CAUSALITY RELATIONSHIP BETWEEN SUSTAINABILITY FACTORS AND WATER MANAGEMENT: THE EMERGING MARKET STUDY

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How to cite this paper: Mukwarami, S., & Fakoya, M. B. (2022). Causality relationship between sustainability factors and water management: The emerging market study. *Journal of Governance & Regulation, 11*(2), 144–158.
https://doi.org/10.22495/jgrv11i2art13

ISSN Print: 2220-9352
ISSN Online: 2306-6784

Received: 25.09.2021
Accepted: 14.04.2022

JEL Classification: D24, O19, Q25, Q56, F64
DOI: 10.22495/jgrv11i2art13

Abstract

This paper evaluates the causality relationship between sustainability factors and water management in the South African public sector. The quest to partake in this research is motivated by the need for addressing the prevailing water services delivery challenges (WSDCs) and infrastructure funding deficit challenges (Ruiters, 2013). Given the severity of WSDCs in South Africa, the question which needs redress is whether sustainability factors influence water management and vice versa. Therefore, the main objective of this paper is to explore a unique approach to addressing WSDCs by investigating the bidirectional relationship between sustainability factors and water management. Data spanning 2009–2019 on sustainability factors and water management was collected using quantitative content analysis from web-based sources of purposively selected eight metropolitan municipalities in South Africa. Using Granger non-causality tests, social and environmental management practices have had a bidirectional relationship with water management. Besides, causality analysis involving corporate governance and economic measures failed to produce outright opposite direction connections. The results suggest that stakeholders and policymakers should acknowledge the role of sustainability factors in addressing investment challenges confronting the water sector. Therefore, the study recommends further research into establishing the significance and direction of the relationship between sustainability factors and water management.

Keywords: Investments, Governance, Water, Sustainability, Environment

Authors' individual contribution: Conceptualization — S.M. and M.B.F.; Methodology — S.M.; Investigation — S.M.; Resources — S.M. and M.B.F.; Writing — S.M. and M.B.F.; Supervision — M.B.F.; Funding Acquisition — S.M.

Declaration of conflicting interests: The Authors declare that there is no conflict of interest.

Acknowledgements: We wish to express our gratitude to the Africa Centre for Sustainability Accounting and Management (ACSAM) for making the funds available to cover the publication fees.

1. INTRODUCTION

The increasing global attention on sustainability factors' influence on managing water sector investment (WSI) continues to put water services authorities (WSAs) under pressure to focus on sustainability performance for improved delivery of water services. The need to achieve the 2030 United Nations' Agenda towards Sustainable Development Goal 6 persistently raises many questions about the best approach of addressing the water sector's underinvestment gap that has continued to exacerbate water services delivery challenges (WSDCs). The persistent endeavours to improve water provisioning efforts (WPEs) are motivated by the need to seek sustainable solutions to challenges existing in the water sector, namely: climate change, population growth, rapid urbanization, poor governance, outdated infrastructure, and funding challenges (Butler et al., 2016; Schleifer, 2017). Given the essence of water to the social and economic development, intensifying proper WPEs through adhering to social, economic, governance and environmental (SEGE) practices provide an impetus for creating stability within the water sector through attracting investments. The global drive to increase investment in water management (IWM) continues to get louder as the Organisation for Economic Co-operation and Development (OECD, 2015) posits that developed nations agreed to spend 2% of their gross domestic product (GDP) on sustainable water infrastructure management. Within the African setting, the African Capacity Building Foundation (ACBF, 2016) suggests that Africa requires US$11biilion to address the water provision gap. However, the demand for substantial WSI is against the backdrop of budget deficiency. The need to increase IWM is against a lack of financial capacity by developing countries to meet the investment needs. Therefore, business-as-unusual approaches are indispensable to ensuring that WSAs focus on implementing the best strategies of dealing with SEGE practices to address existing WSDCs.

In the context of South Africa, the government made remarkable progress in water provisioning through rolling out intensive infrastructure development programmes (Hollingworth, Koch, Chimuti, & Malzbender, 2011). Although evidence suggests that households' access to safe drinking water increased to 88.2% in 2019 (Statistics South Africa, 2019), at least 10% of the population gets drinking water from unsafe sources. However, the prevailing WSDCs are a concerning issue to all stakeholders in the water industry. The Department of Water and Sanitation (DWS, 2017) suggested that R330 billion is required to rehabilitate, renew and maintain water infrastructure assets. Additionally, various studies postulate that a lack of funds to invest in water management is an obstacle to achieving water security, particularly in growing cities (Infrastructure Dialogue, 2015; Ruiters, 2013). Besides, factors, such as weak governance (Chetty & Luiz, 2014), service delivery protests (Morudu, 2017), climate change effects (van den Berg, 2014), and shortage of skills (Infrastructure Dialogue, 2017) continue to harm WPEs by constraining the functionality of water infrastructure resulting in more funding needs. Given the evidence from the literature, it is clear that WSDCs emanate from SEGE practices that have continued to contribute towards instabilities in the management of WSI. However, various scholars made efforts to address funding challenges related to WPEs (Ruiters, 2013; Madumo, 2015; Masindi & Duncker, 2016; McCallum, 2018). In pursuit of seeking solutions to an underinvestment problem, some scholars found that poor corporate governance and financial management practices impede the flow of investments into the water sector in South Africa (Mokgopo, 2017; McCallum, 2018; Jacobs, 2019). Despite efforts, the researchers found out that the main focus of the extant literature concerns the determinants of water investments, ignoring the effects of IWM on SEGE practices.

This paper focuses on understanding why underinvestment within South Africa's water sector still exists despite ever-increasing annual funding. Hence, the water sector requires reconfiguration of water services plans by adopting a sustainability imperative that advocates for a balanced approach to building sustainable infrastructure by considering dimensions of capital, including economic, social, human, and natural (Radej, 2007). Related studies conducted both globally and locally produced inconclusive results. Hence, the quest to rerouting efforts towards adhering to SEGE practices that influence WPEs measured through IWM remains an outstanding issue in the literature. As such, this paper contributes to the existing literature by evaluating the causality between SEGE practice and WPEs in South Africa's public sector to confirm the extent of adherence to the sustainability practices by the municipalities. In an attempt to address WSDCs, this paper will formulate the following questions:

RQ1: Could SEGE practices have a casual effect on WPEs?

RQ2: Can WPEs affect SEGE practices?

To find answers to the questions, the objective of this paper is to examine the bidirectional relationship between SEGE practices and WPEs as represented by IWM in the South African metropolitan municipalities (SAMMs). The study expects to influence policymakers and WSAs to reroute their efforts towards increasing and attracting substantial IWM by promoting good SEGE practices.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature. Section 3 analyses the methodology used to conduct empirical research on the relationship between sustainability factors and WPEs as proxied by IWM. Additionally, methods, presentation and analysis, discussion of results, and conclusion are presented in Sections 4, 5, and 6, respectively.

