Journal of Mines, Metals and Fuels, *71(12C): 349-356; 2023. DOI: 10.18311/jmmf/2023/47277*

Print ISSN : 0022-2755

Journal of Mines, Metals and Fuels

Contents available at: *www.informaticsjournals.com/index.php/jmmf*

Water Audit Practices in Indian Educational Institutions - A Critical Review

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Abstract

This study critically examines the water audit practices in educational institutions across India, aiming to identify the gaps and challenges in water management within these settings. With India facing severe water scarcity issues exacerbated by rapid urbanization and population growth, effective water management in educational institutions is imperative for sustainability and conservation efforts. Utilizing a mixed-methods approach, the research will encompass a comprehensive literature review, qualitative interviews with key stakeholders including administrators, facility managers, and Environmental experts, and quantitative data analysis of water usage patterns. By evaluating existing water audit frameworks, policies, and implementation strategies, the study seeks to assess their effectiveness and relevance within the context of Indian educational institutions. Furthermore, it will explore the socioeconomic, infrastructural, and behavioral factors influencing water consumption patterns and conservation efforts. The findings of this research aim to inform policymakers, educational administrators, and other stakeholders about the current state of water management practices in educational institutions and provide recommendations for enhancing sustainability and resilience in the face of water scarcity challenges.

Keywords: *Conservation Efforts, Environmental Experts, Policy Makers, Sustainability, Urbanization, Water Audit*

1.0 Introduction

Water audits were adopted in the late 1980s to address drought-related shortages, leaks, and losses. An audit evaluates an individual, group, system, etc. based on trial work. Water audits give a scientific basis for classifying all system water use[1]. It fights drought-related shortages, leaks, and losses. International Water Association (IWA) and American Water Work Association (AWWA) started a big initiative to analyze the reduced above-related problem with an audit. The finest water management tool is an audit. A water audit can identify and measure ways to reduce water usage and losses[2]. Besides managing water concerns, water audits and analysis can save taxpayer money and resources.

Banks typically issue statements for customers that show money pouring in and out of their accounts and debits and credits. Water audits show how much water enters, leaves, and is distributed to consumers. Financial audits are essential in business, but water audits are infrequent in public water sources worldwide[3].

1.1 Importance of Water Audit

Erroneous metering, illegal use, and customer distribution account for a small portion of water use[4]. A water audit determines water use and destination. The water audit's detail depends on system data. Water leaks happen in all systems for several reasons[5]. Lost water is poorly documented. Customers and the system pay for

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water loss. Utility companies cannot eliminate water loss. Water loss is unavoidable, and stopping it is not worth the cost. However, a water audit can help manage most water system loss. Operating a water utility is like any other business. India has 16% of the world's people, 4% of its land, and 4% of its water[6]. Averaging 50% of precipitation in fewer than 100 hours or 15 days, this water is used 365 days a year. India's yearly water availability per person is 1820 m, down from 6000 m in 1947. Current conditions necessitate water audits in India and worldwide. It helps discover public monies wasted due to water loss and unlawful connections, rather than the most efficient use of water resources while conserving the environment[7].

1.2 Advantages of Water Audit

1.2.1 Informed Decisions

Water audits help educational institutions make informed choices about resource allocation, like where to invest time and money for water management[8].

1.2.2 Efficient Use

Audits pinpoint areas of water loss, enabling schools and colleges to fix leaks and optimize usage, leading to more efficient water use.

1.2.3 Cost Savings

By reducing water waste, institutions save on utility costs and may avoid the need for expensive[9] infrastructure upgrades.

1.2.4 Revenue Boost

Proper metering and billing identified through audits can increase revenue, allowing for improved financial management of water resources.

1.2.5 Awareness Building

Audits raise awareness among students and staff about water conservation efforts, fostering a culture of responsibility[10].

1.2.6 Educational Tool

Water audits serve as an educational and public relations tool, showcasing an institution's commitment to sustainability and environmental stewardship[11].

