

-RESEARCH ARTICLE-

## WATER PRICING AND ITS DETERMINANTS IN NAMIBIA

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### —Abstract—

As per the United Nations, the provision of affordable portable water is considered an inherent entitlement for every individual. The lack of global access to water is a prevalent issue, despite its status as a fundamental human right, primarily attributed to the exorbitant cost associated with its acquisition. The absence of effective coordination, inadequate planning and strategizing, suboptimal policy implementation, and the dearth of necessary regulatory mechanisms collectively contribute to the limited

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availability of affordable water access. The objective of this study was to ascertain the factors that contribute to the escalation of Nam water tariffs in the Khomas region of Namibia. The investigation employed a mixed-methods approach. There has been a notable rise in the Khomas region of Namibia. The study employed a mixed-methods approach. The research revealed that various factors influenced the pricing of water, including the type of water services, the conditions associated with water provision, water collection methods, water quality, pumping distance, facility costs, and the age of the water infrastructure. The study proposes the implementation of various measures to effectively manage groundwater resources, including the enforcement of water laws and regulations, the implementation of water protection and emergency preparedness protocols, the renewal of infrastructure, and the replacement of obsolete water systems. The study additionally proposed that Nam water's management should place greater emphasis on risk management and foster collaboration and integration among stakeholders in matters pertaining to water pricing.

**Keywords:** Water, Tariff, Infrastructure, Nam Water, Right

## INTRODUCTION

Water is a vital necessity for all living organisms (Baguma et al., 2013). The provision of both basic access to safe drinking water and the availability of water at an affordable cost are crucial (Mack & Wrase, 2017). The impediments to water supply include a deficiency in coordination, the absence of comprehensive plans and strategies, the ineffective execution of policies, and the inadequate availability of essential regulatory tools (Remmert, 2016). There is a need for universal accessibility and affordability of the mentioned resource (Sáez-Martínez et al., 2011). Consequently, it is imperative that the water tariff framework ensure the accessibility of water at an affordable price.

The equitable, reasonable, manageable, and just pricing of water is advocated due to the widely acknowledged recognition that the provision of clean water constitutes a fundamental human right. In light of the prevailing understanding that the provision of water is an inherent entitlement of individuals, it is important to acknowledge that this right is not universally realised, particularly in underdeveloped countries (Dungumaro, 2007). In the majority of nations, the responsibility for water delivery services lies with the state, which also assumes the role of establishing and enforcing laws and policies to facilitate the distribution of water.

Given the limited availability of water in Namibia, the Ministry of Agriculture, Water, and Land Reform (MAWLR) assumes the responsibility of effectively managing and utilising the country's water resources in a manner that safeguards both the well-being of the population and the environment (Water & Sanitation Policy, 2008). The establishment of the Namibia Water Corporation (Nam water) can be attributed to the

implementation of the Water and Sanitation Policy Framework (WASP). The primary objective of Nam Water, established in accordance with the Namibia Water Corporation Act, 1997 (Act 12 of 1997), is to provide bulk water services at prices that encompass all relevant expenses (NamWater Ltd, 2018). The objective of this study is to ascertain the factors that contribute to the escalation of Nam water tariffs in the Khomas region of Namibia.

## **Problem Statement**

The objective of this study is to examine the pricing of water and the factors influencing it in the context of Namibia. The purpose of this study is to examine the variables that affect the pricing of water in Namibia and to comprehend the manner in which these factors influence the accessibility and affordability of water resources across various sectors and socio-economic strata within the nation. This research aims to contribute to the development of effective strategies for sustainable and equitable water management in Namibia by identifying the key drivers of water pricing and examining their effects.

## **BACKGROUND OF THE STUDY**

Namibia is a sovereign nation situated in the southwestern region of the African continent, characterised by its geographical proximity to the Atlantic Ocean in the western direction. The region is renowned for its varied topography, encompassing the Namib Desert, coastal plains, and the Kalahari Desert. Namibia, with an estimated population of 2.7 million individuals, encounters considerable obstacles in the effective management of its water resources and the provision of accessible water for its inhabitants. Namibia exhibits a scarcity of water resources, primarily due to its prevailing arid and semi-arid climatic conditions. The nation's water resources predominantly originate from three primary sources, namely surface water, groundwater, and recycled or reclaimed water. Namibia is characterised by several prominent river systems, namely the Orange River, Kunene River, and Okavango River.

The determination and pricing of water are of utmost importance in addressing the water management challenges encountered in Namibia. The Namibian government has acknowledged the significance of sustainable and effective water allocation and has enacted several policies and regulations to govern water pricing and utilisation. The objectives of these policies are to facilitate equitable pricing, foster conservation efforts, and guarantee equal opportunities for accessing water resources among various sectors and socio-economic strata. The water sector in Namibia is subject to various significant factors that impact the determination of water pricing. The determinants encompass various economic factors, such as the expenses associated with the development, operation, and maintenance of water supply systems' infrastructure.

Additionally, they encompass the accessibility and cost of energy necessary for the treatment and distribution of water. Water scarcity, the effects of climate change, and pollution are just

a few of the environmental factors that have an impact on water pricing in Namibia. Furthermore, it is imperative to consider social factors such as affordability, equity, and the socio-economic ramifications of water pricing on marginalised communities. Gaining insight into the factors that influence water pricing in Namibia is of utmost importance in order to develop efficient policies and strategies that promote the long-term viability and fairness of water resource management. This study seeks to contribute to the development of suitable water pricing mechanisms in Namibia by analysing the factors that influence water pricing. The aim is to achieve a balance between the economic, environmental, and social aspects of water resource management in the country.

The distribution of water in Namibia is a financially demanding endeavour, primarily due to the substantial upfront investment required for infrastructure development and the ongoing expenses associated with its maintenance, as indicated in the Nam Water report of 2019. The Nam water Act of 1997 establishes that the pricing structure of Nam water is predicated upon the principle of full cost recovery, whereby all expenditures associated with the provision of water are accounted for and compensated. The Nam water rates are determined through a consultative process involving the Minister responsible for Water and are subsequently endorsed by the Cabinet. This process aligns with the principle of full cost recovery, which is employed in the tariff-setting procedure. The notion that the long-term viability of the Water Supply and Sanitation (WSS) sector is contingent upon its ability to attain self-sufficiency is widely accepted.

