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Lack of Information is the Bane of Water Distribution Systems Maintenance Challenges in South Africa

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Abstract

Information is essential when it comes to the issues surrounding water distribution infrastructural damage and associated intrinsic problems. If information on any ravaged water infrastructure is not promptly shared or sent to the appropriate authority in order to take necessary step to fix the problem, this might have negative impact on water distribution and supply of potable drinking water to the people. This article demonstrates that damaged and defective water distribution systems such as water pipes are prone to contamination of water. To this end, there is need to report any damaged infrastructure noticed by citizen in order for the authority to promptly intervene and effect necessary repairs or maintenance. More importantly, the article highlights the importance of disseminating information on the health problems arising from drinking of contaminated water as a result of defective water distribution systems. It highlights the roles of water service providers in ensuring that they maintain effective and efficient water infrastructure administration and governance for the purposes of addressing the problems of water distribution infrastructural challenges whenever they occur. To achieve this, it is part of the civic responsibility of the citizens to report any water infrastructural damage or leaks to the authority. It also highlights the importance of constant maintenance and refurbishment of existing water distribution infrastructure by skilled and experts in order to be able to continue to provide unhindered quality water services. It emphasizes the need for access to clean water through the use of modern and up-to-date water infrastructures that are appropriate for water supply and distribution purposes. As part of the sustainable solution, it presents the usefulness of water safety plan in addressing the problem of water contamination and pollution. Over and above it highlights the significance of shared information on the issues regarding water and sustainable water infrastructural maintenance.

Keywords: Information; Report; Defective water infrastructure; Contamination; Health hazards; Water management plans; Water service providers

Introduction

It is common cause that the first information any water department or authority will provide to anyone is that water is important to human life and survival and by extension to agriculture and plant life. Water is also important to the earth and the ecological balance of the earth. Infrastructure is necessary for a country or an organization to run smoothly and some examples are building, transport, power supplies and water [1]. With regard to water infrastructure, this consists of bulk abstraction and conveyance infrastructure as well as local treatment and distribution [2]. Water distribution systems are component parts of water infrastructure which have significant pathways to ensuring that water is safe for drinking from the catchment source up to the end-users and consumers [3].

Obviously, water pipes are usually used for water distribution, however, they could constitute source of problems if they are old, leaking, contaminated or passed through unhygienic routes [4]. Therefore, detecting the problem on time and passing the information to the appropriate authority would amount to sustainable water distribution systems which is a means of sustaining the collection and distribution systems, treatment plants and other infrastructure that collects, treats and delivers water-related services to the consumers [5].

On a daily basis, the media and information sector of water department keep reporting and informing the general public that South Africa is experiencing problem of damaged water distribution systems throughout the country particularly in the informal settlements and the rural areas. Most of these systems have deteriorated and in the states of disrepairs. They asserted strongly that these problems are inhibiting the supply and delivery of clean drinkable water [6].

The Department of Water Affairs (DWA) is responsible for most of the bulk water infrastructure, as well as the

implementation of policy and regulation required to produce and supply clean, safe quality water to consumers [7]. Pursuant to this, in terms of the National Water Act (NWA) 36 of 1988 (NWA), the DWA is mandated to regulate all water resources of South Africa and it is also responsible for the prevention of pollution and contamination of water and also the protection of all water infrastructure in the country.

The NWA describes pollution as "the alteration of the properties of a water resource so as to make it, among others, harmful or potentially harmful to the welfare, health or safety of human beings" [8]. Against this backdrop, any damage to water distribution systems fall within the ambit of this description.

This is said against the backdrop that major sources of water pollution are as a result of pipe bursts and corrosive pipes which release chemicals or harmful substances into the water inside the pipe and contaminate it [9].

There is an ample information and a prolific literature on the right to access to water but research or information on water distribution systems and infrastructure that are being used to distribute drinking water from the centralised treatment plants or sources such as encashment, the water plants, water stations, and water reservoir to the consumers is very limited [10].

