation will be. Thirdly, the context-specific nature of operations, for example vulnerability to natural disasters or hilly topographies that require higher operational expenditure allocations, impact the budget allocated[24]. Finally, as highlighted in the previous section, political influence from external actors may result in a higher budget allocation.

Taking thresholds that have been established by the Head Office into account, the area management teams come up with a proposed budget and present this at a regional workshop. After a review and negotiation process at this workshop, a draft budget is prepared and sent to the top management for approval[25]. These draft budgets are then discussed by NWSC's top management and Board of Directors. Before they are approved, more budget cuts are made to ensure the budget meets NWSC's strategic direction and that of the government, while leaving some funds available for unexpected costs. Since the NWSC is fully government-owned, the budget is then sent to the Parliament of Uganda for approval upon which the funds are delivered to the area in the new financial year quarterly[26].

In determining capital expenditure and operational budgets, priority is often placed on items that extend services or that would allow the area to bring in more money to the corporation. This emphasis on revenue generation can be traced to the need for the NWSC to operate on the basis of cost-recovery. How important a maintenance activity is to ensure a desired level of service appears to be of secondary importance. One of the small-town senior technical specialists working in the small towns explained how this happens in practice, '*Asset replacement is not a top priority in NWSC, you will find that when it comes to time for budget approval, it is usually the first vault for budget reallocation for capital [development] projects…*'[27] This means that in determining budgets available for asset management, the Head Office's interests determine the priorities. Given that service extension is a major need in many small towns across Uganda, the Head Office prioritizes service extension over asset maintenance.

The revenues collected from water sales by small towns are usually lower than those of bigger towns which in turn means that their budgets will be equally lower[28]. The logic behind this approach is that the NWSC, as a commercial public utility, needs to ensure sufficient revenue generation. Service disruptions in larger towns/cities impact NWSC's revenue flows much more than those in smaller towns. Therefore, to safeguard its revenue coffers, towns that generate more revenue receive larger budgetary allocations for asset management. While this is a pragmatic approach that fits the regulatory environment in which the NWSC operates, it often pushes small-town managers to run water assets beyond what could be considered prudent in order to raise higher revenues and therefore secure higher asset management funding. A senior static plant manager at Head Office illustrates this practice as follows: '*I often tell them [small-town pump attendants] to run the pump for about ten hours and rest it for two, but the area [management] teams tell the attendants to keep pumping so that they can sell more water*'[29].

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[24] Interviewee MB4.
[25] Interviewee MB1, MB2, MB4.
[26] Interviewees MB1, MB3, MB4.
[27] Interviewee MB3.
[28] Interviewee MB2, MB3.
[29] Interviewee HO6.

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In addition to securing budgets, managers in small towns also need to lobby to have their approved budgeted items delivered within the financial year. Here the managers rely on connections with staff in the authorizing departments and engage with them frequently to appeal to them to prioritize the small town's asset requests. They may also need to escalate their requests from planned activities to those of an emergency nature in order to have them given more priority[30]. This pressure is used at almost all stages from budgeting to the award of the contract for work/supplies. '*The ability to get all our funding requests depends on how well we can 'escalate' matters so they are not ignored by Head Office. It is all about 'creating pressure*'[31]. Even with this lobbying arrangement, small towns are usually only able to access 60% to 80% of their planned budgets[32]. This means that some assets are either partially maintained or postponed to the next financial year.

At the same time, the dire state of assets, regardless of the small town's size or billing, requires funding to keep them functioning beyond the budgets that have been allocated for this purpose[33]. Given these resource constraints, operators at the lowest level either do not undertake maintenance activities or strip down an asset they consider less critical and use its parts to maintain another asset that is considered more critical. These practices were described in detail by one of the Head Office senior managers, '*You see something, you can't fix it because you don't have money to buy a spare part […]. So, you vandalise one item from this asset to fix the other one… Therefore, most of the [assets] in the areas are left to rot away, so we end up asset stripping!*'[34].

Because of the persistent gap between the financial needs for asset management and the funds available, small-town asset managers are often faced with the need to borrow funds. A small-town manager often has no choice but to secure funding outside the NWSC resources to keep assets running[35]. This was also corroborated by a senior manager at HO: '*When [top] management teams go to the areas, they harass managers to lay pipes even when money has not been sent. What happens then is that [small town] managers most times will use their own money or even borrow…*'[36]. While the NWSC reimburses these borrowed funds, it creates a conflict-of-interest where asset managers become part-time investors who contract work out to themselves and then also supervise the same work[37].