In the event that the service provider lacks access to suitable sources of funds, they will encounter difficulties in sustaining water services at rates that are economically feasible for the broader population. The Namibian government has expressed apprehension regarding the inadequate performance of the water sector, acknowledging the problem of ineffective water supply distribution across the country (Karuaihe et al., 2014). The categorization of Namibia as a "water-stressed nation" according to per capita water availability, as indicated by Karuaihe et al. (2014), highlights the significance of this matter. Karuaihe et al. (2014) presented additional evidence supporting the notion that the region's constrained water resources can be attributed to the increasing demand, escalating costs, and societal transformations in sub-Saharan Africa. The observed trend involves the government's active promotion of alternative providers or community initiatives to address the deficiency arising from its acknowledged inability to supply affordable water to its populace in the necessary quantity, quality, and timeliness (Zamani et al., 2021).

The regulation of water pricing within the water sector seems to lack a systematic approach, despite the establishment of the Water Regulator of Namibia, which has not yet commenced its operations. According to the Ministry of Agriculture, Water, and Land Reform, 2021<sup>1</sup>, the establishment of the Water Regulator does

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<sup>1</sup> [https://www.parliament.na/wp-content/uploads/2021/07/Vote38\\_Water.pdf](https://www.parliament.na/wp-content/uploads/2021/07/Vote38_Water.pdf)

not alter the current situation. Insufficient revenue collection poses a significant challenge for national water utilities in their efforts to uphold the integrity of the country's water infrastructure (NamWater Ltd, 2019). The equitable distribution of water expenses across various income levels is often hindered by challenges associated with defining water pricing and the structure of water tariffs. The provision of clean drinking water exhibits a certain degree of disparity among water consumers (Zhang et al., 2022). The increase in water rates has been observed to be disproportionate to the corresponding increase in water consumption, surpassing the national Consumer Price Index in certain instances. The unsustainability of these increases has been determined in the NamWater Ltd (2018).

The principal objective of this study is to ascertain the challenges encountered by Nam water in delivering water services within the Khomas area of Windhoek, Namibia. The primary objectives of this study are to ascertain the precise determinants that impact Nam water's adjustments to water tariffs in Windhoek, located in the Khomas Region. Additionally, the study aims to explore potential approaches for improving water service provision in the region, even in the face of escalating water costs.

## LITERATURE REVIEW

The study's theoretical foundation is based on systems theory, and it suggests that organisations can gain an understanding of adversity by examining the interconnections between different components and the overall structure of the organisation (Ashoori et al., 2017). Consequently, numerous factors play a role in determining the cost of water. Ali et al. (2022) defines systems theory as an interdisciplinary field that investigates systems, which are cohesive assemblages of interconnected and interdependent elements that can arise from either human agency or natural phenomena. Boland and Whittington (2000) posit that each system possesses causal boundaries, is subject to environmental influences, is characterised by its structure, function, and role, and is expressed through interactions with other systems.

The price of water, competition in monopolistic water markets, government restrictions, the pricing strategies used by regulated utilities, the interaction of demand and supply forces, consumer perceptions, and the purchasing power of customers are some of the things that affect water tariffs (Chu & Grafton, 2021; Hellwig & Polk, 2021; Kernan et al., 2017). Lower-cost providers have the ability to deliver additional quantities of water without incurring additional expenses. Lowering producer costs leads to an enhancement in supply. As the cost of water increases, there will be a corresponding decrease in the quantity supplied at a given price (Chu & Grafton, 2021). The cost encompasses various components such as labour expenses, expenditures on raw materials, and remuneration for staff members (González-Santander et al., 2022).

In the context of a monopolistic water market, sellers engage in price competition, thereby influencing the pricing framework within the sector (Hellwig & Polk, 2021). The decline in prices within the water market can be attributed to the intensification of competition among suppliers. In the event that customers value quality, service providers will react to an external increase in the quantity of suppliers by reducing their prices and improving their quality in a balanced Nash equilibrium (Kernan et al., 2017). It is incumbent upon governments to ensure a just and equitable allocation of essential goods and services at reasonable prices (Massarutto, 2020). In essence, the determination of commodity prices by the government is contingent upon the accessibility of water, and the escalation of taxes results in a corresponding elevation of costs and prices. Individuals may seek alternative options in situations where regulations impose barriers or increase the cost of accessing water (Li et al., 2022).

In contrast to an unregulated setting, the implementation of a price cap on a profit-maximising monopoly supplier of a singular commodity has the potential to diminish the quality of said product (Bjørner et al., 2021). The establishment of a higher price is possible when the demand for water exhibits inelastic characteristics, while a lower price can be determined if the demand is elastic (Chebil et al., 2022). In situations where supply remains stable and demand is robust, there is a possibility of price increases. However, in order to maintain competitiveness, prices must be reduced when demand experiences a decline (Yang et al., 2020). The influence of price on consumers' perceptions of cost and financial hardship has been observed in a study (Chu & Grafton, 2021). In the event that consumers possess greater purchasing power, they will be endowed with the capacity to allocate higher financial resources towards services and water.

If a group possesses limited purchasing power, they may opt for goods and services that are affordable (Favre & Montginoul, 2018). The effectiveness of a community is enhanced when it possesses knowledge regarding the age of a system, its maintenance budget, and the availability of funds for improvements (Molinos-Senante & Donoso, 2016). Chebil et al. (2022) highlight that ageing water infrastructure has emerged as a significant national concern. It is imperative for municipalities and utilities to undertake the replacement of their obsolete levees, reservoirs, and flood control systems. Based on Nam water's estimations pertaining to the Khomas region, it has been determined that pipe leaks contribute to an annual water loss or non-revenue amounting to approximately 15% (NamWater Ltd, 2020).

Climate change poses a significant risk to the global water system due to its multitude of hazards (Chu & Grafton, 2020). The aridification of the Earth's hottest regions is occurring due to the release of greenhouse gases. The cost of extracting water from deep boreholes increases due to the depletion of water tables caused by climate change, especially in instances where equipment malfunctions. Global water prices and tariffs will be affected by this phenomenon (De Clercq et al., 2018). The implementation of

regulatory measures pertaining to public drinking water serves to mitigate the adverse consequences arising from contamination for individuals utilising public water sources (Lewis et al., 2019). Legislation is enacted to prevent the occurrence of water contamination, waste, abuse, excessive consumption, and inefficiency.