Water distribution systems are pumps, valves, storage tanks, reservoirs, meters, fittings and other hydraulic appurtenances [11]. These distribution systems represent vast majority of the physical infrastructure for water supplies to consumers and as such, in most cases, constitute the primary management challenge from both operational and public health points of views [12].

The discussions and the insights on the various challenges and problems emanating from defective and damaged water distribution systems spurs an appreciation of the multidimensional nature of the problem of access to clean potable water [13]. This article examines amongst other things, whether there is adequate information on the conditions of water distribution systems in South Africa and to what extent they are suitable for reserving, transmitting, distributing and supplying of clean and safe drinking water to the consumers [14].

In South Africa, lack of information on damaged water distribution systems is the major impediment to access to clean drinkable water [15]. It is against the backdrop of this problems that this article attempts at offering satisfactory solution which would enabled ample access to a safe drinking water through the use of sustainable water distribution systems.

In South Africa, the right to clean, accessible and adequate water is guaranteed in section 27(1)(b) of the Constitution of South Africa, 1996 which provides that "everyone should have the right of access to sufficient water." The Constitution also provides that water is a human basic need and it should be provided, realized and fully enjoyed by everyone. It is the responsibility of the Government to ensure that everyone has unhindered access to safe and adequate water supplies [16]. Disseminating information on clean and safe water are critically imperative considering the health hazards arising out of drinking of contaminated or polluted water. Therefore, the use of proper and functional water infrastructure is critically imperative for the purposes of distributing and supplying water [17].

Therefore, to achieve this outcome, the focus is on enforcing water quality standards at both the treatment plants and the distribution systems. Ideally there should be no change in the quality of treated water from the time it leaves the treatment plants until the time it is consumed [18]. However, in reality, substantial changes can occur to finished water as a result of complex physical, chemical and biological reactions [19]. It is against the backdrop of this that some reports of water borne disease outbreaks suggest that the distribution systems remain a source of contamination and this needs to be addressed in order to curb epidemic [20]. Hence, if water distribution systems are damaged and defective for whatever reason, then the water being conduit through it might be contaminated in the process and this might have negative impact on the health and well-being of the consumers [21]. Undoubtedly, this will be a blatant violation of the right to have access to clean drinkable water [22].

The problem continues because information on these problems is rarely shared [23, 24].

Therefore, the methodology for this article is literature review on damaged water infrastructure to establish the causes of water distribution systems challenges which in many cases have led to water seepage, spillage, wastage, water contamination and pollution and impact negatively on the health of the consumers as a result of outbreak of diseases from drinking unsafe water [25].

The Significance of Quality Water Distribution Systems

The significance of quality water distribution systems to ensure effective and efficient distribution and supply of water resource cannot be overstated. There is need for widespread awareness that these systems need to be carefully managed in order to deliver good drinkable water [26]. More importantly, water makes a huge contribution to the World's economy because it is used in virtually all aspects of social and economic activities [21]. Without a stable supply of clean, fresh water for human consumption and ecosystems, human would cease to exist [9]. Providing safe drinking water for the people who currently lack it is one of the greatest challenges facing many countries in the world today and South Africa is not an exception [27]. According to Pandey "water is the important constituent of life support system. No one can live and even dream to live without water." To have access to safe drinking water, water distribution systems are used to make the access meaningful. Having access to quality safe water means that all the infrastructural components that are required to supply water to the consumer are in good conditions and free from defects [28].

According to the Department of Treasury, South Africa (2015), infrastructure is defined as "immovable assets which are acquired, constructed or which results from construction operations or moveable assets which cannot function independently from purpose built immovable assets." While infrastructure delivery is defined as "the combination of all planning, technical, administrative and managerial actions associated with the construction, supply, renovation, rehabilitation, alteration, maintenance, operation or disposal of infrastructure." Accordingly, infrastructure delivery management contextualises the supply chain management system for infrastructure. Pursuant to this, "infrastructure is required by the state and state-owned businesses to deliver services to citizens." Water infrastructures perfectly fall within the ambit of this description because they are meant to provide and deliver water services to the people.