The systems

Asset registers

When it comes to asset information recording systems, experience is the most widely used asset register in NWSC's small towns[38] as measured data are often unavailable[39]. Relying on experience allows for work duties to be executed faster since the decision makers who are the very custodians of the information can react faster to the multiple breakdowns that occur daily. Finally, experience is used because it incorporates details of current and previous asset conditions and performance[40].

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[30] Interviewees MB1, MB2, MB3,MB4, BK1, SP1, HO2.
[31] Interviewee MB2.
[32] Interviewee MB1.
[33] Interviewee MB1, MB2, MB3, HO2.
[34] Interviewee HO2.
[35] Interviewees MB7, MB5, MB2, MB15, BK1.
[36] Interviewee HO2.
[37] Interviewee HO2.
[38] Interviewees MB14, MB15, KW6.
[39] Interviewees KW3, SP1, MB3
[40] Interviewees MB3, MB7, MB10, MB11, MB12, MB13, MB14.

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The other asset register available are the GIS block maps. These maps store asset details like length, size, pressure rating, and location of pipes, fixtures (like valves and reservoirs), and other civil structures like pump houses. What they do not indicate, however, is the maintenance history of these assets or their present condition[41]. In the small towns, these maps are mainly used by the commercial teams for locating customers to obtain their meter readings and/or disconnect them. As it relates to asset management, these registers were only used by engineers to plan for asset replacement or make designs for service extensions[42]. The limited use of these maps also rests in the unavailability of enough functional and software-enabled computers to access these maps. Additionally, many small-town staff lack the necessary skills to make use of these maps especially for asset management decisions which do not relate to extensions or replacements[43].

Online asset registers are the newest of all information systems. The most commonly used are the Customer Relations Management (CRM), Computerized Maintenance Management System (CMMS), E-procurement, and E-inventory applications. The CRM stores information on the status and details of current and previous maintenance works, which are input by the very staff involved in the asset management process. While this system is available to all actors, only technical specialists like engineers and technical supervisors make full use of it. This is because most plumbers lack the necessary computer-literacy skills to make use of them[44]. Additionally, the reactive nature of maintenance works means that inputting information into the CRM comes secondary to actually finishing the job on ground[45]. Given that the CMMS is still in the initial stage of being rolled out, many asset operators had not heard of it and so its usage was almost non-existent. While it is user-friendly as staff only need to be able to operate a smartphone to engage with it, it has not been readily accepted yet. The first reason is that asset operators are irritated by the additional responsibility of inputting raw data which they have recorded physically in books or their heads. Secondly, not all staff have good quality smartphones to run the CMMS properly. More than that, staff feel that the daily internet costs required to use this application is an expense they cannot meet given that the NWSC is not providing an allowance for this expenditure[46].

Relying on the experience of individual actors means that the accuracy of data is difficult to assess as it depends on how much an individual knows or can recall about an asset. Moreover, the actor may have an incentive to use/present knowledge on assets strategically depending on their own personal interests[47]. Small-town asset managers often conceal and/or alter the true details of the condition/performance of their assets due to fear of being penalized for bad asset performance. As explained by a Head Office senior manager: '*We are very well aware that many of the areas falsify their water production figures so that they can portray a good NRW performance yet the situation on ground is bad… Part of this is to be blamed on us, because once accurate information of the situation is provided, people [local asset managers] are bashed…To avoid this, they have learnt to fidget with figures…*'[48]. Where data are unavailable, estimates are made using experience to fill these data gaps. While these data are better than no data at all, it is often exaggerated again to present good performing assets. '*Even the meters*

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[41] Interviewee AM3.

[42] Interviewees MB3, MB11, MB1.

[43] Interviewees MB10, MB12, MB13, MB3.

[44] Interviewees MB10, MB12, MB13, MB3.

[45] Interviewees HO1, HO2, MB1, HO6.

[46] Interviewees AM1, AM3, ES1.

[47] Reports of abuse are not uncommon with some staff requesting for more materials than will be used, so they can keep the extra for private work (Interviewees MB3, MB2).

[48] Interviewee HO4.