Water suppliers in metropolitan areas have the crucial responsibility of being the primary providers of water. In order to avoid facing financial penalties, these suppliers must ensure strict adherence to the regulatory frameworks that govern water delivery systems (Massarutto, 2020). The inability to construct new water supply infrastructure is a common challenge faced by numerous bulk water suppliers, primarily due to financial constraints. The availability of grants and funding options is limited (Mu et al., 2019). A majority of respondents, specifically over 70%, reported that their inability to allocate sufficient funds and time hindered their ability to engage in investments related to disaster preparedness (Ashoori et al., 2017). The absence of a water supply emergency plan may lead to a significant loss of life and a subsequent economic downturn (Boland & Whittington, 2000)

The primary objective of this study is to examine the unique circumstances of Namibia, a nation located in southwestern Africa that is characterised by a scarcity of water resources. The research will make a valuable contribution to the existing body of knowledge on water pricing in Namibia's water sector by focusing on its unique challenges and characteristics. The results of this study will provide valuable insights that can be directly applied to enhance water management strategies and policies in Namibia. The objective of this study is to conduct a thorough examination of the factors that influence the pricing of water in Namibia. While previous research may have investigated certain facets of water pricing, the objective of this study is to comprehensively analyse the combined economic, environmental, and social factors. Through the examination of various determinants, this study aims to provide a comprehensive comprehension of the intricate factors associated with the establishment of water prices in Namibia.

## RESEARCH METHODOLOGY

The study employed a mixed-methods approach, integrating both quantitative and qualitative research methodologies. The study conducted in the Khomas region, specifically in Windhoek, focused on the utilisation of a phenomenological qualitative research approach to explore the qualitative dimension of the issue. The aim was to identify potential solutions that could enhance the delivery of water services, even in the face of rising water tariffs, with the assistance of Nam Water Namibia. The research utilised a descriptive survey design to investigate the factors that influence the water rates of Nam water in the Khomas region of Namibia. The study adopted a research paradigm that combined elements of positivism and interpretivism. Additionally, a descriptive survey approach was employed to gather data on the variables related to the water rates.

The demographics of this study encompass the entire population of 410 staff members employed by Nam Water in the Khomas region. The [Yamane and Sato \(1967\)](#) formula was employed to select a representative sample, as expressed by the equation  $n = N/(1+a^2 N) = 410/(1+0.025 \times 410) = 207$ . The researchers employed purposive sampling to select the key informants for the study, who comprised front-line workers (clerks, administrators, some managers, etc.). The aforementioned methodology proved to be optimal as it enabled the researcher to selectively recruit participants who possessed the requisite knowledge pertaining to the subject matter. A total of 12 respondents participated in the in-depth interviews.

**Closed-ended:** The data for this investigation was collected through the use of self-administered questionnaires and a guide for conducting a key informant interview. The pilot study for this examination was conducted at the Oshakati Nam water branch, with a total of ten participants involved. The findings of the pilot study were considered during the process of revising double-barrelled questions. In consideration of the pilot study's findings, the questions within the interview protocol were reorganised. The qualitative data analysis was conducted through the identification and development of themes that aligned with the objectives of the study. The researchers employed Tesch's eight-step data analysis process to input the data ([Creswell & Poth, 2016](#)). The following items are included: The researcher gains a comprehensive understanding by diligently examining all the transcripts and annotating marginal notes as relevant thoughts arise pertaining to each topic.

The researcher selects a specific transcript from a collection of transcribed interviews and commences reading it, engaging in reflective contemplation as he progresses through the text. During this phase, it is imperative to analyse the inherent significance of the material rather than solely focusing on its surface-level content. In order to compile an exhaustive inventory of all subjects, it was necessary to iterate through this procedure multiple times. Subsequently, the subjects were classified into "important issues," "unique topics," and "leftovers." The list is used for the purpose of evaluating the data. The codes were strategically positioned alongside the relevant sections within the texts and served as a concise representation of the respective topics. We conducted an examination to determine if any additional categories or codes emerged through the use of our initial categorization approach.

The concepts were formulated by the researcher in a highly vivid manner prior to their categorization. An attempt was undertaken to decrease the overall quantity of categories by consolidating themes that exhibited interrelatedness. Lines were employed as a means of establishing connections between different categories in order to illustrate the interrelationships between them. Subsequently, the researcher made a deliberate choice to assign an official abbreviation to each category and proceeded to arrange the codes in a specific order ([Antwi et al., 2015](#)).

The study utilised various visual representations, such as tables, graphs, and pie charts, to present the quantitative data that was collected. Thematic analysis was employed as a methodological approach to examine and interpret qualitative data. Braun and Clarke (2006) propose that thematic analysis is a qualitative data analysis approach that involves systematically examining a dataset to identify, explore, and document recurring patterns.

### Validity and Reliability

The construct validity of the study pertains to the degree to which the selected research variables effectively and accurately depict the concepts being examined. In order to ascertain construct validity, the study will utilise established measurement scales and validated survey instruments whenever appropriate. Construct validity can be enhanced by carefully selecting relevant determinants and employing appropriate theoretical frameworks.

In order to bolster the dependability of the study, standardised data collection instruments, such as surveys, will be utilised. These instruments will consist of clearly defined variables and response options. Ensuring the reliability of a study's findings necessitates the utilisation of established research methodologies, systematic data analysis techniques, and meticulous documentation of the research process.

## RESULTS PRESENTATION, ANALYSIS AND DISCUSSIONS

Results for the factors that affect water tariffs are shown in figure 1 below.