2. LITERATURE REVIEW

2.1. Sustainability imperative

The sustainability imperative is a balanced approach to building sustainable infrastructure that considers dimensions of capital, including economic, social, human, and natural capital (Radej, 2007). The sustainability imperative confirms that a significant and robust relationship exists among the three capital dimensions. Mell (2010) narrowed this proposition by affirming that the point of linear

connectivity between built capitals, social and human capital, natural capital, and viable ecosystem exists. Water infrastructure components encompass natural infrastructure such as dams and lakes (Hollingworth et al., 2011) and built infrastructure, which requires human beings' input for effective operation. On the same note, it is equally essential to ensure that implemented innovative technologies do not necessarily upset the entire ecosystem; it should enhance the natural system. Therefore, a decision to incorporate the imperative sustainability approach in water infrastructure development discussion is due to the theory's potential to influence policymakers in achieving equality between dimensions of capital to avoid further damage to the ecosystem. In simple terms, given that the sustainability imperative is adopted successfully in the construction and management of sustainable water infrastructure, the desired co-existence between dimensions might present an investment potential in the water sector resulting in meeting water investment needs. Therefore, it is plausible for urban planners to adopt sustainability imperatives as a possible measure for overcoming water provisioning challenges.

2.2. Corporate governance factors and water provisioning efforts

Corporate governance is a topical theme in sustainable development discourses. Governance issues in the water sector are apolitical and revolve around social and economic misfortunes emanating from malfunctioning water utilities in developing countries (United Nations Educational, Scientific and Cultural Organisation [UNESCO], 2015). Reliability in the provision of water and sanitation is achievable when corporate governance practices (CGPs), such as effectiveness in service delivery, openness, transparency, public participation, and engagement and responsiveness to dynamics to water demand play a role in water management (United Nations [UN], 2018). Besides, corporate governance dimensions include transparency and accountability, the composition of board structure, relationship with stakeholders, legal and regulatory, and ownership structure (Cardoso, 2015). Given the essence of water in achieving sustainable development goals (SDGs), it is clear that CGPs influence WPEs (as presented by IWM) aimed to ensure that adequate funding is made available for improved water service delivery. Similarly, increasing WSI is critical in ensuring that good CGPs are maintained. Hence, for this study, women's presence in the management and the number of experts in the management represent CGPs and WPEs as measured through IWM.

The presence of women in top management within the public sector is still an issue as various studies continue to contribute towards gender equity and the performance of municipalities. The presence of women in local government proved women's multifaceted capabilities. Araujo and Tejedo-Romero's (2018) investigation on the effects of gender equality on municipal transparency in Spain found that women's involvement in municipal governance is a progressive move that promotes adherence to good CGPs, especially concerning information coherence and openness, as well as communication and accountability. Likewise, according to Bishu and Heckler's (2021) study on women and men municipal managers doing and undoing gender, women in leadership perform masculine gender work as they tend to work very hard to create more opportunities to accommodate more women in management. Concerning the impact of women in municipal governance, Brenya, Mensah, and Nyarko (2015) examined women's participation in the governance structure of a municipality in the Kumasi Metropolitan Assembly, found that women's involvement in local government administration strengthens management capability. Cabaleiro-Casal and Buch-Gómez (2020) studied women in Spanish municipal councils and budgetary policies, and they found that change from male to female mayor tends to influence budget policies. Likewise, the study reveals that female politicians' presence with right-wing ideology on municipal boards tends to decrease expenditure on non-social spending resulting in better service delivery. Hernández-Nicolás, Martín-Ugedo, and Mínguez-Vera (2018) empirically analysed the linkage between gender of mayors in Spanish local government and different budget items. The results reveal that women's participation in local government improves the economic situation besides lowering annual interests on loans and adhering to debt repayment obligations with more focus on increasing expenditure on social protection and security. Inconsistently, Cabaleiro-Casal and Buch-Gómez (2020) evaluate the impacts of female politicians on municipal; councils and fiscal performance. The result reveals that the female mayor and more female councillors tend to worsen the performance of Spanish municipalities fiscally through increasing budgetary imbalances. Consistent with the above results, Adnan, Sabli, and Abdullah (2013) evaluated the connection between gender diversity in boards and firm performance in 26 government-linked companies and 26 non-government linked to companies registered on Bursa Malaysia. The findings reveal that gender diversity fails to yield positive financial performance (FP) as the number of women on the boards is still too insignificant to cause any changes to firm performance. Also, in a study that considered various CGPs proxies, including chief executive officer duality, size of the board, and a number of the board meetings, board composition, size of the firm, and gender diversity of the board, Ng'etich (2015) found a positive link with FP in water companies in Kenya. Given the findings from studies reviewed, it is clear that gender equity plays a role in determining the performance of municipalities. The existing literature confirms that women's presence in the governance structure within local municipalities has had causality effects on municipal performance. There is no evidence to suggest studies that focused on the influence of IWM on gender equity. Hence, a literature gap exists, as the researcher found no studies that test the two-way relationship. Therefore, continuous efforts to establish bidirectional linkages between gender equity and WPEs are imperative to addressing gender inequalities to enhance WPEs.

In an attempt to understand the bidirectional connection between the quality of human resources and WPEs measured through IWM, various studies

present contributions. Ramutsheli and Janse van Rensburg (2015) undertook a comprehensive study that took the literature review and review of documents approach to assess the root causes for local governments' failure to achieve better performance in municipalities. The study established that poor human resources practices in the form of incapacitation problems, shortage of skills, and unethical practices consequently lead to poor municipal performance, Avellaneda (2009) looked at municipal performance and quality of the mayor in 40 Colombian municipalities. The results from the study reveal that the qualifications of the mayor have influenced school enrolment that resulted in decreasing the number of illegal armed groups, leading to better social service delivery. In a study that utilised the tobit regression model, Monkam (2014) analysed the relationship between local municipality's productive efficiency and its determinants in South Africa. The results reveal that financial autonomy and the quality of human capital in management and administration influence the productive efficiency of the municipalities. In support of the above findings, Rocha, Orellano, and Bugarin (2018) analysed the relationship between a mayor's qualifications against expenditure on private and public. The study found that educated mayors tend to spend less on their expenses, hence, channelling more funds towards the community-based service delivery that improves the performance of public entities to convince the government to inject more funds in the form of conditional grants. Given the essence of well-qualified personnel in promoting good CGPs, Dlalisa (2009) established that poor CGPs in the form of poor recruitment processes misguided by biased patriotism have indeed crippled the performance of municipalities. Addionally, Patience (2015) studied infrastructure management in Ekurhuleni Metropolitan Municipality and found that technical staff shortage, poor planning and budgeting, ineffective succession planning, and the non-existence of infrastructure knowledge have contributed to poor infrastructure management. Thus, compromising efforts to achieve optimal performance of the infrastructure results in poor performance in delivering basic services. Mehlape (2017) raised the issue of the role of human resources development in improving municipal services. After employing a comprehensive literature review survey, the study acknowledged that poor municipal administration is mainly due to ineffective human resources management practices. Mbili (2020) studied human capital development and service delivery in Ray Nkonyeni Local Municipality utilised Chi-square statistical tools. The study findings provide evidence suggesting that improvements to human resources management practices and service delivery performance are positively correlated. The results further reveal that a lack of skills match tends to harm efforts to improve efficiency in the service delivery within the local government sphere. Given the studies reviewed, it is apparent that the quality of human resources in governing municipalities matters most as most studies found positive correlations. However, the non-existence of the studies that examine the impacts of IWM on the quality of human resources leaves a critical gap in addressing challenges confronting WPEs. Hence, there is a need to explore various ways that municipal councils could use to attract the best talents through ensuring that attractive salary packages are made available to lure trained water experts or train the existing employees.