Nowadays, prosperous countries pride themselves based on the state of their nation's physical infrastructures. Infrastructures and in particular, sustainable infrastructures that have been put in place and exist in a country are usually being used to measure the advancement of the country's economic growth, development and standard of living indicators in modern day civilisation [29]. Poor infrastructure in a particular country portrays that the country is not doing well economically and hence, the citizens are presumed not to be prosperous and there is tendency and likelihood that they will be living below the poverty line [30]. Therefore, a viable economy needs good and modern infrastructure for the systems of transport, energy, water and waste management and social infrastructure to make life worth living. Modern infrastructure is driver of economic growth and development [31]. Over and above, availability of well-functioning infrastructure is required for good life and high standard of living, however, the lack of modern infrastructure amenities will produce contrary result thereof [32]. It has been medically proven that availability of good infrastructure in a country has positive impact on the people because of their potential to improving the quality and length of human life [33]. The Constitution of South Africa recognises this, the reason why the right to socio-economic goods, services and amenities are guaranteed in the Constitution, one of which is unhindered access to adequate clean and safe drinking water by everyone living in the country [34]. The Constitution also provides that the government should do everything within its available resources to promote, provide, realise and fulfil the right to access water. The implications of these constitutionally guaranteed access and right to safe drinking water means that the infrastructure needed to distribute and deliver water services must also be of good quality for optimal and safe water distribution and consumption [35]. Against the backdrop of this, water pipes being used to distribute water are expected to be in good conditions and should always be maintained so that they do not get corroded, busted and start leaking to the extent that water contained in them is contaminated and rendered unsafe for drinking and consumption [36]. The right to access to water is holistic in that water and the infrastructure to convey and supply water must be infrastructural proper and sound. The reality physically on the ground is that majority of water infrastructure in South Africa have aged and easily breakable and the water they retain is health hazard. Therefore, there is need to overhaul, repair or outright replacement of most of these water infrastructural amenities using Water Safety Plans Approach (WSPA) [37]. WSPA is described as "an improved risk management tool designed to ensure the safety of **drinking water** through the use of a comprehensive risk assessment and risk management approach that encompasses all **steps** in water supply from catchment to consumer." The WSPA approach was developed for purposes of organizing and systematizing a long history of management practices applied to **drinking water** and to ensure the applicability of these practices to the management of drinking-water quality. It draws on many of the principles and concepts from other risk management approaches, in particular the multiple-barrier approach and the Hazard Analysis and Critical Control Points (WHO, 2008). WSPA have also been described as "an effective way of ensuring that a water supply is safe for human consumption and that it meets the **health** based standards and other **regulatory requirements**. It is based on a comprehensive risk assessment and risk management approach to all the **steps** in a water supply chain from catchment to consumer" (WHO, 2008) [38].

Water Distribution Systems Challenges in South Africa

It is generally accepted that poor and old water infrastructure are the major challenges facing delivery of good and quality water services to consumers in South Africa [39]. Majority of them have been damaged and are not good for the purposes of distributing and supplying water to consumers due to internal and external stresses and other impacts such as weather effects [39]. There is notable insufficient maintenance of existing water infrastructure which has exacerbated the problem of deterioration [40]. Water distribution infrastructure challenges cause wastage of water. For instance, damaged and leaking pipes lead to loss of water wastage, pollution and contamination [41]. **Figure 1** depicts water leaks and water wastage scenario.

Figure 1: Typical water burst causing water wastage. Province, Gauteng City Johannesburg, District City of Johannesburg Metropolitan Municipality.

The DWA's report indicates that there is substantial maintenance non-compliance with regard to the National

Water Resources Strategy (NWRS) of September 2009 which was introduced for the purposes of ensuring that compliance routines are done as at when due. Pursuant to this, Wall admonished thus "infrastructure, once created, is unrelenting in its demand for maintenance and this demand will increase the longer it is ignored. Strong leadership and effective management are irreplaceable ingredients for successful and sustainable infrastructure provision."