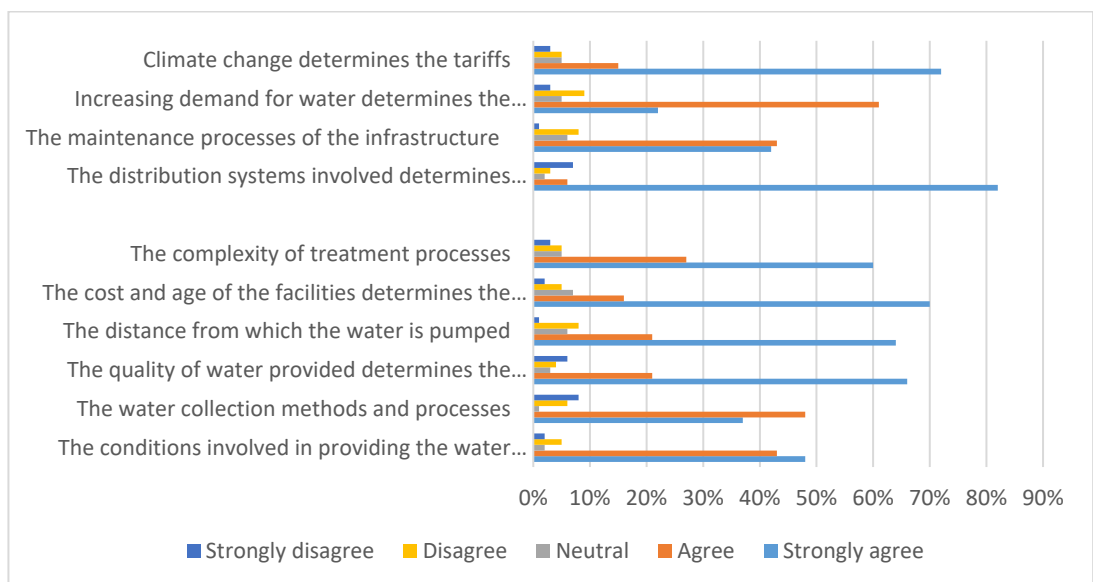


Figure 1: Factors affecting the water tariffs for Namwater during the period

According to the survey participants' ratings of their level of agreement or disagreement with the statement, the circumstances surrounding the provision of the water source might affect water rates. Out of the total sample size of 207 participants, 91% expressed agreement with the statement under consideration, whereas 7% held a contrary viewpoint. The findings suggest that the terminology used in relation to the provision of water resources has a discernible influence on the pricing of water. This observation suggests that the hardness of water influences the amount of chemicals needed for its treatment. Specifically, hard water necessitates a greater quantity of chemicals compared to soft water.

Furthermore, the purification of saltwater, such as seawater, demands more sophisticated chemicals and equipment in comparison to freshwater sourced from rivers. The findings presented in this study are consistent with the research conducted by [Boland and Whittington \(2000\)](#), which demonstrated that the primary factors influencing water prices and tariffs are the Water Resources Management (WRM) practices encompassing the planning, development, and administration of water resources.

Based on the findings of the study, it was observed that a majority of participants, specifically 85%, held the belief that the methods and procedures employed for water collection have an impact on the water rates in Windhoek. Conversely, a smaller proportion of participants, amounting to 14%, expressed disagreement with this viewpoint. The findings of this study indicate that the technique employed for water collection is the primary determinant of water cost. The research by [Chebil et al. \(2022\)](#), which showed that the cost of desalinating seawater is higher than the extraction of water from dams and boreholes, is consistent with the findings presented in this study. The latter refers to the collection of water from natural sources, as well as its treatment, filtration, storage, and distribution for various purposes.

The participants were requested to assess the extent to which they concurred or disagreed with the assertion that the rates are determined by the quality of the water supplied. The statement received agreement from 87% of the 207 individuals who provided their opinions, while 10% expressed disagreement. The findings suggest that the quality of water is a determining factor in the determination of Windhoek's water tariff. The necessity of chemical intervention in the remediation of contaminated or polluted water bodies may result in substantial costs. The research by [Chen et al. \(2022a\)](#), which asserts that water quality refers to the state of water, encompassing its chemical, physical, and biological characteristics, frequently assessed in relation to its suitability for particular applications, such as drinking or recreational swimming.

The survey findings revealed that a majority of participants, specifically 85%, expressed agreement, whereas a minority, specifically 9%, expressed disagreement, in relation to the impact of distance from the water source on water cost. The findings of this study

appear to provide evidence in favour of the hypothesis that there is a positive correlation between the distance required to collect water and the associated costs. This observation can be attributed to the fact that longer distances would require a greater number of pipes compared to shorter distances. Moreover, increased pipeline lengths would necessitate water providers travelling greater distances in order to rectify any faults that may arise within the pipeline system. The findings presented in this study validate the conclusions drawn by [Chu and Grafton \(2021\)](#), who underscored the impact of market distance on input costs, transportation costs, and the effective price of outputs.

The participants were requested to provide their ratings on a Likert scale to indicate their level of agreement or disagreement with the proposition that tariffs are determined by the cost and age of the infrastructure. Out of the total sample size of 207 participants, a majority of 86% expressed agreement with the given statement, while a minority of 7% did not concur. The disruption of water flow occurs as a consequence of inadequate infrastructure. The potential impact on water prices will arise from the costs associated with the replacement and maintenance of the ageing water supply infrastructure in Windhoek, which was originally built several decades ago and is currently in a deteriorated condition. The findings presented in this study align with the research conducted by [De Clercq et al. \(2018\)](#), which demonstrated that infrastructure failure can have significant consequences for both households and enterprises. Such failures can result in disruptions, business closures, financial losses, potential health hazards, and various other adverse outcomes ([Fielmua & Dongzagla, 2020](#)).

The study's participants were requested to assess their level of agreement or disagreement regarding the statement that the intricacy of treatment procedures has an impact on water tariffs. Among the total sample size of 207 participants, a significant majority of 87% expressed agreement, whereas a minority of only 8% expressed disagreement. The results of this study suggest that the removal of water contaminants and undesirable components leads to a decrease in their concentration, thereby rendering the water suitable for its intended purpose. If the procedure incurs significant expenses, it will have a substantial impact on the pricing of water. The potable water provided to Windhoek undergoes purification at the Von Bach purification plant. The expenditure associated with treatment chemicals utilised at the von Bach Purification Plant has witnessed a surge, currently accounting for 38% of the overall Nam water treatment chemical expenses ([NamWater Ltd, 2021](#)).

The chemical treatment methods employed for water sources exhibit regional variations within the country, which can be attributed to the diverse hydrological conditions and the distinct water schemes or sources implemented. Hence, the pricing of water is influenced by the intricate nature of the treatment processes employed by Nam water. The degradation of water quality would lead to elevated expenses in water treatment as a consequence of heightened chemical dosing requirements in the treatment procedure.

The present findings corroborate the previous research conducted by [González-Santander et al. \(2022\)](#), which posited that the presence of chemicals and heavy metals in water can potentially contaminate drinking water if the purification process is not conducted meticulously.

