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Exploring the potential of blockchain technology in enhancing transparency and accountability at local government level in South Africa

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Abstract

This qualitative study explores the potential of blockchain technology to enhance transparency and accountability in local government in South Africa. Despite efforts to promote good governance, local governments in South Africa continue to grapple with challenges of corruption, inefficiency, and lack of transparency. The decentralised, secure, and tamper-proof nature of blockchain technology offers a promising solution. This paper examines the current state of transparency and accountability in local government in South Africa and explores the potential applications of blockchain technology in this context. For data collection, the paper reviews existing literature and documents on blockchain technology and its applications in government and presents case studies of blockchain implementation in local government in South Africa. The findings suggest that blockchain technology has the potential to transform the way local governments operate, by increasing transparency, accountability, and trust in government. Furthermore, the study's findings revealed that local governments in South Africa have initiated various pilot projects leveraging blockchain technology, including the management of land registers, development of secure voting systems, monitoring, and management of essential services such as water and electricity supply, and implementation of robust identity management systems. However, the paper also highlights the challenges and limitations of implementing blockchain technology, including the need for significant investment in infrastructure and the lack of regulatory frameworks. The paper recommends developing a national blockchain strategy, establishing a blockchain regulatory framework, and investing in blockchain infrastructure.

Keywords: Blockchain technology, Transparency, Accountability, Local government, Innovation, Corruption

1 Introduction

The importance of transparency and accountability in local government cannot be overstated. In South Africa, local government plays a critical role in delivering essential services such as water, sanitation, electricity, and roads to communities. However, the ability of local government to deliver these services effectively is often undermined by a lack of transparency and accountability (Mamokhere, 2022). Transparency is essential in local government as it allows citizens to access information about government activities, decisions, and spending. Accountability ensures that government officials are held responsible for their actions and that there are consequences for misconduct (Aranha, 2017). Lack of transparency and accountability creates an environment conducive to corruption, mismanagement, and abuse of power. In South Africa, local government faces numerous challenges that hinder its ability to deliver services effectively. One of the most significant challenges is corruption. The country has a high Corruption Perception Index (CPI) score, ranking 69 out of 180 countries globally, which indicates a moderate to high level of perceived corruption (Fourie & van der Waldt, 2021; Kgobe & Mamokhere, 2021). This ranking suggests that South Africa still has significant work to do in addressing corruption and promoting transparency and accountability in government.

As noted by Munzhedzi (2016), corruption in local government manifests in various forms, including bribery, embezzlement, and nepotism. The lack of accountability and transparency exacerbates corruption,

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making it difficult to detect and prevent. Without effective accountability mechanisms, corrupt officials can act with impunity, undermining the integrity of local government (Sibanda & Lues, 2021). The use of blockchain technology has been proposed as a potential solution to enhance transparency and accountability in government (AIShamsi et al., 2022; Bishr, 2019; Sibanda et al., 2024). Blockchain technology is a decentralised, digital ledger that records transactions and data across a network of computers (Dowelani et al., 2022; Hariguna et al., 2021). In simple terms, blockchain can be imagined as a big digital ledger that records transactions, like money transfers or data sharing, in a secure and transparent way. Instead of one person controlling the ledger, many people have a copy, making it hard to alter or manipulate. When a transaction happens, it is checked by a network of computers to ensure that it is legitimate, and then is added to the ledger, creating a permanent record (Hariguna et al., 2021). This technology ensures that all transactions are accurate, trustworthy, and publicly visible, making it a game-changer for industries that rely on transparency and accountability (Dowelani et al., 2022). As highlighted by Liu et al. (2019), its key features, including immutability, transparency, and security, make it an attractive solution for enhancing accountability and transparency in government.

The Raipur Municipal Corporation in India has leveraged blockchain technology to develop a transparent and tamper-proof system for issuing digital building permission certificates (Harigunani, 2024). This system has not only improved transparency but also generated significant revenue for the municipality. Additionally, the municipality has implemented a blockchain-based public grievance-management system, enabling citizens to file and track complaints, thereby promoting accountability and reducing corruption (Harigunani, 2024). Another example is the city of Dubai, which has implemented a blockchain-based system for tracking and verifying the authenticity of goods, reducing the risk of counterfeiting and improving transparency in supply chain management (Khan et al., 2022).