2.3. Environmental management practices and water provisioning efforts

The existing environmental management practices (EMPs) impact the climate. Hence, leading to many questions about the resilience, longevity, and sustainability of water infrastructure (Esterhuyse, 2012; van den Berg, 2014). Climate change poses costly impacts in terms of maintenance, repairs, and lost connectivity of infrastructure components; yet many of these impacts can be mitigated and avoided by engaging in pro-active climate change adaptation measures (Schweikert, Chinowsky, Espinet, & Tarbert, 2014). The reality is that poor EMPs have led to the heightened incidence of natural disasters that have severely affected the functioning of infrastructure at large (Nel & Denoon-Stevens, 2015), which in turn affect the government's ability to provide essential services. Koop and van Leeuwen (2017) stress that climate change effects threaten water infrastructure and water resources. The impacts of climate change effects on IWM are real. However, Bhattacharya, Romani, and Stern (2012) contend that quantifying the actual investment needed for climate-adaptive sustainable water infrastructure (SWI) seems complex. Hence, suggest that the link between EMPs (expenditure of wastewater management and environmental protection management) and water provisioning efforts measured by IWM exists. Given that EMPs have had adverse impacts on infrastructure development, substantial investments are pertinent to counter the effects of poor EMPs on WPEs. Therefore, it is clear that a bidirectional relationship exists.

It is critical to promote good EMPs that minimise impacts on climate change on WPEs through inducing risks on functioning SWI. Disruptions to the functionality of SWI often result in performance problems that tend to affect the water investment needs of municipalities. For municipalities to invest in environmental protection programmes, financial viability is imperative to ensure funds are available. Folz (1999) evaluated the municipal recycling performance by employing a panel study. The results from the study suggest that the solid waste recycling performance of cities is a success story. The study reviewed that most cities were able to improve the efficiency of their recycling efforts, particularly when compared with the cost of solid waste collection and disposal. Failure to effectively manage environmental risk is likely to trigger climate changes risks. Chinowsky, Schweikert, Strzepek, and Strzepek (2015) examine infrastructure and climate change by focusing on impacts and adaptations in Malawi, Mozambique, and Zambia. Based on a stressor-response approach to estimate impacts of temperature, precipitation, and floods on paved and unpaved road infrastructure, reveals that these three African countries are facing a potential US$596 million bill for maintaining and repairing heavily damaged roads caused by climate change effects such as high temperatures coupled with massive flooding.

Schweikert et al. (2014) examined climate change and infrastructure impacts. They confirm that higher-income countries also face climate change risks which result in substantial damage due to their very costly extensive road networks. However, in lowly developed economies, the cost of damages is not as high because they have invested fewer infrastructure development funds than in vibrant economies. Ali, Zailani, Iranmanesh, and Foroughi (2019) studied the impacts of environmental factors on waste, energy, resource management, and sustainable performance. The data collected from 173 companies operating in Malaysia, were analysed using partial least squares. The study results indicate resource, energy, and waste management have had a positive influence on sustainable performance. Considering the bidirectional effect of the variables, He, Yin, Zhong, and Ding (2017) evaluated the local government's investment impacts on China's carbon emission reduction effect. The cointegration tests and panel data models indicate that local government's investment in EMPs significantly reduced carbon emissions. Nyirenda, Ngwakwe, and Ambe (2013) examined the link between EMPs and firm performance in South African mining companies. The multiple regression statistics results show that EMPs measured through energy efficiency, water usage, and carbon have had an insignificant influence on firm FP. Consistently with the same insignificance results, Maleka, Nyirenda, and Fakoya (2017) analysed the link between expenditure and waste reduction targets in South Africa. Based on the regression analysis model results, a positive and insignificant relationship exists between water-energy reduction targets and firm performance in South Africa. On the same note, waste management expenditure has influenced reduction targets in JSE listed companies. However, the results suggest that organisations are yet to fully embrace the concept of good EMPs in a way that spurs their financial performance. Therefore, according to the studies reviewed, it is apparent that most of the studies consider financial performance IWM as a function of environmental protection management. Hence, there is a need to explore solutions to WSDCs through testing the bidirectional relationship.

In another dimension of study that looked at the bidirectional relationship between variables, He et al. (2017) evaluated the local government investment impacts on China's carbon emission reduction effect. The results from cointegration tests and panel data models indicated that local government investments significantly reduced carbon emissions. Therefore, there is unambiguous evidence to prove that EMPs have an elusive influence on FP in Chinese companies. A study on barriers and enablers of effective implementation of wastewater charges by South African WSAs, found that the lack of organisational resources has created incapacitation problems that negatively impacted wastewater management. The study further pointed out that maintaining the current structure of water charge would result in failing to recoup the cost of treating wastewater (Naidoo, Pearce, Visser, Crafford, Maila, & Harris, 2016). While acknowledging that growth in GDP can spur investment in infrastructure, IWM deficiency remains a challenge. Brown, Meeks, Ghile, and Hunu (2013) analysed the effects of climate hazards on national-level economic growth by considering the precipitation index (proxies by floods, drought, and temperature) as an explanatory variable. They found a negative influence on economic growth as measured through the GDP. Therefore, results from the empirical analysis justify the effects of climate change on the functionality of water infrastructure that resulted in high demand for IWM. Musouwir (2010) found that national budgets on water and sanitation have had a positive and significant impact on GDP per capita, which signals positive economic growth. Environmental innovations are another approach to reducing and controlling pollution, global warming, and depletion of natural resources. Naidoo et al. (2016) looked at the barriers and enablers of implementing cost-effective charges concerning treating wastewater in South Africa. The results from the study established that the lack of organisational resources has created incapacitation problems that negatively impacted wastewater management. Additionally, the study maintained that to recoup wastewater treatment costs, WSAs require to change the wastewater charge structure. It is clear that literature examining the linkage between EMPs and WPEs is scant and characterised by mixed results, hence continued efforts to seek causality effects of the two variables are indispensable to ensure the smooth flow of investment within the water sector.