1.3 Benefits of Water Auditing

1. Achieve water savings with cost-effective strategies and short payback periods.
2. Contribute to water conservation for a sustainable future[12].
3. Enhance competitiveness through operational efficiency and lower costs.
4. Minimize environmental impact and promote responsible water management[13].
5. Align with government guidelines for benchmarking water usage across industries.



Figure 1. Elements of water auditing (CWC, 2005).

1.4 Government Guidelines and Water Conservation

Water conservation is given priority by the latest government directives, which establish standards for water use in several industrial sectors[14]. Under the Jal Shakti Ministry, the Central Ground Water Authority (CGWA), mandates environmental compensation for customers who remove groundwater without the required certification. Any industry using more than 100 m3/day of groundwater is required to participate in an annual water audit and submit its findings to the CGWA within three months. Individuals who use more beyond 100 m3/day are also required to use suitable measures to reduce

their usage of groundwater by 20% over the course of the next three years[15].

1.5 Role of Water Audit in Conservation and Management

Demand for luxury industrial items is rising exponentially due to population growth and rising living standards[16]. Water sustains humans, plants, and animals. Since everyone needs water from birth to death, ancient humans settled around riverbanks. People may go weeks without food but not without water[17]. Three percent of Earth's water is fresh, while 70 percent is ice, glaciers, and groundwater. Consider using five liters of water and only getting one teaspoon of fresh water[18]. Lakes, rivers, and dams hold 0.26% of Earth's freshwater[19]. About 88.4 crore people need clean drinking water, according to a 2012 water aid report[20]. India averages 4 trillion m3 of rainfall, but only 1.123 trillion m3 is available, and it is unevenly distributed, with 1090 cm in Meghalaya and 10 cm in Rajasthan[21]. Drinking, brushing teeth, cooking, using faucets, watering gardens, and other daily actions require water. Water is scarce in some locations due to wasteful consumption. Some projects conserve water[21]. Uncontrolled water waste is high. Too little water, inefficient use, and unsustainable sources worsen this issue[22].

Loss of water has a significant impact. From an economic point of view, water waste is expensive[23]. Global water loss is expected to be substantial, amounting to roughly 3900 crore dollars year and 126 billion m3[24]. It is difficult to deliver clean water while conserving water resources since a significant portion of the water supplied is either stolen or leaks from distribution systems along the way, missing its intended consumers[25]. Water loss is regarded as a worldwide problem that has significant consequences for water management and calls for a carefully considered managerial approach founded on a greater understanding of the factors that influence and cause water loss[26]. Because water usage is well managed, a tool called Water-Audit is employed. One of the best ways to monitor water usage and encourage conservation is through water audits. The waterworks' operational efficiency and state of maintenance, encompassing those used for thermal power, irrigation, industry, hydropower, and home water supply, among others, are assessed using this methodology. The study's goal is to enable the water distribution network to more confidently evaluate non-revenue water and determine what steps may be taken to lessen non-revenue water economically[27].

The rising demand for water from urbanization and population growth exacerbates sustainability and conservation challenges[28]. Under these conditions, environmentalists and policymakers must address water scarcity immediately. Thus, water audits are crucial for assessing consumption trends and guiding water management programs. Audits provide valuable consumption data to decision-makers, enabling targeted conservation and informed infrastructure development[28]. Environmentalspecialists emphasize the need to prioritize conservation and encourage local residents to use water wisely. By working together and implementing preventive laws like water audits, urban areas can reduce scarcity and ensure the availability of this important resource for future generations.

2.0 Methods for Water Auditing

Here's an explanation of each method for water auditing in Indian educational institutions (Figure 2):

2.1 Source Evaluation

This step involves assessing the various sources of water available to the institution. It includes identifying the primary sources of water supply, such as municipal water, groundwater, or rainwater harvesting systems. The quality and reliability of each source are evaluated to understand the institution's dependence on external water sources.

2.2 Calculation of Authorized Consumption

In this step, the authorized or expected water consumption for the educational institution is calculated based on factors such as the size of the institution, the number of occupants, and the typical water usage patterns. This calculation provides a benchmark against which actual water consumption can be compared to identify discrepancies or inefficiencies.