Kenya has emerged as a pioneer in harnessing blockchain technology to drive transparency, accountability, and efficiency in governance and public service delivery. As noted by Ondiek and Onyango (2024), the Kenyan healthcare sector has seen significant gains, with blockchain-based systems tracking pharmaceuticals, verifying authenticity, and ensuring regulatory compliance. This has led to a marked reduction in fraud, improved distribution of medical supplies, and enhanced patient care (Ondiek & Onyango, 2024). The country's land registry has also undergone a transformative overhaul with the introduction of "LandCoin", a blockchain-based platform that secures land titles, creates an immutable ledger, and minimises disputes and fraudulent activities (Wilkins & Mwanza, 2018). Kenya's national digital identity strategy, Huduma Namba, leverages blockchain to create a secure, transparent, and tamper-proof ledger for identity data storage and verification (Tonu et al., 2019). This innovative approach mitigates identity theft and unauthorised access, safeguarding citizens' personal data.

According to Ghazali (2018), in the education sector, Kenya has collaborated with the Africa Union and the University of Nairobi to develop a blockchain-based system for issuing and verifying academic degrees. This groundbreaking solution tackles the perennial problems of fraud and forgery associated with traditional paper-based certification (Ghazali, 2018). Through its adoption of blockchain technology, Kenya has taken a significant stride toward creating a more transparent, accountable, and efficient governance framework, with far-reaching benefits for its citizens. The Kenyan government's successful implementation of blockchain technology to enhance transparency and accountability in governance offers valuable lessons for South African municipalities seeking to improve their own accountability and service delivery. Through the adoption of similar blockchain-based solutions, South African municipalities can increase transparency, reduce corruption, and promote citizen engagement, ultimately leading to more effective and responsive governance.

The adoption of blockchain technology in Kenya faces several hurdles, including limited ICT infrastructure, insufficient workforce skills, and inadequate leadership buy-in (Imani, 2017). Furthermore, the entrenched culture of corruption in government financial processes, which blockchain technology aims to eradicate, presents a significant obstacle. To fully harness the potential of blockchain-enabled services, Kenya must address critical factors such as developing robust technical expertise, establishing supportive regulatory frameworks, and fostering a mindset shift towards decentralised governance (Imani, 2017).

In South Africa, the City of Johannesburg has explored the use of blockchain technology for land

registration, aiming to improve transparency and reduce corruption in the land administration process (Sibanda & Lues, 2021). While these examples are promising, further research is needed to explore the applications and effectiveness of blockchain technology in enhancing transparency and accountability in local government in South Africa. The research question guiding this study is: Can blockchain technology enhance transparency and accountability in local government in South Africa? This study aims to explore the current state of transparency and accountability in local government in South Africa, examine the potential applications of blockchain technology, investigate the challenges and limitations of implementing blockchain technology, and provide recommendations for policymakers and practitioners.

2 State of transparency and accountability in local government in South Africa

The state of transparency and accountability in local government in South Africa is a pressing concern that has garnered significant attention in recent years. Despite the country's democratic transition in 1994, which ushered in a new era of governance, local government in South Africa continues to grapple with issues of transparency and accountability (Mabizela & Matsiliza, 2020; Sithole, 2021). The Constitution of South Africa (1996), which is hailed as one of the most progressive in the world, enshrines the principles of transparency and accountability in its provisions. However, the reality on the ground paints a different picture. Local government in South Africa is characterised by lack of transparency, which has led to widespread corruption, maladministration, and poor service delivery (Mabizela & Matsiliza, 2020; Ramodula & Govender, 2020; Sithole, 2021). The auditor-general's reports over the years have consistently highlighted the poor state of financial management, lack of accountability, and inadequate oversight in local government (Kaziboni & Radulovic, 2023; Ramodula & Govender, 2020). For example, the 2021/22 auditor-general's report revealed that only 38 out of 257 municipalities in South Africa received a clean audit, while most municipalities had material findings against them (Auditor-General of South Africa, 2022). This lack of transparency and accountability has eroded public trust in local government, leading to widespread protests and demands for better service delivery (Ramodula & Govender, 2020).