Therefore, for sustainable infrastructure that will stand the test of time, consistent and persistent maintenance is key component. National Treasury-Standard for Infrastructure Procurement and Delivery Management 2015 defines maintenance as "the combination of all technical and associated administrative actions during an item's service life to retain it in a state in which it can satisfactorily perform its required function."

Addressing the water infrastructure problems connote that the right people need to be hired to carry out maintenance and repairs. To this end, highly skilled professionals with competency in water engineering and management are potent parts of the solution. This is said against the backdrop that there is problem of huge capacity shortage of water engineers and artisans which has created a huge gap in the aspects of repairing and replacing damaged water infrastructure.

Those that are available and currently working have inadequate capacity to embark on and do most of the engineering aspects of water infrastructure in terms of repairs, fixing or building new infrastructures in South Africa [42]. The problem is exacerbated by the failure of the government to invest enough money in water infrastructure upgrade and repairs. Where investment was made, corruption and nepotism have been the major hindrances to utilizing the money for carrying out repairs, replacement and fixed the problems. Officials and service providers have continued to embezzle money earmarked for fixing water distribution Infrastructure.

In order to properly maintain and upgrade the current water distribution systems, it has been estimated that about R1.4 Billion is needed annually. However, it is pertinent to point out that even if the money is made available, there could still be challenges in maintaining water distribution systems because the DWA is currently experiencing huge lack of skilled personnel to implement and supervise maintenance.

Worse still, few skilled personnel that are available are getting old and retiring while others have resigned to join the private sectors. It has been observed that wrong approaches or strategies have always been used to attempt to solve the problem and these have continued to fail because the focus has always been on "an isolated focus on capital expenditure rather than through life-cycle costing models. Life-cycle costs include capital and operating/maintenance expenditure requirements for projects, providing sustainable infrastructure."

Various professional bodies and the media have constantly been reporting that water distribution systems are at the end of their lifespan and will require upgrade or replacement. It has been reported that since 2006 "a disturbing mismatch between water demand and bulk infrastructure development has come to light.

This mismatch was precipitated by comprehensive failure to meet water demand management targets." The DWA are partially responsible for this because they have been complicit in the sense that the DWA is known for taking protracted and very long time in identifying or responding to serious infrastructure problems. This failure can only be attributed to symptomatic of the severe shortage of capacity within the DWA.

There is also available information on the fact that due to poorly maintained water distribution infrastructure, there is a serious problem of uncontrolled high level of pollution caused by water contamination as a result of defective and deteriorating water distribution systems as depicted in **Figure 2**.

Figure 2: Typical water pipe embedded in dirty sand within a dirty environment which will corrodes and contaminates water in the pipe.

Figure 3 shows that pollution and contamination of water are very pervasive to the extent that the water equipment that supposed to separate decanting of acid mine drainage which finds its way into the water reservoir and eventually water pipes is unable to perform this function because it has been severely rotten and damaged, therefore enabled the transportation of contaminated and polluted water to the end-users for consumptions [43].

Another critical challenge is that attention has been focused on building new water distribution infrastructures instead of investing more on frequent maintenance and improvement of existing infrastructures in order to create sustainability of water services to the consumers. Therefore, to alleviate this problem, "there is urgent need to implement water demand management (WDM) to align demand growth with bulk infrastructure development to minimize the risk of supply shortfall" [2].

Figure 3: Typical old and corrosive pipes which are not good for water distribution because they must have been contaminated. Drinking from this source will definitely cause health hazards. It is also a source of water borne diseases.

Health Problems Arising from Defective Water Distribution Systems

Obviously, there have been constant announcements in the media that polluted or contaminated water are the major contributors to health problems such as diarrhea and other hygiene-related diseases [44]. Water usually becomes polluted and unsafe for drinking as a result of defective or deteriorating water infrastructure as depicted in **Figure 3**.