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sometimes are defective, so estimates are made to favor the performance of the area which is seen to be doing well and they even get awards [for exemplary performance]'[49].

The online registers also have their fair share of accuracy issues. Firstly, not all maintenance jobs are recorded in the CRM, it is only those that require repair materials or those that come through the call centre[50]. So, this means the details of repair works that do not require materials from the store are seldom captured. Additionally, the computer-illiterate plumbers use other staff to input these details for them. Moreover, since updating the system is never a priority, jobs are often completed without the details being entered[51]. What results is a system with a mixture of accurate, missing, and inaccurate data that is meant to inform IAM planning and decision-making.

Maintenance strategies

Reactive maintenance was found to be the most common approach employed in the small towns. Light renewals are used to repair a fault in order to restore equipment to functionality as quickly as possible. This implies that the assets' lifespan is only prolonged in the short term and the risk of reoccurrence is high. Because this option is the quickest and cheapest in the short-term, it is usually the first option considered and adopted[52]. An experienced senior technical staff explained that *'[w]e are forced to touch only where it is itching…Not all breakdowns require immediate attention, some are bigger than others'*[53].

Planned preventive maintenance was a familiar approach in the small towns but was only used for critical or high-risk assets that are prone to fail more frequently. Such assets typically include electromechanical plants that require constant servicing or replacement due to iterative wear and tear. Staff engaging with water treatment plant and distribution pumping equipment, have incorporated this approach into their work. However, how much and how frequently it is done depends largely on the financial allocation made available and how quickly it is received from the Head Office[54].

Asset replacement was the least relied upon method with most of the new assets used in water extension projects. Non-functional assets were commonly replaced with refurbished assets from other areas/branches with rare one-off new asset replacements. This process happens in three different forms. The first is where full replacement of an asset is done and this usually occurs when an asset critical to service delivery breaks down and cannot be repaired. This often means that funds have to be reallocated from a different budget to make this possible. The second form is through partial replacement of an asset. This usually occurs when full asset replacement is being done in phases or when the part of the asset that has failed is replaced to allow the entire asset to continue functioning. This is the most common form of asset replacement used because it is cheaper with less service interruption times. The third form is where full and/or partial replacement are done in a planned way through approved budgets[55]. This is the least preferred option of all the three by small-town asset managers because it takes a relatively long time, while their assets usually need replacement much faster.

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[49] Interviewee HO2.

[50] Since about 2019–2020, the NWSC implemented a policy that allowed repair materials to be provided for only maintenance jobs that are recorded in the CRM or CMMS systems. Jobs from the call centre are automatically placed into the CRM system by call centre agents (Interviewees HO3, HO4, HO5, MB3).

[51] Interviewee MB3.

[52] Interviewee MB12, MB13, MB14.

[53] Interviewee MB3.

[54] Interviewees SP1, SP2, HO6.

[55] Interviewees MB3, SP2, HO2.

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The result of this maintenance strategy of partial replacement is that old water delivery infrastructure assets are forced to coexist and function at the same level as newer assets in the service delivery systems. A common combination is to have new pumps steer water through old water pipelines into older reservoirs. The high efficiency of the new pumps can overpower the older assets leaving many leaks and bursts along the network[56].

DISCUSSION

Scholars like Pathirana *et al*. (2018), Boulenouar & Schweitzer (2015), and Tafazzoli (2017) argue that IAM is a system designed to address infrastructure systems that are in crisis and creates the building blocks for future-proofing service levels. In other words, these authors suggest IAM can deal with resource-deprived situations typically found in middle- and low-income countries. While we acknowledge the usefulness and need for decision-support tools to identify the challenges for asset management, our case study of seven small towns in Uganda nuances the applicability of IAM in such contexts. The IAM frameworks presented in this article suggest that asset management decisions start from assessment of existing infrastructure assets and relate this to a desired service level. Although this approach is seemingly logical, the practice of asset management in a small town is significantly more complex and messier than what the step-wise IAM frameworks suggest. The asset management approach in practice revolves more around using what's available and getting the best out of it, even though the assets might be run down in the process. In doing so, the asset management in practice contradicts the IAM approach.