In South Africa, municipal officials are controlled through a combination of top-down and bottom-up mechanisms. Top-down control is exercised through oversight and audits by provincial governments, as well as national government interventions when necessary (Sithole, 2021). The provincial government can take over municipal functions if a municipality fails to fulfil its obligations, as stated in the Constitution (Ramodula & Govender, 2020). Additionally, municipalities are subject to legislative and regulatory frameworks such as the Municipal Systems Act, 2000, which guides local public administration and human resource management. Bottom-up control is achieved through citizen participation and engagement. This includes mechanisms like ward committees, which provide a platform for citizens to participate in decision-making processes (Tshiki, 2024). Municipalities are also required to make their administration transparent and accountable to the public, allowing citizens to hold officials accountable for their actions (Koto & Kanjere, 2021).

According to Mazibuko and Fourie (2017), the provincial governments, which are supposed to exercise oversight over municipalities, often lack the capacity and resources to do so effectively. Furthermore, the national government's oversight role is often limited to providing funding and policy guidance, rather than actively monitoring and evaluating the performance of municipalities (Mazibuko & Fourie, 2017). According to Koto and Kanjere, (2021), this lack of effective oversight has created an environment in which corruption and maladministration can thrive. For example, the VBS Mutual Bank scandal, which involved the looting of millions of rands from the bank by municipal officials and politicians, highlighted the lack of effective oversight and accountability in local government (Mupangavanhu, 2021). The scandal led to widespread outrage and calls for greater transparency and accountability in local government.

Another significant challenge facing local government in South Africa is the lack of transparency in procurement processes. Procurement is a critical area of local government, as it involves the allocation of significant resources to service providers and contractors. However, the procurement process in local government is often shrouded in secrecy, leading to widespread corruption and irregularities (Mazibuko & Fourie, 2017). As noted by Koto and Kanjere (2021), the lack of transparency in procurement has

been exacerbated by the lack of effective regulation and oversight. For instance, the Municipal Supply Chain Regulations, which are supposed to govern procurement processes in local government, are often flouted with impunity (Koto & Kanjere, 2021). Tshiki (2024) argues that this lack of transparency and accountability in procurement processes has led to corrupt activities, with many municipalities awarding contracts to companies and individuals with close ties to politicians and officials. The consequences of this corruption are dire, as it leads to poor service delivery, inflated prices, and a lack of value for money. For example, the City of Johannesburg's procurement processes were recently found to be irregular, with many contracts awarded to companies with close ties to politicians and officials (City of Johannesburg Council, 2023).

The lack of transparency and accountability in local government in South Africa has been exacerbated by the lack of effective citizen participation and engagement. As claimed by Mazibuko and Fourie (2017), citizen participation and engagement are critical components of democratic governance as they provide citizens with a voice and a stake in the decision-making process. However, in South Africa, citizen participation and engagement in local government are often limited to tokenistic consultations and public hearings (Bester, 2020; Matloga et al., 2024). Many citizens feel disconnected from the decision-making process, which has led to widespread disillusionment and disengagement. Furthermore, the lack of effective citizen participation and engagement has created an environment in which corruption and maladministration can thrive. Lack of citizen oversight and engagement has allowed many municipalities to get away with irregularities and corruption, without being held accountable (Koto & Kanjere, 2021; Mazibuko & Fourie, 2017).

According to Harigunani (2024), one of the primary intentions of blockchain systems is to promote decentralisation and transparency, thereby reducing the need for top-down oversight. By leveraging blockchain technology, South African municipalities can indeed become more transparent and accountable to citizens. This is achieved through the creation of an immutable, tamper-proof ledger that records all transactions and activities, making it possible for citizens to track and verify the actions of municipal officials (Sibanda et al., 2024). Furthermore, blockchain-based systems can simplify complex procedures by providing a clear and accessible audit trail, enabling citizens to better understand and engage with municipal decision-making processes (Sibanda, Basheka & van Romburgh, 2024).