2.4. Social factors and water provisioning efforts

Globally, transitioning social challenges are evident, including uneven urbanisation, gender inequality, youth unemployment, stakeholder participation, and affordability constraints (van den Berg, 2014). Global changes have started to impact WPEs as water provides a critical link with many social factors, such as sanitation services provision, health issues, vulnerability to diseases, education, and urbanisation (De Carvalho, Carden, & Armitage, 2009). Furthermore, water security is closely linked to housing and infrastructure deficiencies in cities (Turok & Borel-Saladin, 2014). As such, water availability remains an indispensable issue in realising the notion of developing sustainable cities. Social factors influence water services providers' financial performance that, in turn, affect sustainable water management and IWM in the local government sphere. These factors are employment rate, population density, the wealth of population, literacy level, and population size to age (Kleynhans & Coetzee, 2019). Given the impacts of social practices on the water services delivery systems (WSDSs) in cities, it is imperative to interrogate further concerning how social practices influence IWM that, in turn, affect the effectiveness and efficiency of the WSDS in cities.

The extant literature suggests that social practices have had a significant influence on the availability of IWM needs. In this regard, the study considers population size and expenditure on housing opportunities created as two variables representing social practices. Kleynhans and Coetzee (2019) assessed the financial condition of South African municipalities in KwaZulu-Natal. The assessment used data from 2009 to 2015's findings suggest that the ratio of the non-working

age group to the total population is one of the most significant factors affecting the municipalities' financial condition. Mahabir (2010) found negative results in a study that examined the impacts of high population density on South African municipalities' performance regarding the increase in services provision expenditure. Gomez, Perdiguero, and Sanz (2019) noted that an increase in rural migration to middle-high income areas had created enormous pressure for the government to improve sustainable water infrastructure footprint (SWIF). Asoka, Thuo, and Bunyasi (2013) found out that the capacity of available water infrastructure responsible for providing essential services responded negatively to population growth as access to clean water had become a challenge in managing water infrastructure and providing services. Furuoka's (2013) study employed a bounds test to analyse the long-term relationship between population growth and economic growth in Thailand. The results support the population-driven economic growth hypothesis by indicating a long-run positive relationship between population growth and economic growth. Mukherjee and Chakraborty (2016) examined the link between urbanisation and the demand for water and sanitation services. The results established that the high rate of urbanisation and economic growth has led to increased demand for water and sanitation services. Asoka et al. (2013) examined the impact of population on infrastructure and service provision. They found that the water infrastructure responsible for providing basic services has been negatively affected by the population growth as clean water inaccessibility has become a significant challenge. Limited studies looked at the bidirectional linkage between the concerned variables. Therefore, it is imperative to close the literature gap. Similarly, the mixed results regarding how the population is related to FP/IWM require further investigation, as the local authorities seek solutions to long-standing WSDCs in cities.

The housing issue as a social aspect has a close link with WPEs, as municipalities have to improve water supply capacity to accommodate new housing units. In understanding how new housing opportunities affect basic services provision, Ogra and Onatu's (2013) study looked at Gauteng metropolitan municipalities' housing development projects focusing on urban fringe areas. However, the study pointed out that a surge in urban population has led to accommodation shortages. The establishment of informal settlements gradually becomes a significant challenge in delivering essential services. These scattered settlements mean that the municipalities require substantial funds to expand the SWIF to accommodate new residents. Additionally, residents of informal settlements are poor and cannot afford to pay for basic services. Therefore, funding for water provision remains the burden of the government as urban sprawl takes place, and more funds are needed to fund the expansion of the SWIF. In the same vein, in an analysis involving the social and economic variables and local governance of finances, Zafra-Gómez, Antonio, and Muñiz's (2010) ordinary least squares (OLS) results reveal that social and economic aspects, including housing taxes and the social and economic wellbeing of the residents, determine a local authority's potential to generate revenue. Borel-Saladin and Turok (2015) examine urbanisation in South Africa on a sustainable trajectory. The study focused on whether population growth in the cities has improved housing, public services or not. The study acknowledged that employment growth coincided with demographic trends resulting in poverty eradication and improved urban infrastructure development, which led to better access to services. Considering housing as a social factor, Glossop (2008) examined housing and economic development in London. The results show that suitable housing can attract and retain skills and, thus, result in more investments in cities. Concerning housing programmes' effects on investment needs in the water sector, there is a need to embrace a holistic approach to confronting social practices that pose intolerable threats to stability in the water sector. Hence, the study sought to evaluate the bidirectional linkage between social practices as defined by housing programmes and water provisioning efforts as represented by IWM.

2.5. Economic practices and water provisioning efforts

Water and economic issues are intertwined and cannot be discussed in isolation, as pointed out in the literature (Bourne & Zulunga, 2016; Gurara, Klyuev, Mwase, & Presbitero, 2018). Economic factors are critical in determining the effectiveness of the WSDSs and the management of WSI. The relationship between water and the economy is bidirectional and, this is in line with development-led infrastructure theory. The Organisation for Economic Co-operation and Development (OECD, 2016) explains that investing in water security upgrades spurs economic growth. Also, an improvement in economic growth results in policy reforms, strengthening institutions for water management, and financing investments in water-related technologies, infrastructure, and information systems. Given this scenario, economic factors play a critical role in managing sustainable water infrastructure, as local governments transform urban areas into sustainable cities equipped with effective and efficient WSDSs. For this study, discussing literature that analyses the bidirectional relationship between economic practices and WPEs as measured by IWM is critical to addressing WSDCs.

Financial performance (FP) in municipal councils is a concerning issue as WSAs provide water services at affordable prices which do not reflect costs. Therefore, the financial performance of municipalities remains questionable as various studies continue to produce inconclusive results. Başci and Başci (2016) examined the effect on the FP of 81 Turkish municipalities' water investment decisions. They found that most financial ratios have had a significant and positive influence on drinking water investment except for financing ratios and tax to revenue ratios. Besides, financing ratios and tax to revenue ratios have had a positive effect on sewerage investments. Inconsistently, the same variables that positively correlated with water investments showed a negative relationship with sewerage investment. In a study, Schoeman (2011) analysed the FP and sustainability of local government in South Africa. The study assessed the revenue collected from internally generated

sources on debtors' outstanding, ageing of debt, and dependence on conditional grants. The results indicate that reliance on grants and poor performance of internally generated collection continue to pose challenges to the sustainability of municipalities. Maclean (2015) assessed the financial viability of selected municipal councils in the Eastern Cape. Despite a coherent legislative framework to guide financial management practices, the study results suggest that most municipalities lack adequate financial resources to deliver essential services. Mavhungu (2011) studied the non-payment of municipal services in the Vhembe District Municipality. The study acknowledged that despite sending bills to residents, payments for services consumed are not forthcoming. We have noted that most existing studies on this narrative focused more on what influences FP, and less attention focused on the influence of IWM on FP. Hence, the long-standing literature gap requires attention in establishing a bidirectional relationship between FP and IWM.