Whereas the IAM frameworks focus strongly on the existing infrastructure assets and the desired level of service, it pays relatively little attention to the complex institutional landscape in which water providers operate. In the Ugandan cases, the institutional environment has a significant influence on how assets were managed. In these cases, the budget available for asset management is largely determined by the NWSC Head Office and, thus, is also strongly influenced by the strategic objectives and interests of the Head Office. Given the (inter) national emphasis placed on ensuring universal service coverage, these objectives strongly relate to service extension. This means that budget allocation for extension is favored over maintenance of assets. This finding also suggests an interesting impact of conflicting messages emanating from the global water community. As explained in the introduction, the global water community has increasingly promoted IAM as a promising approach to ensure sustainable water supply provision. At the same time this global water community also strongly emphasizes extending water supply services through initiatives such as SDG target 6.1, which seeks universal service coverage by 2030. The cases studied suggest that addressing these two, seemingly complimentary, dimensions simultaneously is a formidable task.

The mandate of the NWSC to operate as a commercial public entity means that the water utility prioritizes areas that are able to contribute to the organization's revenue stream. This is a logical priority given NWSC's mandate to operate as a commercially viable utility and so all its operational areas must contribute to this target. Small towns are therefore incentivized to focus their operations and the management of their assets on optimizing revenue streams and/or reducing costs (especially in the short-term), rather than managing infrastructure assets from a more sustainable, long-term perspective. Assets are thus operated and managed strategically to ensure the towns quickly generate revenues that offset invested capital and repetitive in the short-term. The challenge is that this approach tends to be much costlier in the long-term as the case studies have revealed.

The Ugandan cases show the peculiar relationship a water service provider has with its environment in reporting performance. Similar to other countries where increasing emphasis is placed on performance comparisons

[56] Interviewees MB11, SP1.

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(such as through benchmarking schemes), small-town water providers in Uganda also have to report their performance to their Head Office. In this process, they have an incentive to report a better performance than they may actually be achieving. In other words, the reported asset performance is often different from what the assets are actually delivering on ground. This implies it is possible for a small town to be seen as achieving its targets in the reports, yet the asset-performance on ground is below the desired standard. Additionally, these altered-performance figures are used to allocate resources for assets which are perceived to be in better condition, leading to a disconnect in the availed resources with those that are actually needed on ground.

Apart from these institutional factors that make the introduction of IAM complex, factors relating to the individual employee also impact its introduction and ownership by the service provider. Firstly, implementing IAM requires the support of the asset operators. However, they may be more comfortable with the traditional approach leading to opposition to the IAM approach. For some operators, the ad hoc and informal asset management practices of the past may be more lucrative than the IAM approaches forwarded by the Head Office. Secondly, these operators need to have the capacities and the resources to implement asset management activities. Without such capacity and resources, it is unlikely that the traditional asset management practices of the past will disappear.

The results presented in the previous sections also lead to questions about the promotion of IAM as a best-practice for asset management. IAM has been strongly promoted by the global water community. Utility managers seeking support (financial, expertise, technology) must present their utilities as being progressive and ready to implement best-practices for asset management. Brunsson has argued that 'organizations must demonstrate congruence with the values and norms of their environment in order to receive support' (Brunsson, 1986: 165). As such, the NWSC needs to show that it adheres to the best-practices of the global water community by developing an IAM policy, even if its actual implementation in small towns may deviate considerably from the policy-text.

CONCLUSION

Although we acknowledge the relevance and importance of IAM frameworks as an important management tool for water utility staff, we suggest in this article that the actual practice of asset management is more complex than these frameworks suggest. The neat, linear steps that these frameworks prescribe tend to be more muddled in practice. Moreover, the context in which a water provider strongly dictates the incentives and priorities that determine how infrastructure assets are being used and maintained.

The cases presented in this article also highlight the relevance of agency of the small-town manager in ensuring the continued operation of infrastructure assets. As far back as 1945, the challenges of small-town water services' provisioning were already touched upon by Dillery (1945:118) who wrote, '*A first class water works man in a small town needs the wisdom of a Solomon, the patience of a Job, the political tack of a Jim Farley, the tenacity of a General McArthur, the diplomatic ruthlessness of a Von Papen, the strength of a Pittsburgh steel worker and a doctor's degree in engineering*'. The case of the Ugandan small towns, which also identify the need of some small-town managers to pre-finance certain maintenance works or even borrow money to finance these works, suggest that also financing skills should be added to Dillery's list.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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