2.3 Evaluation of Apparent Losses

Apparent losses refer to water losses that occur due to metering inaccuracies, unauthorized consumption, or billing errors. This step involves assessing metering

systems for accuracy, identifying instances of unauthorized water use (e.g., leaks, theft), and reviewing billing records to detect discrepancies. By identifying and addressing apparent losses, the institution can improve water management and reduce unnecessary consumption.

2.4 Evaluation of Real Losses

Real losses refer to physical losses of water caused by leaks, pipe bursts, or other infrastructure failures. This step involves conducting a systematic assessment of the institution's water distribution network to identify areas prone to leaks or losses. Techniques such as leak detection surveys, pressure testing, and hydraulic modeling may be employed to quantify the extent of real losses and prioritize infrastructure maintenance or repair efforts.

2.5 Performance Measurement

This final step involves evaluating the overall performance of the water management system within the educational institution. Key performance indicators (KPIs) such as water consumption per capita, water loss percentage, and compliance with regulatory standards are measured and analyzed to assess the effectiveness of water conservation efforts and identify areas for improvement. Performance measurement provides valuable feedback for refining water management strategies and promoting sustainable practices.

By following these methods for water auditing, Indian educational institutions can effectively monitor and manage their water resources, reduce wastage, and promote environmental sustainability.

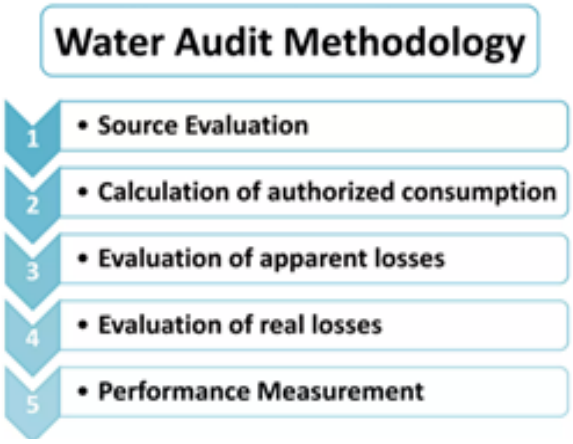


Figure 2. Water audit methodology.

3.0 Review Discussion on Water Audit

The Water Audit Report for School of Pharmacy, Centurion University of Technology and Management University in Sunkarimentu, Pitamahal, Rayagada sheds light on the institution's water management practices and infrastructure. With a primary reliance on bore wells, the campus ensures a steady supply of freshwater for various purposes, including drinking, domestic use, and construction projects. The report highlights the presence of three borewells on campus, each varying in depth and flow rate, collectively yielding 44 kilolitres per day (KL/day). This water is stored in nine overhead tanks, totaling a capacity of 44,000 litres, strategically positioned to supply water to different buildings via gravity. The distribution mechanism encompasses a well-planned pipeline network, delivering water from sources to storage tanks and further to usage points like taps in kitchens and bathrooms. Despite the absence of a metering system, an estimated daily water usage of approximately 86 KL/day is derived from accepted benchmarks, covering irrigation, domestic activities, and construction needs. However, challenges such as the disposal of wastewater and the lack of a comprehensive metering system pose areas for improvement. The report underscores the importance of implementing water accounting measures, installing flow meters, and adopting environmentally friendly initiatives to ensure efficient water management practices. Through these efforts, the institution can strive towards sustainable water usage and conservation, aligning with its overarching environmental policy of recycling, reusing, reducing, and recovering resources.

The water audit of the Digvijay autonomous post graduate college Rajnandgaon, Chhattisgarh reveals a comprehensive overview of its water resource management and consumption patterns. The institution primarily relies on its own water sources, including borewells and hand pumps, supplemented by municipal supply for staff settlements. Water is distributed through galvanized steel pipelines covering various facilities such as laboratories, gardens, hostels, and common areas. Borewells fulfill the majority of institutional requirements, with one borewell catering to 75-80% and another to 20-25% of the demand. Additionally, water coolers equipped with reverse osmosis and ultraviolet treatment ensure safe drinking water

availability across multiple locations on campus. The audit identifies laboratory usage as the primary consumer of institutional water, followed by gardens, bathrooms, hostels, and drinking water facilities. However, challenges such as inadequate wastewater disposal infrastructure and limited water conservation initiatives are evident. Suggestions for improvement include addressing drainage issues, implementing rainwater harvesting systems, and enhancing water reuse and recycling practices. Overall, the audit underscores the need for sustainable water management strategies to mitigate wastage and ensure the efficient utilization of water resources within the institution.