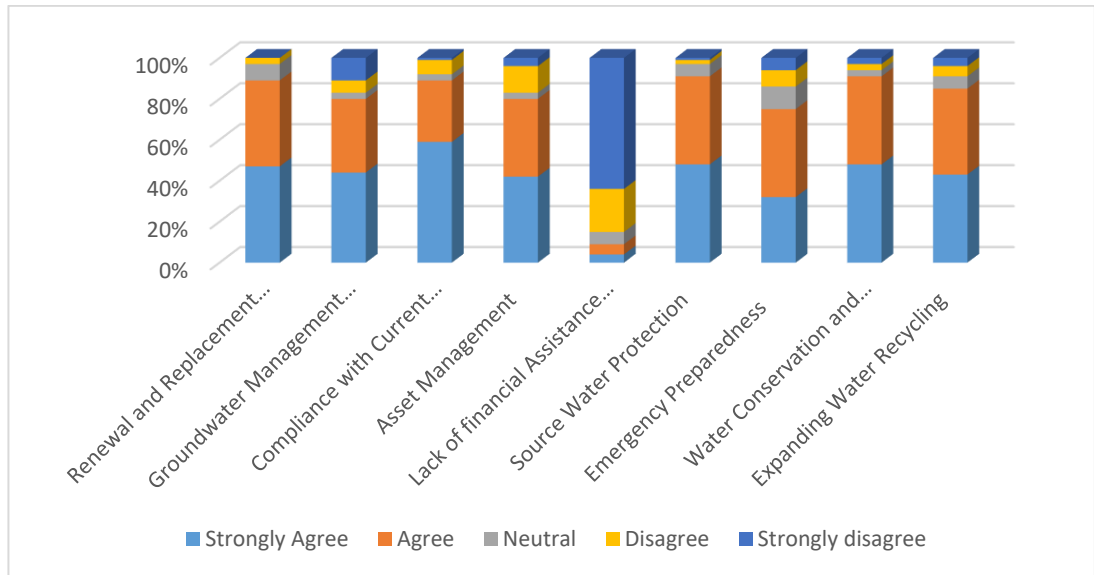
In relation to the determination of tariffs, a majority of 88% of respondents expressed agreement with the involvement of distribution systems, while a minority of 10% expressed disagreement. The aforementioned findings indicate that the water distribution infrastructure, responsible for conveying potable water from treatment plants and reservoirs to end-users or from dams to treatment plants, significantly influences the determination of water tariffs. The present findings corroborate the assertions made by [Hu et al. \(2022\)](#) regarding the comprehensive nature of the distribution system, which encompasses all components of the water system beyond the treatment stage. Notably, the distribution system typically comprises storage tanks, pipes, valves, and hydrants.

The participants were requested to provide their ratings on the extent to which they concurred or disagreed with the assertion that tariffs are determined by water infrastructure maintenance procedures. Among the 207 participants, a majority of 85% expressed agreement, while a minority of 9% expressed disagreement. The findings of this study suggest that, within the Nam water context, infrastructure maintenance involves both planned and unplanned maintenance activities for all water infrastructure. Furthermore, it is observed that during regular operation, this infrastructure experiences typical deterioration that necessitates attention. These findings corroborate the assertions made by [Leflaive and Hjort \(2020\)](#) regarding the maintenance plant, which they defined as the physical location where technical objects are situated and maintenance tasks are performed. Water pricing is influenced by the costs associated with the maintenance procedures of the water treatment facility ([Lewis et al., 2019](#)).

The majority of respondents, specifically 83%, expressed agreement with the notion that increasing water consumption has an impact on tariffs. Conversely, a minority of respondents, specifically 11%, expressed disagreement with this idea. The results of this study show that variables like population density have a significant impact on the cost per unit of supplied water. The demand for water exhibits a positive correlation with the growth of population and per capita GDP, in tandem with the demand for food and energy. The population of Windhoek has experienced an average annual growth rate of 3.36% over the past five years. Moreover, as the population of Windhoek expands, there is a corresponding increase in consumption, leading to an escalated demand for water. The research by [Li et al. \(2022\)](#), which found that the increase in water demand is outpacing population growth, is consistent with the findings of this study. This trend can be attributed to the presence of inadequate and deteriorating water infrastructure, as well as the rapid expansion of industrial and urban areas.

The participants were also requested to express their degree of concurrence or discordance regarding the assertion that tariffs are influenced by climate change. A mere 8% of the participants expressed disagreement, while a substantial 87% indicated agreement. The findings of this study suggest that there is a tendency for rainfall to increase both in frequency and intensity. This phenomenon has the potential to contribute to a rise in instances of flooding, particularly during periods of heavy rainfall, as well as exacerbate drought conditions by reducing the availability of water resources. The potential decrease in groundwater availability for potable water consumption could potentially influence the process of groundwater recharge. Climate change is causing alterations in the temporal availability of water resources.

The aforementioned elements serve to underscore the pressing concern regarding water security, as they are specifically directed towards addressing the issue of water scarcity (Mason, 2022). According to the findings of Molinos-Senante and Donoso (2016), elevated temperatures have the effect of intensifying evaporation rates, leading to a decrease in surface water availability and subsequent desiccation of soils and vegetation. In comparison to cooler conditions, periods characterised by low precipitation exhibit a higher degree of aridity. Namwater encounters several challenges, as depicted in Table 2.



**Figure 2:** Challenges faced in the provision of water

A significant proportion of respondents (89%) expressed agreement with the notion that Nam water encounters challenges in the process of renewing and replacing outdated water infrastructure. Conversely, a mere 3% of participants disagreed with this perspective. The water industry encounters challenges in urban areas, including issues related to sewer leakage and infrastructure repairs. These issues may arise due to

negligence, significant fluctuations in temperature, or unintentional harm (such as a contractor digging through a line). The primary challenges associated with water infrastructure in contemporary times, however, pertain to antiquated systems and insufficient funding for the purpose of modernization. The findings corroborate Nam water's assertion that the replacement and enhancement of obsolete infrastructure pose a significant challenge, resulting in increased water costs. These findings provide support for the assertions made by [Mu et al. \(2019\)](#), who argue that the ageing of infrastructure contributes to an elevated risk of failure and inadequate adherence to environmental regulations.

The majority of interviewees, specifically 80%, expressed the perception that Nam water's management of groundwater poses a significant challenge. Conversely, a smaller proportion, namely 17%, held a differing viewpoint. The findings of this study indicate that the management of groundwater, specifically the Berg Aukas, Seeis, and Karst boreholes, is a significant factor contributing to the constraints faced by Windhoek's water supply. The primary cause of this phenomenon can be attributed to the deterioration of groundwater quality and, in certain cases, the excessive extraction of groundwater resources. The findings presented align with the research conducted by [Molinos-Senante and Donoso \(2016\)](#), which demonstrated that inadequate management practices have negative consequences, including the decline of aquifer levels, degradation of groundwater quality, disruption of ecosystems, and, in specific instances, land subsidence and the intrusion of seawater. The ramifications of water contamination in groundwater or the deterioration of surface water are frequently severe, resulting in a restricted water supply, particularly in urban areas dependent on groundwater sources ([Ofosu & Sarpong, 2022](#)).