Non-revenue water (NREWA) is a cost to the WSAs. Failure to recover full-water cost tends to impact adversely the efforts to deal with water investment challenges. Hence, the problem of NREWA attracted many scholars who argued that economic losses experienced by WSAs raise many questions about the financial viability within the local government sphere. Fostering FP improvement is an alternative approach to achieve effectiveness and efficiency in using SWI and ensuring the management of IWM. Makhari (2016) assessed water service delivery in three cities, namely the City of Tshwane, Cape Town City, and Ethekwini. Ironically, most of these WSAs remain dependent on government subsidies as they fail to recoup water costs. Mavhungu (2011) studied the non-payment for municipal services in the Vhembe District Municipality. The study acknowledged that despite sending bills to residents, payments for services consumed are not forthcoming. Evidence suggests that residents are unwilling to honour their financial obligations due to ignorance, stubbornness, and poverty. Murrar, Tamim, and Samhan (2017) evaluated the determinants of NREWA and financial performance for Palestinian WSPs. Factors, such as staff productivity, energy cost, daily consumption, average price, and WSPs' size and structure significantly affected NREWA, with only water production not having a significant impact. On the same note, financial viability was regressed over the same variables and established that all variables had a significant effect on financial performance except viability service providers' structure and size. The reduction of NREWA has had a positive influence on the performance of WSPs, leading to an improvement in the quality of services under specific social, economic, and institutional frameworks, as in Palestine. Additionally, Maramba (2016) assessed the extent of NREWA for Norton Town in Zimbabwe using NREWA data from 2004 to 2015. According to the results, the average NREWA was 34%, and it surpassed the regional average of 20% to 25%. Inaccurate metering, the use of old and outdated meters, the absence of active leakage management inhibit the reduction of NREWA. Therefore, without addressing economic losses emanating from NREWA, achieving effective WSDSs through proper SWI and IMW management remains a pipedream. Van den Berg (2014) focused on drivers of NREWA. The panel data analysis results from the fixed-effects model point that a higher level of NREWA is due to many factors, including settlement patterns, population density, type of distribution network, the opportunity cost of water loss, and the environment in which the water utility operates. The majority of the studies that examined the impacts of NREWA on the performance of municipalities proved that NREWA harms the financial performance in municipal councils. While various studies focused on effective management of NREWA to enhance financial performance, a few studies looked at how to address WSDCs through increasing IWM to avail more funding needed to contain high levels of NREWA.

Most studies that examined the unidirectional relationship between SEGE practices and IWM found positive, neutral, and negative outcomes. A study that sought to establish reciprocal causations involving a bidirectional relationship between SEGE practices and WPEs as presented by IWM is key to addressing WSDCs.

3. METHODOLOGY

The study employs a correlation research design that uses quantitative data to investigate the bidirectional relationship between SEGE practices and water provision efforts in local governments. Therefore, the study uses inferential statistics to conclude the association between SEGE practices and water provisioning efforts. The study employs various statistical procedures, including descriptive statistics, correlations matrix, multicollinearity, units root test, and Granger non-causality tests to establish the causality effect between the SEGE practices and WPEs represented by IWM.

3.1. Panel data approach

The panel data allows the researcher to track changes to the information collected over some time. Depending on the study objective, various panel data analysis approaches, such as ordinary least squares, fixed-effects, random-effects, and structural equation models are employed to analyse the data. Concerning this paper, the main objective is to establish the bidirectional relationship between SEGE practices and IWM in SAMMs. Therefore, the study employs Grander non-causality tests introduced by Dumitrescu and Hurlin (2012) to examine the causality relationship between SEGE practices and IWM. According to Granger (1969), Granger non-causality test is a popular method for measuring linear dependence between two random variables. The study adopts the following framework equation to establish the bidirectional relationship between SEGE practices and WPEs as measured through IWM.

$$\Delta Y_{i,t} = \sum_{k=1}^{p} \beta_k \Delta Y_{i,t-k} + \sum_{k=o}^{p} \theta_k \Delta X_{i,t-k} + U_{i,t} \qquad (1)$$

Therefore, U is normally distributed with $U_{i,t} = \alpha_{i,t} + \varepsilon_{i,t}$, p presents the number of lags, and are $\varepsilon_{i,t}$ *i.i.d.* $(0, \sigma^2)$. It assumes that the autoregressive coefficients β_k and the regression coefficients θ_k are constant for $\beta \in [1, N]$. Moreover, further assumption

indicates that the parameters β_k are identical for all the individual municipalities, while the coefficients θ_k could have municipality-specific dimensions. However, for Granger non-causality tests to produce reliable and robust results, data must be stationary with no unit root. Also, multicollinearity must not exist among the variables.

3.2. Data and the model

The study objective examines the bidirectional relationship between SEGE practices and WPEs as measured by IWM in the SAMMs. The study considered 278 municipalities in South Africa as the population. Furthermore, due to data availability constraints, we purposively selected all SAMMs that are as follows: the City of Johannesburg, City of Cape Town, City of Ekurhuleni, Buffalo City, City of Tshwane, City of Ethekwini, Nelson Mandela Municipality, and Mangaung Municipality. Moreover, we employed quantitative content analysis to collect secondary data (2009–2019) from publicly available web-based sources and municipal annual reports. The study extracted data from the public platforms, including internet-based councils' annual statements and hardcopies collected from individual municipalities. Besides, the National Treasury's municipal finance data (http://municipaldata .treasury.gov.za), https://municipalities.co.za, and the South Africa Local Government Association (SALGA)'s Municipal Barometer web-based portal were the primary sources of the research data. An explanatory research design that jointly worked with a correlational causality research approach examined the relationship between SEGE practices and IWM. Because water is a common denominator in sustainable development, the study considered Granger non-causality tests to establish the bidirectional relationship between SEGE practices and IWM.

Table 1. Showing detailed description of variables

Variable	*Description*	*Sources*
IWM	Total investment in water management	Amount of money (ZAR) spent on acquiring new water assets and maintenance of existing assets
EHOCR	Expenditure on housing opportunities created	Amount of money (ZAR) expensed on building new houses and renovating the existing ones
POPSZ	Population size	South Africa district population projections for all metro
WOGOS	Women in governance structures	Number of women in management within municipal structure including female councillors
WPTSE	Water professionals and technically skilled employees	A number of all employees are professionally and technically qualified as water experts
EOEPM	Expenditure on wastewater management (in ZAR)	Amount on money (ZAR expensed on the management of wastewater)
EOWWM	Expenditure on wastewater management	Expenditure on wastewater management
NOSRE	Net operating surplus margin	Net operating profit on operating revenue (in percentage)
NREWA	Percentage of non-revenue water	Unaccounted water on water purchased or purified (in percentage)

$$NRWA = \frac{Number\ of\ kilolitres\ (kls)\ of\ water\ purchased\ or\ purified\ -Number\ of\ kls\ of\ water\ sold}{Divided\ by\ the\ number\ of\ kls\ (kilolitres) of\ water\ purchased\ or\ purified} \times 100$$

$$Net\ operating\ surplus\ margin = \frac{Total\ operating\ revenue - Total\ operating\ expenditure}{Total\ operating\ revenue} \times 100$$