3 Understanding blockchain technology

At its core, blockchain technology is based on a simple yet powerful concept: a chain of blocks, each containing a set of transactions or data which are linked together through cryptographic hashes (Olalekan, 2024). As noted by Lansky (2021), this creates a permanent and unalterable record of all transactions or data that have taken place on the network. The basic principles of blockchain technology are rooted in cryptography, game theory, and distributed systems (Garcia, 2021; Kshetri & Voas, 2018). According to Maza (2019), advanced cryptographic algorithms and protocols ensure that transactions or data are secure and tamper-proof and that nodes on the network behave honestly and work together to validate transactions. Distributed systems means that the network operates in a decentralised manner, without the need for a central authority (Maza, 2019).

One of the key characteristics of blockchain technology is its ability to operate on diverse types of networks. There are three main types of blockchain networks: public, private, and consortium (Garcia, 2021). Shava and Mhlanga (2023) state that public blockchain networks, such as Bitcoin and Ethereum, are open to anyone to participate in the network. Private blockchain networks, on the other hand, are restricted to a specific group of users and are often used within organisations (Garcia, 2021). Consortium blockchain networks are a hybrid of public and private networks, where a group of organisations come together to form a network (Dai & Vasarhelyi, 2017; Sarker et al., 2021). Each type of network has its own advantages and disadvantages, and the choice of network depends on the specific use and requirements. For instance, public blockchain networks offer an elevated level of decentralisation and security but may be slower and more expensive to use (Dai & Vasarhelyi, 2017). Private blockchain networks, on the other hand, offer faster transaction times and lower costs but may be less secure and more centralised (Beck et al., 2017).

Blockchain technology has several features that make it an attractive solution for enhancing transparency and accountability. Unlike traditional centralised systems, blockchain technology operates on a decentralised network of nodes, each of which has a copy of the blockchain (Sarker et al., 2021). According to Tak (2023), this ensures that there is no single point of failure and that the network can continue to operate even when one or more nodes go offline. Another key feature of blockchain technology is its immutability. Once a transaction or data is recorded on the blockchain, it cannot be altered or deleted (Atzori, 2017; Jimoh et al., 2018). According to Lansky (2021), this ensures that the blockchain provides a permanent and tamper-proof record of all transactions or data. Blockchain technology provides a high level of transparency, as all transactions or data are recorded on a public ledger that can be accessed by anyone (Garcia, 2021).

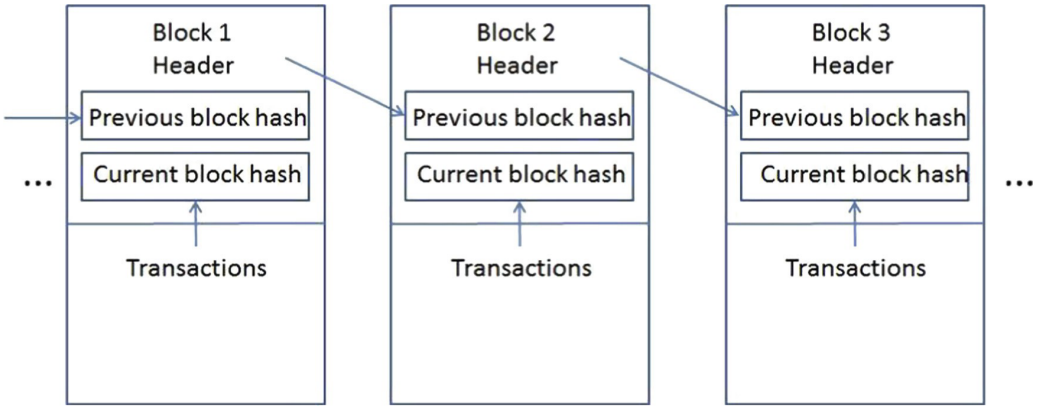

Figure 1: Simple blockchain. Source: Kshetri, 2021.

Figure 1 illustrates a straightforward sequence of interconnected blocks, where each block contains a unique digital fingerprint, or hash, of the preceding block. Specifically, block 2 incorporates the hash of block 1, while block 3 contains the hash of block 2, and so on. This creates an unbroken chain of blocks, with each subsequent block inextricably linked to its predecessor. The combination of this interlinked structure and a consensus algorithm ensure the blockchain's integrity, rendering it impervious to tampering and alteration.