The reason for this has been elaborately explained by Pandey thus "most of our water bodies have become polluted due to industrial growth; urbanization and man-made problems mainly the result of population growth. Poor sanitation and contaminated drinking water arising from human activity and natural phenomena create serious problems in human health."

The chief sources of water pollution are sewage and other wastes such as industrial effluents, agricultural discharges and industrial wastes from chemical industries, fossils fuel plants and nuclear power plants [45].

They create a larger problem of water pollution rendering water no longer fit for drinking, agriculture and, as well as for aquatic life. More than 2.6 Billion people-40% of the world's population lack basic sanitation facilities and over one Billion people still use unsafe drinking water. As a result of this, thousands of people die every day from diarrhea and other water, sanitation and hygiene-related diseases while many suffer and are weakened by illness [45].

In the KwaZulu-Natal Province in South Africa, there have been reports of waterborne diseases such as diarrhoea as a result of the intake of contaminated water in different parts of the country. Diarrhoea are largely caused by contaminated water and inadequate sanitation [46]. It can cause death especially to those who live in the informal communities that have poor sanitation facilities. Children are usually the hardest hit because their immune system may not be strong enough to accommodate or withstand the strong impact produced through the drinking of the contaminated water [47]. Therefore, the South African government has indicated that "the fear of an epidemic outbreak of waterborne disease in South Africa had always been a reality [9].

The country has witnessed a dramatic increase in the number of reported potential waterborne diseases, especially in the KwaZulu-Natal Province due to many communities relying on untreated water from surface resources for their daily supply, and/or do not have access to adequate sanitation facilities [9].

The World Health Organisation (WHO) finding revealed that the reason for high prevalence of water borne diseases was that "one-sixth of humanity lack access to any form of safe and improved water supply within 1 kilometre of their home and one-fifth of humanity lack access to any form of adequate and improved excreta disposal." This is a perfect example of the prevailing situation in South Africa where pipe borne water had been installed miles away from homes of the consumers [48].

People have to travel to go and fetch water with buckets and sometimes the buckets are without lids and during the course of transporting the water, harmful substances are blown into the water making it unsafe for drinking, yet the people will have to drink it for survival [49]. Often, this results in outbreaks of waterborne disease and causing sickness which can lead to loss of life and economic burden for individuals and the entire communities [41].

Addressing Water Distribution Systems Maintenance Challenges

Historically, the types and ages ofwater infrastructure in South Africa particularly the pipes that make up water distribution systems range from cast iron installed during apartheid era to plastic pipes being currently used nowadays need to be subjected to regular maintenance in order to sustain them [50].

It is pertinent to point out that most of these pipes have life spans and as such they do expire and need replacement. Pursuant to this, the DWA needs to make substantial investment in pipe assessment, repair and replacement for proper and adequate maintenance.

One of the strategies that have been suggested for ensuring the delivery of good drinking water is the adoption of a WSPs. Interestingly, the WHO has designed comprehensive guidelines for Drinking-water Quality (GDWQ) aimed to protect public health and eliminate the chances of water pollution and waterborne diseases from the water encashment up to the end users.

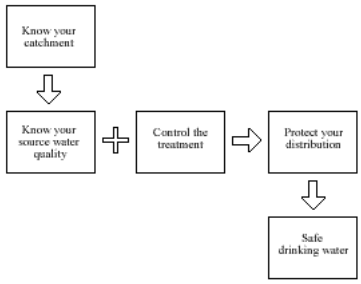

Figure 4: 'Catchment to consumer' approaches to risk management of the safety of drinking water.

Figure 4 shows the significant pathway to ensuring that water is safe for drinking from the catchment source up to the end-users and consumers. More importantly, the catchment source needs to be verified and confirmed for purity before transportation and distribution commences. There is also the need to ensure quality control to ascertain that all the equipment that will be deployed to purify and filter water are in good order and of good quality. The crux is that while all these measures have been taken, sanitary and maintenance measures for the distribution channels that will take water to the end users are very important and must be proper and fit for the purposes. Water pipes are usually used for distribution and in most cases they could constitute source of problems if they are old, leaking, contaminated or passed through unhygienic routes. Distribution needs to be carefully protected in order to avoid all these problems if outbreak of water-borne diseases is to be avoided. If distribution is perfectly protected, undoubtedly, it will result to the supply of clean and safe drinking water as demonstrated in **Figure 4**.