Therefore, we have a balanced panel data set for SEGE practices and IWM on eight SAMMs. To determine the bidirectional relationship between the IWM and SEGE practices, the following two models are estimated:

$$\Delta TOIWM_{i,t} = \sum_{k=1}^{p} \beta_k \Delta IWM_{i,t-k} + \sum_{k=o}^{p} \theta_k\ \Delta \mathrm{SEGE}_{i,t-k} + U_{i,t} \quad (2)$$

$$\Delta SEGE_{i,t} = \sum_{k=1}^{p} \beta_k \Delta SEGE_{i,t-k} + \sum_{k=o}^{p} \theta_k\ \Delta IWM_{i,t-k} + U_{i,t} \quad (3)$$

While *SEGE* represents social, environmental, governance, and economic practices, *IWM* represents the total investment in water management. Before the researchers conducted Granger non-causality tests, Levin-Lin-Chu unit root test, the multicollinearity tests, and correlation tests to ensure that the data is free of misspecifications that have effects on regression coefficients and error terms (results shown in Tables 2–4).

Table 2. Levin-Lin-Chu unit root test

Variable	*Adjusted t and p-value*		*Order of integration*
IWM	-3.9494	0.0000	1 (0)
HOCRE	-3.0002	0.0013	1 (0)
PBWAR	-2.6888	0.0036	1 (0)
EOWWM	-2.7045	0.0034	1 (0)
EOEPM	-5.1943	0.0000	1 (1)
WOGOS	-3.1888	0.0007	1 (1)
WPTSE	-5.8659	0.0000	1 (1)
NOSRE	-3.3660	0.0004	1 (0)
NREWA	-3.2438	0.0006	1 (0)

In ensuring that Granger non-causality tests produce reliable and unbiased results, the Levin-Lin-Chu unit root proves that no unit root exists in the variables, implying that all variables are stationary, which is desirable.

Table 3. The variance inflation factor results showing multicollinearity

Variable	*Variance inflation factor (VIF)*	*1/VIF*
POPSZ	7.25	0.137959
WOGOS	3.91	0.255857
WPTSE	3.63	0.275778
NREWA	2.53	0.394826
EHOCR	2.03	0.492588
EOWWM	1.72	0.582204
EOEPM	1.50	0.664988
NOSRE	1.29	0.776402
Mean VIF	3.03	

Variance inflation factor was employed to measure the degree of multicollinearity. Given the results, as shown in Table 3, a mean VIF of 3.03 is far less than 10, implying that multicollinearity does not exist between variables.

Table 4. Correlation matrix

	IWM	*POPSZ*	*EOWWM*	*EOEPM*	*EHOCR*	*WOGOS*	*WPTSE*	*NOSRE*	*NREWA*
IWM	1								
POPSZ	0.5855	1							
EOWWM	0.2316	0.5084	1						
EOEPM	0.2146	0.4049	0.1499	1					
EHOCR	0.1716	0.5084	0.4448	0.2214	1				
WOGOS	0.3563	0.74	0.4951	0.2795	0.5009	1			
WPTSE	0.3015	0.4907	0.2278	0.1538	0.3395	0.0553	1		
NOSRE	0.0568	-0.0159	0.0602	-0.0325	0.213	-0.1191	0.2869	1	
NREWA	-0.2678	-0.4681	-0.2267	-0.1294	-0.276	-0.0794	-0.7494	-0.1101	1

Table 4 shows a correlations matrix result that further proves that no close correlation exists between all the variables concerned.

4. RESULTS

Considering that IWM is key to sustainable development, continued efforts to align SEGE practices with water investment plans are imperative WSDCs. Hence, this implies that IWM and SEGE practices have a direct influence on each other. Therefore, to achieve the objective relating to determining the bidirectional relationship between SEGE practices and IWM, this study employs Granger non-causality tests. The study considered lag lengths 1, 2, and 3 in exploring the bidirectional relationship between SEGE practices and IWM.

4.1. The bidirectional connection between social practices versus IWM

After considering lag length 1–3 in determining the causality relationship between expenditure on housing opportunities created (*EHOCR*) and total investment in water management (*IWM*), the results in Table 5 suggest that *IWM* does not Granger-cause *EHOCR* as all p-values within lag lengths 1, 2, and 3 are above the threshold of 0.05 significance level. Hence, results imply the approval of the null hypothesis ($H1_0$).

Table 5. Granger non-causality test results: Social practices versus IWM

Pairwise Granger causality tests Sample: 2009–2019			
Null hypothesis	***Probability values***		
	Lag 1	***Lag 2***	***Lag 3***
$H1_0$: IWM does not Granger-cause EHOCR.	0.3404	0.6781	0.5461
$H2_0$: EHOCR does not Granger-cause IWM.	0.2636	0.0106	0.0769
$H3_0$: IWM does not Granger-cause POPSZ.	0.0002	0.0044	0.2602
$H4_0$: POPSZ does not Granger-cause IWM.	0.0257	0.0057	0.2936

Contrary to the above results, *EHOCR* failed to Granger-cause *IWM* in the first and third years (lag 1 and 3). Whereas in the second year (lag 2), changes in *EHOCR* managed to affect *IWM*. Therefore, the null hypothesis ($H2_0$) cannot be accepted. The existence of a causality relationship suggests that the causal effect of *EHOCR* on *IWM* happened in the second year, meaning that municipalities responded to water investment needs two years after investing in creating housing opportunities. The causality impact of *EHOCR* on *IWM* is in line with Glossop (2008), who found that housing programmes have influenced the attraction of skilled workforce needed to attract investments. While considering the causal effect of *IWM* on *POPSZ*, evidence suggests that during the first (lag 1) and second years (lag 2) of changes in *IWM*, the population size in SAMMs responded as the p-values for both lag lengths are below a significant level of 0.05. Similarly, *POPSZ* granger caused *IWM* during the first year (lag 1), and the subsequent year (lag 2). Hence, the results suggest that the null hypothesis ($H3_0$) cannot be accepted. The results are in line with the government's municipal funding framework that encompasses local government equitable shares (LGES) and municipal infrastructure grant (MIG) formulas that use population size as one of the determinant factors in deciding the level of funding. The bidirectional relationship between *POPSZ* and *IWM* resonates well with Kleynhans and Coetzee (2019), they found out that population size has had a significant impact on FP that also tends to affect *IWM*. Hence, the results suggest that the null hypothesis ($H4_0$) cannot be accepted.

4.2. The bidirectional connection between EMPs versus IWM

As indicated in Table 6, *IWM* does Granger-caused *EOWWM*, only during the first year (lag 1) and third year (lag 3) because all p-values are below the confidence interval of 5%. Given the results, the null hypothesis ($H5_0$) cannot be accepted.