While the benefits of blockchain technology in promoting transparency and accountability in government are evident, it is crucial to consider the potential challenges and limitations of its implementation. Azmi and Nugroho (2023) emphasise that one significant hurdle is the need for widespread technological infrastructure and expertise, particularly in developing countries or regions with limited resources. Moreover, the integration of blockchain technology into existing government systems may require significant institutional and regulatory reforms, which can be complex and time-consuming (Alketbi et al., 2020). Blockchain technology also raises questions about data privacy and security, particularly in cases where sensitive information is involved (Azmi & Nugroho, 2023). Therefore, it is essential to adopt a nuanced and content-specific approach to implementing blockchain technology in government, one that considers the unique challenges and opportunities of each country or region. This may involve investing in capacity-building and training programmes, developing new regulatory frameworks, and establishing robust data protection protocols (Lansky, 2021).

4 Research methodology

This systematic review aimed to explore the potential of blockchain technology in enhancing transparency and accountability at local government level in South Africa. A comprehensive search strategy was employed to identify relevant studies published in English between 2015 and 2024. The search terms used included "blockchain technology," "transparency," "accountability", "local government", and "South Africa". A systematic search of major databases, including Scopus, Web of Science, Google Scholar, and ScienceDirect, was conducted. These search engines were selected based on their relevance to the research

topic, comprehensive coverage of academic literature, and peer reviewed publication indexing, while Google was used to search for grey literature, conference proceedings, reports and other non-peer-reviewed sources. A total of 50 peer-reviewed articles and book chapters were selected for inclusion in the study, based on their relevance to the research topic and their publication date (Aspers & Corte, 2019).

The selected literature was analysed using thematic analysis, which involved identifying and coding key themes and concepts related to blockchain technology adoption in local government in developed and developing countries including South Africa. The thematic analysis was conducted in two stages. First, the literature was coded using an inductive approach, where codes were generated based on the data (Gerring, 2017). Second, the codes were grouped into themes, which were then analysed to identify patterns and relationships. The analysis revealed several key themes, including the potential of blockchain technology to enhance transparency and accountability in local government, and the challenges and limitations of implementing blockchain technology in local government. In addition to the peer-reviewed articles and book chapters, 20 documents were selected for inclusion in the study, including government reports, policies, and guidelines related to blockchain technology adoption in local government.

The quality of the included studies was assessed using the Critical Appraisal Skills Programme (CASP) qualitative checklist (Long et al., 2020). The CASP checklist is a widely used tool for assessing the quality of qualitative studies. The checklist evaluates the quality of studies based on criteria such as the clarity of the research question, the appropriateness of the study design, and the rigour of the data collection and analysis methods. Studies that scored high on the CASP checklist were considered to be of high quality, while those that scored low were considered to be of low quality. The data extracted from the included studies were synthesised using a narrative approach. The narrative synthesis involved summarising the findings of the included studies, identifying patterns and themes, and drawing conclusions about the impact of blockchain technology on transparency and accountability.

5 Results and Discussion

This section examines the findings and implications of leveraging blockchain technology in local government in South Africa, highlighting its potential to drive efficiency, transparency, and innovation.

5.1 Supply chain management

One of the potential applications of blockchain technology in local government in South Africa is supply chain management. According to Sibanda et al. (2024), blockchain technology can be used to track the movement of goods and services through the supply chain, ensuring transparency and accountability. For example, blockchain technology can be used to track the origin of goods, ensuring that they are genuine and not counterfeit (Casallas et al., 2020; Chigudu, 2020). This can be particularly useful for local government procurement, where ensuring the authenticity of goods and services is crucial. The media has on several occasions reported that the South African Police Service (SAPS) has seized and confiscated large quantities of counterfeit goods, valued at millions of rand, in various raids and operations conducted across different provinces and cities in the country. According to Kamble et al. (2019) the potential benefits of using blockchain technology in supply chain management include increased transparency, reduced risk of corruption, and improved efficiency. As observed by Tshiki (2024), South Africa's Corruption Perceptions Index (CPI) score has remained stagnant in recent years with scores in the 40s, indicating persistent struggles in tackling corruption and promoting accountability. In the 2022 CPI report, the country received a score of 43 out of 100, placing it 72nd out of 180 countries globally. This highlights the need for significant improvement in South Africa's anti-corruption efforts.