The water audit conducted by a team of experts provides a thorough analysis of water inflows and outflows within the G.D. Goenka Education City, Sohna Road, Guru Gram**,** offering valuable recommendations for water conservation. By implementing the suggested measures outlined in the report, significant water savings can be achieved across various areas of the campus. These measures range from the installation of water meters and aerators to the use of low-flow fixtures and the prevention of leakages. Additionally, future initiatives include the formation of a dedicated Sustainable Cell to monitor implemented measures, the revision of calculations based on adopted measures, and the implementation of a water management policy. Moreover, the institution plans to apply for water conservation awards and collaborate with the audit team to set up LEED ARC and LEED Lab, aligning with the United States Green Building Council's comprehensive approach to sustainability. Overall, the water audit report serves as a roadmap for enhancing water efficiency within the institution, aiming to position it among the leading institutions in water conservation and sustainability practices.

The water audit conducted at International Institute of Information Technology; Bangalore main campus emphasizes the importance of establishing an integrated water management framework to effectively conserve water resources. This framework considers various factors such as regional water quality and availability, socio-economic dynamics, and stakeholder perspectives. Historical data and current measurements serve as the baseline for assessing potential energy-saving measures and improvements recommended in the audit report. The recommendations include initiatives like replacing high-flow toilets and faucets with low-flow alternatives, retrofitting urinals with automatic flush systems, and implementing efficient irrigation practices for landscape areas. The audit underscores the need for prioritizing and monitoring the implementation of these proposals to quantify actual water savings achieved. Enspar Energy Solutions Pvt Ltd, the auditing entity, expresses gratitude to IIIT Bangalore and VAR management service for the opportunity to conduct the audit and offers continued support in implementing water conservation measures and sustainability initiatives within the facility.

The water audit report for the campus, Centurion University of Technology & Management Ramachandrapuram, Jatni, Odisha reveals a comprehensive overview of its water management practices. The utilization of diverse water sources, including borewells, municipal tankers, recycled water, and rainwater harvesting, ensures a consistent supply for various needs. The distributed system of storage tanks, coupled with a well-planned pipeline network, facilitates efficient distribution of water across the campus. Despite the absence of metering systems, the estimation of water usage for different activities demonstrates a proactive approach to resource management. Moreover, the campus's commitment to wastewater treatment and reuse reflects a sustainable approach to water disposal. Efforts to prevent water wastage through infrastructure maintenance, technological interventions, and awareness programs further underscore the institution's dedication to water conservation. However, there remains room for improvement, particularly in implementing metering systems for accurate data collection and identifying opportunities for enhanced conservation practices. Overall, the report highlights both commendable initiatives and areas for development in the campus's water management strategy.

The water audit conducted at the Kelappaji College of Agricultural Engineering in Tavanur offers a detailed examination of water usage, supply, and losses across various distribution points on campus. It emphasizes the significance of conserving water resources and identifies areas where improvements can be made to minimize wastage and ensure efficient water management. An important observation of the audit is the significant difference between the water supplied from the

overhead tank and the actual usage recorded at different distribution points. This indicates notable water losses occurring either due to leaks or unauthorized usage. The comparison between measured and estimated values reveals variations, particularly in areas such as staff duplexes and the farm nursery, suggesting potential areas for improvement in water conservation practices. The study puts forward several recommendations to mitigate water losses and enhance water management on campus. These include conducting thorough inspections of the water distribution system to detect and repair any leaks or damaged fittings, upgrading outdated fittings and replacing corroded pipes, implementing wastewater recycling systems to reduce overall water consumption, and launching awareness campaigns to educate campus residents about the importance of water conservation and ways to minimize wastage. Additionally, the suggestion to close the outflow valves of the overhead tank during nighttime when water usage is minimal is highlighted as a practical measure to reduce unnecessary water loss. Overall, the water audit underscores the necessity for proactive measures to address water wastage and improve water efficiency on campus. By implementing the recommendations provided, the college can effectively conserve water resources, reduce operational costs, and contribute to environmental sustainability.