Table 6. Granger non-causality test results: EMPs versus IWM

Pairwise Granger causality tests *Sample: 2009–2019*			
Null hypothesis	***Probability values***		
	Lag1	***Lag 2***	***Lag 3***
$H5_0$: IWM does not Granger-cause EOWWM.	0.0003	0.0714	0.0128
$H6_0$: EOWWM does not Granger-cause IWM.	0.0347	0.6416	0.6760
$H7_0$: IWM does not Granger-cause EOEPM.	0.0599	0.0857	0.1349
$H8_0$: EOEPM does not Granger-cause IWM.	0.0649	0.4323	0.6451

The results suggest that change in *IWM* in SAMMs triggered *EOWWM*, implying that municipal councils should ensure that funding challenges relating to wastewater receive urgent attention. The results are consistent with Naidoo et al. (2016), who established that a lack of financial resources spurs incapacitation challenges. While *EOWWM* only Granger-caused *IWM* in the first year (lag 1), second- and third-year *IWM* failed to respond to changes in *EOWWM*.

In the case of the bidirectional relationship between *IWM* and *EOEPM*, the results suggest that the null hypothesis ($H7_0$, $H8_0$) cannot be accepted considering that a p-value of 0.0599 (lag 1) is within the threshold. The results further imply that *EOEPM* responded to changes in *IWM*. In the subsequent years (lag 2 and 3), all p-values are above 0.05, as this proves that *TOIWM* failed to Granger-cause *EOEPM*. The reverse direction of the two variables deceits that *EOEPM* have had no effects on *TOIWM* throughout lag lengths 1 to 3. The results are contrary to the findings of various studies that established that EMPs such as waste, energy, and carbon emission affected the performance of municipalities (Horta, Camanho, & Dias, 2016; He at el., 2017). Furthermore, the lack of causality effect on *EOEPM* on *IWM* exposes municipalities' lack of collaborative approaches in dealing with *EOEPM* to bring about changes in *IWM*. It is fundamental for SAMMs to invest in sustainable infrastructure as a defense mechanism against floods and stormy weather to avoid severe infrastructure damages (Grames, Prskawetz, Grass, Viglione, & Blöschl, 2016). Hence, there is a need to remain focused by the municipalities in trying to link EMPs and management of WSI for improved services delivery.

4.3. The bidirectional connection between corporate governance practices and IWM

Given the results shown in Table 7, it is clear that *IWM* managed to Granger-caused *WOGOS* only during the first year (lag 1), as evidenced by the p-value of 0.0522. Hence, the null hypothesis ($H9_0$) cannot be accepted. While in years 2 and 3, *TOIWM* failed to influence *WOGOS*, suggesting the acceptance of a null hypothesis ($H10_0$). Looking at the reverse direction between the variables, *WOGOS* seems to have had no impact on *IWM* in three consecutive years. However, implying that the number of women within the governance structure of the municipal councils did not have an impact on decisions relating to IWM. However, the results are inconsistent with outcomes of Araujo and Tejeko-Romero's (2018) study that found that gender diversity in the municipalities improved transparency resulting in better FP.

Table 7. Granger non-causality test: CGPs versus IWM

Pairwise Granger causality tests Sample: 2009–2019			
Null hypothesis	***Probability values***		
	Lag 1	***Lag 2***	***Lag 3***
$H9_0$: IWM does not Granger-cause WOGOS.	0.0522	0.4201	0.3682
$H10_0$: WOGOS does not Granger-cause IWM.	0.8459	0.5344	0.6108
$H11_0$: IWM does not Granger-cause WPSTE.	0.7827	0.4373	0.7386
$H12_0$: WPSTE does not Granger-cause IWM.	0.1870	0.0338	0.0011

Also, Table 7 reveals that the *IWM* Granger-caused *WPSTE* as p-values representing lag lengths 1–3 is above the significance level of 0.05. The results suggest that changes in *IWM* have had no impact on water experts, implying that municipalities failed to fund water management operations adequately to influence the number of water experts. In a way, the results agree with Masindi and Duncker (2016), who found that municipal councils are failing to use good salary packages to attract required skills. On the other hand, *WPSTE* managed to Granger-cause *IWM* in the lag lengths 2 (0.0338) and 3 (0.0011), as evidenced by p-values below 0.05. Hence, the null hypothesis ($H12_0$) cannot be accepted. The existence of a causality relationship between *WPSTE* and *IWM* proves that the municipalities have taken the right course of action to address challenges confronting the water provisioning efforts, as confirmed by Infrastructure Dialogue (2015) in the study on South African conservation with infrastructure dialogue.

4.4. The bidirectional connection between economic practices and IWM

The relationship between *IWM* and *NORSE* proved to be one-sided. According to the results shown in Table 8, the null hypothesis ($H13_0$) is not acceptable, as changes in *IWM* Granger-caused *NORSE* within lag length 1 (0.04775). While in the following two consecutive years, *NORSE* failed to respond, the narrative that SAMMs lack adequate funding to manage water infrastructure. Looking at the one-way direction relating to *NOSRE* effects on *IWM*, the Granger non-causality test disapproves the existence of the relationship as all p-values (lag lengths 1–3) are above the confidence interval of 5%. Hence, results imply the approval of the null hypothesis ($H14_0$). The results suggest that SAMMs failed to generate an adequate surplus to influence IWM. The findings resonate with Schoeman (2011), who found that poor revenue management practices continue to influence the FP of municipalities.

Table 8. Granger non-causality test: Economic practices versus IWM

Pairwise Granger causality tests *Sample: 2009–2019*			
Null hypothesis	***Probability values***		
	Lag 1	***Lag 2***	***Lag 3***
$H13_0$: IWM does not Granger-cause NORSE.	0.04775	0.1590	0.0767
$H14_0$: NOSRE does not Granger-cause IWM.	0.7462	0.8585	0.3361
$H15_0$: IWM does not Granger-cause NREWA.	0.2741	0.3752	0.5302
$H16_0$: NREWA does not Granger-cause IWM.	0.2416	0.0016	0.0229

While municipalities are struggling to contain economic losses due to the surge in *NREWA*, results in Table 8 suggest that *IWM* failed to Granger-cause *NREWA*, implying the approval of the null hypothesis ($H15_0$). The findings further reveal that the municipalities' failure to deal with *NREWA* remains an obstacle in addressing water infrastructure maintenance challenges (Madumo, 2015). *NREWA* failed to cause an effect on *IWM* in the first year (lag 1), implying that the null hypothesis is acceptable ($H16_0$). Two years after changes to *NREWA*, *IWM* responded as the p-values for lag lengths 2 (0.0016) and 3 (0.0229) are below a significant level of 0.05. Consequently, the results further prove that the continued surge in the *NREWA*, as confirmed in literature (McKenzie, 2014), perpetually presents challenges in managing WSI.