5.2 Land registration

Another potential application of blockchain technology in local government in South Africa is land registration. Blockchain-based solutions can provide a secure, decentralised and transparent framework for recording land ownership, mitigating the risks of disputes, corruption, and land title fraud (Liang et al., 2021). Blockchain technology can be used to create a digital ledger of land ownership, which can be accessed by all relevant

stakeholders. Aburumman et al. (2020) propose that this can help to ensure that land ownership is accurately recorded and that any changes to ownership are properly documented. Blockchain technology also improves efficiency in land registration because it can automate many of the processes involved in land registration, such as title searches and document verification, reducing the time and cost associated with these tasks (Min, 2019). Thus, the benefits include enhanced security, increased accessibility, reduced costs, improved data integrity, enhanced transparency in property valuation, and a simplified property transfer process (Maden et al., 2020; Trevor & Thomas, 2019).

According to Sibanda et al. (2024), potential challenges to consider when using blockchain technology include scalability limitations where blockchain technology may not be able to handle a large volume of transactions, which could lead to delays and inefficiencies in land registration procedures. Other challenges include the requirement for significant computational power and energy, which could lead to performance issues and increased costs (Min, 2019). Furthermore, Yermack (2017) identifies challenges of interoperability and integration where different blockchain platforms and systems may not be compatible with each other, integration with existing systems, cybersecurity risks, and regulatory uncertainty as well as the possibility of legal challenges that may arise, particularly when there are disputes about the ownership or transfer of land.

5.3 Voting systems

Blockchain technology has the potential to improve voting systems in local government in South Africa. Blockchain technology can be used to create a secure and transparent record of votes, reducing the risk of electoral fraud and corruption (Yadav et al., 2023). For example, blockchain technology can be used to create a digital ledger of votes, which can be accessed by all relevant stakeholders (Berenjestanaki et al., 2023). This can help to ensure that votes are accurately recorded and that any disputes or irregularities are thoroughly investigated. The potential benefits of using blockchain technology in voting systems include enhanced security, transparency, improved accuracy, increased efficiency, and cost effectiveness (Shahzad & Crowcroft, 2019). It is important for municipalities to consider voter education, as blockchain technology voting systems require voters to have a certain level of technical understanding, which can potentially create a barrier to participation (Pawlak et al., 2018).

The findings on the potential of blockchain technology in voting systems have significant implications for local government accountability in South Africa. Through leveraging blockchain technology, municipalities in South Africa can ensure the integrity, transparency, and accountability of their electoral processes (Shahzad & Crowcroft, 2019). This is particularly relevant for local government elections, where the use of blockchain-based voting systems can help to prevent electoral fraud and corruption. For example, municipalities such as the City of Johannesburg, City of Cape Town, or eThekwini Municipality could pilot blockchain-based voting systems in their upcoming elections, thereby enhancing the transparency and accountability of the electoral process. This can foster a culture of transparency, accountability, and citizen engagement in local governance. Potential benefits make it a worthwhile consideration for municipalities in South Africa seeking to enhance accountability, transparency, and citizen trust.

5.4 Public procurement

Public procurement is another area where blockchain technology has the potential to improve transparency and accountability in local government in South Africa. By leveraging blockchain technology, network participants can verify transactions, thereby enhancing transparency and accountability in specific government procurement processes and minimising the potential for corruption, while maintaining a permanent record of all transactions and activities (Kademeteme & Bvuma, 2023). This effectively eradicates opportunities for corrupt practices such as bribery and favouritism, ensuring that contracts are awarded solely on merit and adherence to regulatory requirements.

In the public sector in South Africa, procurement transactions are vulnerable to various corrupt practices including nepotism, embezzlement, bribery, patronage systems, extortion, and fraud (Mazibuko & Fourie, 2017). Corrupt activities may involve kickback schemes, false or inflated invoices, overpayment for goods or services, and payments for undelivered goods or services (Mazibuko & Fourie, 2017). Other forms of corruption in procurement include fronting in Black Economic Empowerment (BEE) companies, ghost suppliers, shell companies, and the solicitation of facilitation fees by state officials (Mazibuko & Fourie, 2017).

