as the 'Technical Indicator Real Losses' (TIRL). TIRL equals Real Loss Volume/Service Connection/Day. TIRL is the best of these traditional indicators - but should always be calculated when the system is pressurized, to allow comparisons between systems with different levels of supply [55]. However, this indicator still does not take operating pressure into account, which is a major disadvantage. Thus, the best option would be Unavoidable Annual Real Losses (UARL), a methodology which takes account of the local factors of density of connections, location of customer meters on service connections, and average operating pressure [17]. The application of a performance assessment approach was undertaken at one local authority in Sub-Saharan Africa, the City of Harare.

4.3 Financial Indicators

There are many different financial indicators available, and it has been necessary to restrict the listing to those which are likely to be measurable in the context of government bodies whose accounting systems are not geared up to management accounting [62]. In urban water and sewerage systems, the efficiency of revenue collection is one of the most important indicators; many organizations simply do not collect the user charges from those to whom they send bills. Improving this indicator is one of the highest priorities for increasing revenue [62]. Thus, NRW performance assessment indicators play a very important role in enhancing service delivery efficiency of water utilities and these indicators are easily applied in developing countries.

5. Case study of the City of Harare

5.1 Background Information

A case study of Harare, Zimbabwe was documented in this paper. The Greater Harare Region has a population of about 2.1 million people. The average water losses are in the range of 60%. The case study sought to assess the level of management of NRW. The assessment was done following the self assessment methodology proposed by the International Water Association [7].

5.2 Harare Water NRW Performance Assessment

Self Assessment Matrix on Non-Revenue Water management for the best practice developed by Africa Development Bank [3] was adopted to assess levels of interventions for each NRW management strategy employed in Harare Water. According to Harare Water utility assessment matrix which was done for the Urgent Water Supply and Sanitation Rehabilitation Program for Harare in 2011, it was reported that, the level of NRW management in Harare is 3 out of 5 scores developed for the excellence in NRW management as shown in Table 5. This self-assessment methodology was adapted from the International Water Association (IWA) to assess the efficiency of water utility [60].

Table 5: NRW management assessment matrix for Harare Water

Level of Managemen	Level				
3	1 (Poor)	2	3	4	5(Excellent)
	No monitoring of NRW indicators.	% NRW monitored	% NRW monitored	Some actions are undertaken to reduce commercial or physical losses but without NRW managemen strategy.	IWA Water Balance available and regularly updated.
	No NRW managemen strategy.	Water Balance is available.	Water Balance available. Some actions are undertaken to reduce commercial or physical losses but without NRW management strategy.		Physical and commercial losses' performance indicators monitored.
		No NRW managemen strategy.			Regular NRW reductior activities as per a comprehensive NRW management strategy.
					Sufficient budget for NRW management

The NRW implementation level is divided into 5 levels. For each level, there is a range of scenarios that describes the implementation level in a given area ("1" is poor and "5" is excellent). The Self Assessment Matrix on Non-Revenue Water management for the best practice developed by Africa Development Bank [3] was adopted to assess levels of interventions for each NRW management strategy employed by Harare Water. The proposed assessment parameters for utility's NRW management are shown in Table 6. Table 6 presents the enabling factors for each of the strategies currently implemented and proposed respectively.

Table 6: Enabling factors and challenges for each implemented strategy

Strategies		Strengths (enabling factors)	Weaknesses (barriers to implementation)	Opportunities (for increasing the levels of interventions)	Threats (to the strategy)
CURRENTLY IMPLEMENTED	Pipe Replacement	Mains data for the areas that require pipe replacement is known	Construction difficulties in built up areas and water cut off during replacement	Employment of zone based customers in pipe replacement to increase participation	Financial Resources
	Pressure Release Valve (PRV) servicing	Data on PRV available	Corroded PRV	Use of PRV which can control pressure during off-peaks period	Resources
	Leaks and Burst repairs	Data on networks available	Manual maps in use	GIS asset management system	Resources
	Meter Replacement	All connections metered. Need replacement	Leaking and corroded service pipes and water cut off during repairs	Proper metering will increase revenue	Resources (funding, manpower) Vandalism (destroying)
	Task Force for active leak Detection	Pipe routes are known and accessible	Current slow pace of repairs – turnaround time	Increasing support for demand management	Funding
	DMAs and Pressure Management	Zones are well defined	Failure of valves, meters, pressure control valves	Increased water supply control -	Resources
	Improve metering (Bulk Meters in Supply and Distribution mains)	Data known, areas accessible	Water cut off during repairs	Employment of zone based customers in pipe replacement to increase participation	Resources
	Reduction of Night Pressure	Data on PRV available	Use of Fixed PRV which are not flexible	Flexible PRV to control pressure during off-peaks period	Resources

According to Harare Water Utility assessment matrix which was done for the Urgent Water Supply and Sanitation Rehabilitation Program for Harare in 2011, it was reported

that the level of NRW management in Harare is 3 out of 5 scores developed for the excellence in NRW management as shown in Table 5. This self-assessment methodology was adapted from the International Water Association's (IWA) to assess the efficiency of water utility [60]. However, this study showed that NRW management situation in Harare Water, considering strategies used and according to the ranking that was done referring to individual strategies, was 2.67 out of 5 representing 53.4% implementation of NRW strategies.

From the case study it was concluded that the implementation of NRW management strategies is just intermediate to minimize losses to the acceptable values as suggested by [59] and [23]. The improvement in the efficiency of the sector should go a long way in financing the need to improve access and/or quality of water production and distribution. Continuing the public or private financing of the sector without significant efficiency improvement is a major waste of scarce resources. Efficiency savings exceeds revenue from user fees which implies that average tariff levels continue to be too high as compared to what they would be if firms were operated efficiently [64]. The main challenges are however not in the water sector. Governance issues and the weakness of institutions have been and continue to contribute to a large share in the excess of costs [64].

6. Conclusions and Recommendations

NRW percentage by volume, Infrastructure Leakage Index and benchmarking methodologies thus play a pivotal role in assessing the efficiency of performance of water utilities worldwide. Whereas, performance assessment systems and benchmarking are useful tools for evaluating and improving WDS efficiency, their application in the water industry of developing countries is still limited. The systems and tools developed for the water industry may not be directly applicable to WDSs of the developing countries. As a result water utilities in developing countries should be more proactive in their operation and adopt international standards in their operations in order to match their developed countries counterparts.

The prospects for WLM lie in increasing capacity building of water utility employees, research, performance based contracting, emerging new equipment and technology for leak detection, and increasing dissemination of emerging "state-of-the-art" tools and methodologies for water loss reduction and performance improvement of utility water services. Operational performance efficiency is very vital for perpetuation of a sound service delivery. Many water utilities fail to identify and apply indicators appropriate and relevant to their operations. Thus, developing countries utilities should be capacitated to be able to apply assessment indicators in order to elevate their systems efficiency to international standards. This is mainly because their systems suffer from inadequate water supply, poor billing, and poor operation and maintenance records, resulting in exceptionally high NRW, and poor service delivery coupled with unrealistic water pricing. Water utilities and regulators of the operations of water utilities should make it a top priority that utilities operate within the right frameworks of efficiency assessment indicators. Thus, performance assessment systems including self assessment methodologies are applicable to the Zimbabwean situation.

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