The delivery of water to Windhoek poses a significant challenge in terms of ensuring adherence to current and anticipated water regulations. The disagreement rate among the 207 participants was found to be only 8%, resulting in an agreement rate of 89%. The findings imply that recently enacted water usage restrictions have an impact on the water supply in Windhoek. Certain regulations impose restrictions on the utilisation of particular chemical substances in the process of water purification, along with the prohibition of extracting water from designated, prohibited areas. In order to establish or expand new water sources, it is imperative to adhere to the Nam water regulations concerning environmental impact assessments. Nam water states that adherence to the Water Resource Management Act is imperative. These results support [Sibly \(2020\)](#) findings, which show that a variety of stakeholders, including companies, governments, civil society, communities, and others, face various water-related difficulties.

These challenges encompass issues such as pollution, inadequate infrastructure, limited management capacity, and policies and regulations addressing water scarcity. Asset management poses an additional challenge. The research findings indicated that 80% of

the participants expressed agreement, whereas 17% expressed disagreement. The aforementioned findings indicate that, despite substantial financial resources allocated, the water infrastructure in Nam water has been subject to insufficient management. The ageing of the water infrastructure supplying water to Windhoek has led to various social accidents and incidents, which have had a detrimental impact on the provision of water services to the city. These findings are consistent with the research conducted by [Sivagurunathan et al. \(2022\)](#), which revealed that a significant number of water supply pipes in various cities experience annual bursts, resulting in ongoing disruptions to the water supply in Windhoek. Furthermore, a multitude of instances of infrastructure failure, predominantly affecting pipelines and pump stations constructed several decades ago, have been documented.

Nam water's insufficiency in funding for capital improvements is evident, despite the fact that the study reveals a notable disparity in opinions among respondents. Specifically, a significant majority of 86% expressed disagreement with this notion, while a mere 9% concurred. Based on the results of this study, it can be concluded that Nam water possesses a robust financial standing and an adequate cash flow to support its capital improvement endeavours. Despite the perennial challenge faced by many business owners in effectively managing cash flow, Nam water exhibits a robust financial standing in comparison to other state-owned enterprises operating within the confines of Namibia. The findings align with the research conducted by [Wang et al. \(2018\)](#), wherein it was discovered that 33% of surveyed business proprietors expressed their primary apprehension to be the insufficiency of cash flow, as indicated in Guidant Finance's 2019 Business Trends Report.

According to a significant majority (89%), it is perceived that Nam water encounters difficulties in safeguarding water sources during the provision of water to Windhoek. Conversely, a mere 3% expressed disagreement with this assertion. Ensuring the integrity of the water supply encompasses the preservation of water stored in reservoirs, aiming to prevent any form of contamination or pollution that may pose risks to human health. Additionally, it involves the prudent management of chemical usage in water treatment processes to avoid excessive application. This situation presents challenges, particularly in the absence of dedicated financial resources, ultimately resulting in individuals consuming water that poses risks to human health. The findings presented in this study support the conclusions drawn by [Yang et al. \(2020\)](#), which indicate that a considerable number of towns are making substantial efforts to protect various sources of water, such as wells, rivers, lakes, and groundwater, from potential contamination. Preventive measures are being implemented in Windhoek to mitigate the risk of contamination or pollution in the dam catchment areas that supply water to the city.

A significant proportion of the participants, constituting 75% of the total, expressed agreement with the notion that Nam water lacks adequate preparedness

in managing emergency situations, specifically in terms of ensuring the provision of safe drinking water to the city of Windhoek. Conversely, a smaller percentage of participants, amounting to 14%, held a differing perspective by expressing disagreement with this assertion. The findings support earlier research by [Zetland \(2021\)](#) that determined proactive preparedness measures can lessen worries, anxiety, and losses related to disasters. In the event of a pipe rupture, it is imperative for communities, households, and individuals to possess knowledge regarding appropriate actions to take and designated locations to seek assistance for water supply ([Zhang et al., 2022](#)).

Nam water faces a challenge in the provision of water to Windhoek due to the need for efficient water use and conservation. Based on the survey data, it was found that a significant majority of respondents, specifically 88%, expressed agreement with the given statement, whereas a comparatively small proportion of respondents, namely 6%, held a contrary viewpoint. The findings indicate that Windhoek's water efficiency practices, encompassing water conservation and demand management, are not being effectively implemented. The present findings corroborate and validate the conclusions drawn by [Ali et al. \(2022\)](#), which posited that a reduction in water discharge down the drainage system corresponds to an increase in the availability of water in lakes, rivers, and streams for both human consumption and wildlife habitat. The efficient utilisation of water resources plays a significant role in maintaining adequate supplies, thereby ensuring the preservation of the environment and the well-being of human populations.

Nam water is confronted with a significant obstacle in its endeavour to expand water recycling, as indicated by the responses of the survey participants. Specifically, 85% of the respondents expressed agreement with this initiative, while 18% expressed disagreement. The process of recycling offers significant energy savings due to the potential for rapid conversion of recycled items into new, unused materials. Moreover, it effectively preserves a substantial quantity of resources ([Ashoori et al., 2017](#)). The practice of water reuse, alternatively known as water recycling or reclamation, entails the retrieval of water from diverse sources, subsequent treatment, and subsequent utilisation for a range of purposes such as industrial operations, ecological rehabilitation, agricultural practices, irrigation, the provision of safe drinking water, replenishment of groundwater, and other advantageous applications. In addition to treated municipal sewage or wastewater, domestic grey water also serves as a significant source of recycled water ([Boland & Whittington, 2000](#)). Recycling, in fact, aids in the preservation of water resources.

### **Presentation of qualitative findings from the in-depth face to face interview.**

A total of twelve individuals were surveyed, consisting of five males and seven females. Out of the total cohort of 12 individuals, it is observed that seven possess master's

degrees, whereas the remaining five individuals hold honours degrees. The age range spans from a minimum of 26 years to a maximum of 56 years. The individuals involved in the study were highly skilled employees and residents who possessed the necessary qualifications to offer valuable insights regarding the issue being investigated, thereby meeting the researcher's expectation.

Presentation and discussion of qualitative data

The data underwent conceptual evaluation and were subsequently presented thematically, with the aim of addressing the study's third research question. Table 1 presents the primary theme and its corresponding sub-themes that emerged from the analysis of the collected data, which were subsequently transcribed and synthesised.