The WSPA is imperative because water suppliers have a duty of care to persons utilising the water or service that they supply and therefore they need to implement and comply with all regulations, statutes, guidelines, good practices and best management practices [51]. By so doing, there is likelihood that at all times; water supplied would be of quality drinkable water [52]. Water suppliers also need to be proactive in their businesses and dealings by ensuring that they asquint their operation in a duly diligent manner such that reasonably foreseeable harm is identified and prevented.

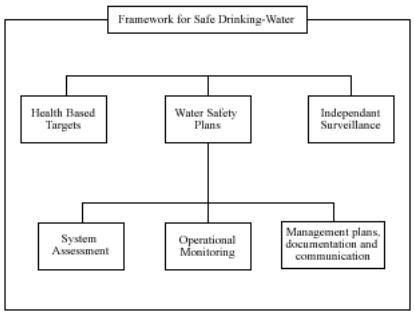

Figure 5: Framework for safe drinking-water.

In order to ensure the delivery of clean and quality water through WSPs, the processes should, as indicated in **Figure 5** comprise of system assessment and design, operational monitoring and management plans (including documentation and communication). These processes are expected to achieve, a health-based targets (based on an evaluation of health concerns); system assessment (to determine whether the water supply chain (from source through treatment to the point of consumption) as a whole can deliver water of a quality that meets the health-based targets; operational monitoring of the control measures in the supply chain, which are of particular importance in securing drinking-water safety; management plans (documenting the system assessment and monitoring; describing actions to be taken in normal operation and incident conditions-including upgrade and improvement), documentation and communication and lastly a system of independent surveillance that verifies that the all these measures and strategies are operating properly.

All these strategies and measures would become realisable and deliverable if there are strong administrative and political wills on the parts of the government and institutions established to see to it that water distribution systems are in good working conditions; and whenever there is report of a defect, it is attended to promptly. This will require constant monitoring, assessment and evaluation of installed water distribution infrastructure. And more importantly, implementation of the existing policies and regulations that pertain to the maintenance, repairs, refurbishment and replacement of defective or damaged water distribution systems should be of paramount importance in order to ensure effective and efficient distribution and delivery of clean and safe drinking water to the consumers.

Conclusion

Water distribution infrastructural maintenance, refurbishment, upgrade and replacement are a critical challenge in South Africa as it continues to impede ample access to clean, quality safe drinking water. These problems have become exacerbated because of lack of information that are readily available to the people on what they should do or where to report to whenever they see or experience these challenges. Similarly, lack of skills to maintain existing water distribution systems or to fix and replace the deteriorating and damaged ones has been identified as a major impediment to access to clean drinking. Health hazards emanating from damaged water distribution systems occur on a daily basis especially in the informal settlements where the indigents and the poor people live. The DWA needs to ensure that WSPA is implemented at all levels and at all times in order to isolate and remove harmful chemicals and contaminants from water. Distribution systems are very crucial to the supply of good quality water, to this end, pipes and other appurtenances required for this should always be in good order and state of permanent maintenance. Leaking pipes and other appurtenances should be promptly fixed or replaced in order to stop spillage, wastage and contamination of water contained in the pipes and reservoir. Persistent and continuous

substantial investments in water distribution infrastructural repairs and replacements are the solutions for the distribution and supply of sustainable clean, safe and quality drinking water. Over and above, curbing water infrastructural defects require the support of everybody and the responsible authorities have the duty to create widespread awareness on what should be done whenever there is any damage to any of the water infrastructure. Reliable and prompt information would, undoubtedly, be an important clue that could be used to take the first step to arrest the ugly situation before it gets out of hands.

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