The water audit at Ahmedpur, Maharashtra manifested that total demand of the municipal committee area was 4.04 million liters per day, including the losses of about 15 percent. The sources of water included the raw water from Limboti dam and Mannar reservoir. The study of water audit revealed that the losses in the system resulted from the leaks in the air valves in raw water rising mains and the overflow at the source. Most of the distribution pipelines were made up of GI or PVC materials were leaking. Water was being supplied to the consumer without being metered and the control usage was not looked upon effectively. Water rates were fixed on a flat rate basis for the consumers. The real losses accounted for 42 percent, while the nonrevenue water accounted to 65 percent of the total. Thus, this water audit helped an insight into the water losses occurring in the area.

Water Audit of Nagpur Municipal Corporation households' article, laid out the methodology of performing a water audit. The study included performing the water audit in five steps which included source evaluation, calculation of authorized consumption, evaluation of apparent losses, evaluation of real losses and measurement of performance. The source evaluation included surveying and measurement of the input given to the complete system. This was then followed by computation of authorized consumption by studying the billed metered consumption. Evaluation of apparent losses followed next, resulting from inaccuracies in water flow measurement, errors in water accounting and unauthorized usage. After this evaluation of real losses was laid in the methodology for finding out the amount of water that physically escaped from the system. The last step of auditing included measurement of the performance of the system by interpreting the information that has been collected.

The water audit report of Gandhi Memorial National College, Ambala Cantt, Haryana, for the year 2020-21 presents a detailed analysis of the college's water sourcing, distribution, storage, and quality. It reveals that the college primarily relies on borewells and connections from the Cantonment Board for freshwater supply, with various overhead and ground water tanks ensuring consistent availability across campus. However, the absence of water flow meters on sources hampers accurate consumption quantification. Despite satisfactory water quality test results, there's room for improvement in water-saving measures, particularly in gardening and rainwater harvesting. Suggestions such as adopting drip irrigation systems and implementing rainwater harvesting techniques underscore the report's focus on sustainability. Furthermore, the need for wastewater management, including the collection and treatment of wastewater for reuse, is highlighted. Overall, the report serves as a roadmap for enhancing water efficiency, reducing wastage, and promoting sustainable practices within the college campus.

The provided excerpt of Shivaji University, Kolhapur, Maharashtra, India emphasizes the importance of conducting water audit to identify and address losses in distribution systems. It introduces the concept of Unaccounted-For Water (UFW) and outlines the components contributing to water losses. Specific issues identified during audits include water overflow, wastage due to open taps, and damage to pipelines. Implementing modern techniques for measuring water loss and

addressing infrastructure deficiencies can improve operational efficiency and conservation efforts.

The water audit on Priyadarshini College of Engineering, Nagpur, provided valuable insights into the significance of conducting water audits to manage and mitigate losses in distribution systems. It outlines a structured five-step process for assessing system input, authorized use, and water losses, emphasizing the importance of accurate measurements and balanced inputs and outputs. The distinction between apparent and real losses sheds light on the different factors contributing to overall water loss, while examples illustrate the practical implications of small discharge rates over time. Overall, the excerpt serves as a practical guide for water utility professionals and policymakers, emphasizing the importance of effective water management for sustainability and resilience.

4.0 Conclusion

In conclusion, water auditing is vital for addressing water scarcity in Indian educational institutions. It identifies and tackles the challenges like shortages and leaks, informing resource allocation and promoting efficiency while saving costs. The discussion emphasized its benefits in informed decision-making, cost savings, and environmental stewardship, supported by government guidelines. Highlighting its role in guiding conservation efforts amidst rising demand, the methods outlined a comprehensive approach. Overall, water auditing provides a roadmap for institutions to manage resources, reduce wastage, and foster sustainability, ensuring water availability for future generations.

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