**Table 1: Theme and sub-themes**

THEME	SUB-THEMES
Theme 1: Strategies that can be used to the increasing Namwater water tariffs for Windhoek, Khomas region, Namibia.	<b>Sub-theme 1.1:</b> Recommendation for management integration
	<b>Sub-theme 1.2:</b> Recommendation for institutional integration
	<b>Sub-theme 1.3:</b> Capacity Building on Water Pricing.
	<b>Sub-theme 1.4:</b> Advocating for policy integration.
	<b>Sub-theme 1.5:</b> Prioritizing risk management.
	<b>Sub-theme 1.6:</b> Encourage active Stakeholders' integration

**Theme 1:** Strategies that can be used to tackle escalating/increase water tariffs in Windhoek

**Sub-theme 1.1: Recommendation for Management Integration**

The study participants expressed the necessity of incorporating management integration into the regulation of water prices. Participant 3 expressed the view that "there is a need for management integration and collaboration in the establishment of the water prices." Participant 10 expressed support for the notion that the coordination of project elements necessitates a clear elucidation of the processes involved, which can be achieved through the implementation of coordinated management integration processes. The process entails making strategic choices among various objectives and alternatives in order to effectively address and surpass the needs and expectations of stakeholders. The entities involved in the Nam water case include the residents residing within the

boundaries of Windhoek, council members and the administration of Windhoek, the Ministry of Urban and Rural Development, and the Ministry of Agriculture, Water, and Land Reform. These parties are required to collaborate and coordinate their efforts. *Engaging stakeholders in coordinated forums is considered an optimal approach for presenting short- and long-term strategies and projects pertaining to the water supply in Windhoek, along with their corresponding impacts on water pricing. These findings underscore the necessity of incorporating management integration into water pricing systems. Project integration management is a distinct knowledge domain within the field of project management that facilitates enhanced collaboration among teams. In order to formulate a comprehensive strategy, integration management encompasses the amalgamation of various processes, systems, and methodologies.*

The findings support the previous study conducted by [Chen et al. \(2022b\)](#), which posited that the process of integrating management practices requires careful consideration of the costs associated with pollution control and sanitation management. The water service providers have the capacity to recognise the significantly elevated water expenses associated with the various accessible water sources, as well as the ultimate treatment prior to disposal. These costs have been incorporated into their water rates through comprehensive management integration ([Yang et al., 2020](#)). Subsequently, the subsequent considerations encompass the technical alternatives for integrated management, encompassing distributed or centrally piped systems, grey infrastructures, and nature-based solutions. Additionally, the requisite economic model and institutional framework are also of paramount importance. In order to ensure the successful completion of a project, project integration management encompasses the coordination of all elements of the project, encompassing its processes and related systems. Project managers demonstrate enhanced proficiency in achieving equilibrium among client expectations, stakeholder demands, and project tasks through the implementation of this approach.

### **Sub-theme 1.2: Recommendation for Institutional Integration**

*The participants in the study recommended institutional integration as one of the solutions to water pricing at Nam water. "There is a need for strong institutional integration, with close coordination between Nam water, the Ministry of Agriculture, Water and Land Reform, relevant ministries, local authorities, including the City of Windhoek, and all relevant stakeholders to ensure harmonized infrastructure and public service planning," said participant 1. This was echoed by participant 4 when she said that "the policy decisions taken by two or more organizations belonging to the same geographic area in order to promote economic cooperation in terms of deepening and/or widening the spheres of coordination under the terms of an agreed pact are strongly needed, especially in deciding the best options that can be used in the provision of water for the general public at reasonable tariffs."*

In order to optimise desirable outcomes such as social protection and the rectification of market failures while mitigating undesirable outcomes such as deregulation, social dumping, and the prioritisation of corporate interests, the integration of institutions becomes imperative. The findings align with the research conducted by [Chou et al. \(2021\)](#), which demonstrated that the integration of institutions facilitates enhanced access to a broader customer base, a more skilled workforce, additional financial resources, and state-of-the-art technologies. Integrated institutions facilitate the cultivation of friendships and relationships that transcend racial and ethnic boundaries while also providing staff members with the necessary skills and knowledge to thrive in an increasingly diverse society and economy. The incorporation of diverse individuals in professional settings can additionally enhance employees' aptitude for leadership, bolster their intellectual self-assurance, and augment their overall job satisfaction ([Chu & Grafton, 2020](#)).

### **Sub-theme 1.3: Capacity Building on Water Pricing**

In order to accomplish its objectives, every organisation must possess competence ([Bathala et al., 2015](#)). In order to ensure the progress of a corporation, it is imperative that its employees possess the necessary skills to navigate and overcome obstacles, such as the implementation of water pricing challenges. The assertion is substantiated by the references provided by the study participants enumerated hereafter: Participant 12 emphasised the significance of knowledge in enhancing workplace competence by stating that individuals responsible for water pricing at Nam water must possess a comprehensive understanding and expertise in matters pertaining to water pricing." Participant 6 stressed more on the issue of being active at work all the time when he said, "*Nam water management must be active all the time for the successful realization of the company's goals and objectives.*"

Participant 8 talked about the need to be competent on the part of stakeholders when he said that "*failure in Nam water is a direct manifestation of incompetence on the part of management.*" The aforementioned findings corroborate the assertions made by [Godfrey \(2012\)](#), wherein it was posited that management should possess a thorough understanding of its existing capabilities as well as the additional ones it requires or requests. Competence serves as a driving force behind an organisation's aspirations and goals.

### **Sub-theme 1.4: Advocating for Policy Integration**

On the issue of advocating for policy integration in water pricing, this is what participant 6 had to say: "*There is a need for policy integration in water pricing because policy integration concerns the management of cross-cutting issues in policy-making that transcend the boundaries of established policy fields and do not correspond to the institutional responsibilities of individual departments.*" This was supported by

participant 9, who also said that *"there is a need for an integrated policy to develop a more comprehensive and integrated view of the global economic and financial environment in order to help inform and strengthen decision-making across the organization's monetary, supervisory, and payments policy responsibilities."*

These findings are consistent with the findings of Favre and Montginoul (2018), who argued that the integration of functional policies is essential due to their interdependence. According to their research, a particular policy has an impact on other policies and is in turn influenced by other policies. Policies serve to establish the objectives of an organisation and offer direction on the strategies and approaches to be employed in order to attain said objectives. Furthermore, policies serve the purpose of delineating crucial activities, including the retrieval of outstanding rental payments and the formulation of strategies for capital replacement. Additionally, they encompass matters pertaining to general regulations within the building (Fielmua & Dongzagla, 2020).