5. DISCUSSION

In evaluating the bidirectional relationship between SEGE practices and IWM, the research employed the Granger non-causality tests. Concerning the bidirectional relationship between social practices as presented by *EHOCR* and *POPSZ* and WPEs as measured through *IWM*, *POPSZ* managed to influence *IWM* and vice versa. The results suggest that the local municipal councils responded to changes in population size and adjusted *IWM*. The results resonate very well with literature that established that high population caused expenditure in service provision to improve (Mahabir, 2010). On the same note, the findings are in line with Asoka et al. (2013), who found that the water infrastructure components responsible for providing the services have been negatively affected by the population growth as clean water inaccessibility has become a significant challenge. Whereas Kleynhans and Coetzee's (2019) study confirmed that the ratio of people who belong to non-working age to the total population is one of the most significant factors affecting the municipalities' financial condition. Therefore, the results further imply that in planning for IWM, determining population size provides direction to manage WPEs to eradicate WSDCs. Also, *EHOCR's* influence on *IWM* in the following year (lag 1) is consistent with the findings of Glossop (2008), who found that housing projects in the city of London positively impacted investment in the city. However, this signifies that municipalities should continue to respond to changes in housing opportunities to address WSDCs through adjusting IWM accordingly.

Regarding IWM and EMPs (as measured through *EOWWM* and *EOEPM*), the Granger non-causality test

results show mixed results. *IWM* managed to influence *EOWWM*. The municipal councils continue to address wastewater management challenges as confirmed in the literature (Tempelhoff, Munnik, & Viljoen, 2007). On the same note, no bidirectional linkage exists between *EOEPM* and *IWM* and only *EOEPM* responded to changes in *IWM*. The existence of a one-way direction between *TOIWN* and *EOEPM* is in line with the results found by Folz (1999) that confirmed that the solid waste recycling performance of cities is a success story as municipalities were able to accumulate some benefits out of recycling efforts. Also, Horta et al. (2016) established that municipal performance tends to be influenced by environmental policy expenditure.

The bidirectional linkage between CGPs as proxied by *WOGOS* and *WPSTE* and *IWM*, the results are elusive. The influence of gender presented by *WOGOS* in municipal councils failed to influence *IWM*. The results are contrary to the study by Ng'etich (2015) that found women to have affected the performance of water companies. While the current situation in the municipal council's structures proves that gender inequalities continue to receive attention, the causality effect of *IWM* on *WOGOS* justifies efforts by the government to invest in upskilling the women so that they can take up higher posts within the municipalities' governance structures. Therefore, continued efforts to increase *IWM* through accommodating more women in the top management are imperative to addressing WSDCs, as women are known for managing water for domestic purposes. The lack of a bidirectional relationship between *IWM* and *WPSTE* is of great concern. Only *WPSTE* managed to influence *IWM* and, this suggests that the presence of water experts in the water sector is a positive step to creating stability in managing WSI. The results are consistent with other previous studies that confirmed that the quality of human resources matters to the performance of municipalities (Monkam, 2014; Ramutsheli & Janse van Rensburg, 2015). Hence, there is a need to ensure that the right skills are available to address challenges concerning mismanagement of funds, poor asset management, and poor CGPs for improved WSDSs.

The bidirectional relationship between economic practices measured through *NOSRE* and *NREWA* and *IWM* confirms mixed results. Given the results, only *NREWA* managed to create an effect on *IWM* after two years. The results are in line with previous studies that established that *NREWA* influenced the financial viability of the municipalities (Murrar et al., 2017). The non-existence of the bidirectional relationship between *NREWA* and *IWM* reveals the lack of serious commitment by the municipal councils to invest in reducing *NREWA*, which has continued to result in economic losses in municipalities (van den Berg, 2014). Contrary to the results, the lack of a bidirectional relationship between *NOSRE* and *IWM* suggests that municipal councils failed to generate adequate revenue to spearhead the funding of water projects. The results further align with the findings of Schoeman (2011), who found that poor revenue performance by municipalities inhibits sustainability of municipal performance. Therefore, municipal councils should continue to link economic practice with IWM to achieve financial sustenance and viability.

6. CONCLUSION

The study examined the bidirectional relationship between social, economic, governance, and environmental practices and water provisioning efforts measured through IWM in the South African metropolitan municipalities. The study used data collected from web-based sources concerning South African metropolitan councils. The study addressed the main objective by employing Granger non-causality tests. The study results revealed that a bidirectional relationship exists between SEGEs practices and IWM in municipal councils. Specifically, only social practices as measured through population size and *IWM* have had a bidirectional relationship. Additionally, EMPs measured by *EOWWM* have had a bidirectional connection with *IWM* at different lag lengths. Also, no two-way causality connection existed between CGPs as measured through *WOGOS* and *WPSTE*. Lastly, given the linkage between economic factors and IWM, only *NREWA* caused *IWM*. Therefore, failure to establish a causal connection between most variables suggests that municipalities are still trying to adapt the theory of sustainability imperative concept that seeks to consider all dimensions of capital, including economic, social, human, and natural capital (Radej, 2007). On the same note, failure to establish an outright bidirectional linkage between practices associated with the economic situation and IWM suggests that municipalities exist to serve the community without making a profit. Similarly, access to water service is a right according to The Constitution of South Africa, and, as such, financial viability policies of the municipalities fulfill the constitutional obligation rather than generating excessive revenue.

Concerning the results, the new perspective presented by the study suggests that stability in the management of WSI provides an impression that by addressing economic, social, environmental, and governance practices, containment of unplanned excessive funding needs to match fiscal capacities of the local governments is possible and achievable. Precisely, the municipal councils should be made aware of the extent to which SEGE practices influence IWM. Given the need to achieve a stable investment-friendly environment in the water sector, aligning SEGE practices to building more sustainable and resilient water infrastructure is imperative to improving water security in cities. With growing rhetoric on developing sustainable cities, we made a modest contribution by exploring an alternative way of addressing WSDCs that create WSI opportunities. Considering the study results, adopting the sustainability imperative concept presents an opportunity for WSAs to draw holistic water service plans to resolve WSDCs. Similarly, this study is most likely to influence WSAs to reconfigure their water services delivery and strategic plans to manage WSIs by ensuring that sustainability dimensions receive equal attention. In an attempt to address the WSDCs in cities, the study made a modest contribution to the extant literature by closing an existing knowledge gap, as to the knowledge of researchers, no evidence of empirical studies that followed a similar approach in the context of SAMMs to investigate the same matter exists.

Concerning the short time frame for the longitudinal study, the results would have been more robust if a study considered a prolonged period covering 20 years. Also, the study was limited to Granger causality tests involving data collected from 8 out of 278 municipalities. Therefore, future studies should continue to explore this narrative as time progresses to gain deeper insights into the matter. Besides, the variables used in the study change over time, and as such, the study results reflect the behaviours of the variables only during the study period. Hence, the researchers recommend applying cointegration tests to determine the long-term relationship between SEGE practices and IWM in further research. Also, future studies should focus on employing structural equations models to establish the direction and significance of the relationship between SEGE practices and IWM to ensure that the water infrastructure underinvestment challenges receive the much-needed attention to contain WSDCs.

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