### **Sub-theme 1.5: Prioritize risk management**

It is imperative for every governing board to establish a comprehensive framework for the identification, monitoring, and management of potential risks (Baysinger & Butler, 2019). Risk management encompasses a broader spectrum of risks faced by organisations, extending beyond mere compliance with legal and regulatory obligations. These risks encompass various aspects, including financial risks, environmental risks associated with global warming, cybersecurity risks, and other potential hazards. The inclusion of citations from the study participants lends support to the aforementioned assertion. When participant 1 expressed the view that Nam water should establish a risk assessment team to mitigate uncertainties, it can be inferred that the participant believes that risk assessment is essential for a supplier to navigate unforeseen circumstances. Regarding the topic of safeguarding oneself against avoidable losses, Participant 2 put forth a distinct yet interconnected recommendation, stating that *"Nam water has to make sure that it shields itself against financial losses and strengthens its cyber security."*

The aforementioned findings offer thorough support for Bansal et al. (2015) claim that effective risk management improves decision-making processes and makes accurate cost-benefit analyses easier. In order for institutions to ensure their survival, it is imperative to undertake a comprehensive evaluation and analysis of potential risks. Ensuring the absence of harm. Risk managers play a crucial role within all organisations. Risk management refers to the systematic approach of identifying, quantifying, and mitigating potential risks associated with property, liability, income, and personnel, with the aim of minimising potential losses. The primary objective of risk management is to safeguard the tangible and intangible resources of the organisation, including its physical infrastructure and human capital, in order to ensure

the uninterrupted and prosperous continuation of its activities. According to [González-Santander et al. \(2022\)](#), there are three primary water-related risks that warrant attention: the risk of excessive water, insufficient water, and water contamination, as well as the potential disruption to freshwater systems. Furthermore, the absence of adequate access to water supply and sanitation can be regarded as an additional water-related hazard.

### **Sub-theme 1.6: Encourage active stakeholders' integration**

The process of stakeholder integration necessitates the active involvement of pertinent stakeholders in the various stages of water resource management, including planning, implementation, monitoring, and evaluation. The study's participants expressed the necessity of involving stakeholders in water pricing initiatives. On this issue, this is what participant 8 had to say: *"Stakeholders of Nam water in the Khomas region need to be active participants for high water connectivity."* Participant 7 also supports the idea in a different way when he says, *"The implementation of water pricing issues requires stakeholders to cooperate in oneness for the achievement of water pricing goals and objectives."* Participant 4 also indicated that *"there is a need for increased collaboration with stakeholders because it improves transparency in the water pricing processes."* *Consequently, this phenomenon engenders heightened levels of innovation, streamlined operational procedures, amplified rates of achievement, and enhanced channels of communication.*

The results mentioned above align completely with the research conducted by [Hellwig and Polk \(2021\)](#), who advocate for the active involvement of stakeholders in the formulation of water pricing strategies, the implementation of programmes and services, and the supervision of said initiatives, all while emphasising the importance of maintaining a strong performance-oriented approach in service delivery arrangements. This approach effectively utilises the combined capabilities of various stakeholders in the water pricing system, fostering a sense of ownership, responsiveness, and resilience. The presence of active members within an organisation ensures a high level of productivity within the system. It is imperative for individuals within an organisation to align their efforts towards a common direction in order to optimise outcomes and attain predetermined goals and objectives ([Hu et al., 2022](#)). Collaboration plays a pivotal role in enhancing decision-making processes within an organisation and fostering a culture of advocacy across the entire business. This endeavour serves as a crucial means to garner support for project objectives and ensure congruence with the organisation's mission and strategy ([Kernan et al., 2017](#)).

## **CONCLUSION**

The objective of this study was to ascertain the factors that influence Nam water's decision to increase water rates for Windhoek. Additionally, it aimed to identify the

challenges encountered by Nam water in delivering water services to Windhoek in the Khomas Region. Furthermore, the study sought to identify potential strategies for enhancing the provision of water services in response to the escalating water rates in Windhoek, Khomas Region.

Several factors have been identified as influential in determining water tariffs. These factors encompass the conditions associated with the provision of water sources, the methodologies and procedures employed for water collection, the quality of the water, the distance over which water is pumped, the costs and age of facilities that determine tariffs, the intricacy of treatment processes, the distribution systems, the maintenance protocols for infrastructure, and the increasing demand for water. A majority of over 80% of the participants expressed agreement regarding the influence of these factors on the pricing of water.

Nam water faces several challenges in delivering water services, which encompass the modernization and replacement of deteriorating water infrastructure, effective management of groundwater resources, compliance with existing and forthcoming water regulations, efficient management of assets, safeguarding water sources, preparedness for emergency situations, optimisation of water efficiency, and the expansion of water recycling initiatives.

The study conducted in Windhoek, Khomas Region, aimed to identify potential strategies for improving water service provision in the face of increasing water prices. These strategies include management integration, institutional integration, capacity building in water pricing, advocating for policy integration, prioritising risk management, and promoting active stakeholder involvement.

The study suggests that it is imperative for management to ensure that the methods of water supply are accurately delineated and clearly defined. It is imperative for the management and staff of Nam water to assume responsibility for these procedures and ensure their integration into all facets of the company's day-to-day activities. Furthermore, it is imperative to establish unambiguous parameters and engage in collaborative efforts with all stakeholders involved in water pricing to ensure equitable implementation. The use of a pricing policy by Nam water is necessary in order to effectively guide and facilitate any future adjustments to the water pricing structure. It is imperative for the Namibian government to actively promote and establish effective platforms that facilitate the collaboration and exchange of ideas among individuals regarding the proper valuation of water resources. Enhanced collaboration between management, the City of Windhoek, and the Water Regulatory Authority of Namibia is imperative in order to ascertain optimal water rates.

## **Some suggestions for further study**

Subsequent investigations may prioritise the evaluation of the efficacy of water pricing mechanisms in fostering water conservation behaviours across various sectors and socio-economic strata. This study aims to examine the correlation between water prices, consumption behaviours, and conservation initiatives while also investigating the effectiveness of behavioural interventions and incentives in promoting water-saving behaviours.

Given the increasing influence of climate change on the availability and quality of water, it is imperative to conduct additional research to explore the enduring consequences of climate change on water pricing in Namibia. This study entails the examination of potential alterations in water demand, supply, and pricing dynamics within various climate change scenarios. Additionally, it involves the exploration of adaptation strategies aimed at mitigating the detrimental impacts on water pricing and accessibility.

## **DECLARATIONS**

### **Availability of data and materials**

The data sets used and/or analysed during the current study are available from the corresponding author on request.

### **Competing interests**

The authors declare that they have no competing interests.

### **Funding**

No funding was received

### **Authors' Contributions**

AS<sup>1</sup>, TM: study design, conceptualization, literature search and review, write-up of original draft, data processing and statistical analyses, and research fund acquisition. The fieldwork and data collection were led by AS<sup>1</sup>, ET, JM and TM. PL, AS and JM: study design approval, conceptualization, review and approval of literature search protocols, critical review and editing of the manuscript. All authors read and approved the final manuscript.

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