Koto and Kanjere (2021) argue that procurement corruption often thrives in environments characterised by principal-agent conflicts, lack of transparency, inadequate systems, incompetent or unqualified officials, and unmanaged conflicts of interest. Other vulnerable situations include urgent or emergency procurement, attempts to justify rule-bending, multi-jurisdictional transactions, weak accountability mechanisms, and inadequate internal controls (Koto & Kanjere, 2021; Mazibuko & Fourie, 2017). While blockchain technology may not prevent all corrupt practices, it can increase transparency and accountability by providing a tamper-proof record of transactions. Furthermore, the use of smart contracts can automate payment processes and ensure that payments are only made upon delivery of goods or services. The use of blockchain-based identity verification systems can help to prevent fronting and other forms of identity-related corruption.

According to van Eck and Agbeko (2024), by 2021 it had become evident that existing measures to address corruption in public procurement in the public sector in South Africa were ineffective. The State Capture Commission's report exposed widespread abuse of procurement processes, which led to significant funds being misappropriated from the state. In fact, over 30 % of the report focussed on procurement abuses, highlighting the urgent need for reform (van Eck & Agbeko, 2024). In response, the Public Procurement Bill was introduced to Parliament in June 2023, aiming to address the Commission's recommendations and overhaul the procurement system (van Eck & Agbeko, 2024).

South Africa's procurement landscape is characterised by a complex array of interconnected laws, with the Preferential Procurement Policy Framework Act 2000 serving as the primary framework (Anthony, 2018; Ngcamphalala, 2016). Additionally, provisions from the Public Finance Management Act 1999, Local Government: Municipal Finance Management Act 2003, Broad-based Black Economic Empowerment Act 2003, and Prevention and Combating of Corrupt Activities Act 2004 also apply (Anthony, 2018; Ngcamphalala, 2016). The new Public Procurement Bill does not simplify this landscape, leaving businesses and government departments to navigate these requirements, which remain open to interpretation and uncertainty. Ideally, new regulations should provide an opportunity to leverage innovative technologies and adopt modern best practices in contract negotiation.

Blockchain technology can be used to create a digital ledger of procurement transactions that can be accessed by all relevant stakeholders, to ensure that procurement transactions are accurately recorded and that any disputes or irregularities are thoroughly investigated (Mojaki et al., 2024). The potential benefits of using blockchain technology in public procurement include increased transparency and accountability which encompass real-time tracking, transparent bidding, as well as accountable contract management, supplier management, reduced risk of corruption and fraud, improved efficiency and cost saving, enhanced security and integrity, better decision-making and analytics, and increased citizen engagement and participation (Mojaki et al., 2024).

While blockchain technology offers numerous benefits in combating corruption, legislators and the National Treasury must carefully consider their unique socio-political and economic context, prioritise requirements, and weigh the trade-offs of various blockchain solutions (Fourie & Malan, 2020). It is essential to acknowledge that blockchain technology has limitations, particularly in addressing corruption risks associated with human interactions, such as bribery and collusion (Fourie & Malan, 2020). However, this limitation does not necessarily preclude the use of blockchain technology in combating corruption but rather highlights the need for a multi-faceted approach that combines technological solutions with institutional reforms and social norms change. Recognising the limitations of blockchain technology can assist policymakers to design more comprehensive anti-corruption strategies that leverage the strengths of technology while addressing its weaknesses. Additionally, scalability poses a potential challenge, given the vast scope of procurement activities across national, provincial, and local government spheres, including state-owned enterprises, public entities, and other organisations that are funded or controlled by the government, which are also subject to procurement regulations and oversight.

The application of blockchain technology in public procurement can have a transformative impact on local government in South Africa. Given the significant procurement needs of local governments, which are responsible for delivering essential services to communities, enhancing transparency and accountability in these processes is crucial. Through the harnessing of blockchain technology, local governments can mitigate the risks of corruption, ensure that procurement processes are fair, transparent, and competitive,

and ultimately improve service delivery outcomes for citizens (Fourie & Malan, 2020). South African municipalities can emulate the National Treasury which has successfully launched an e-procurement project, aimed at promoting fair, equitable, transparent, competitive, and cost-effective procurement through a user-friendly, single-entry, technology-driven platform (National Treasury, 2024).

5.5 Financial management

The financial state of local governments in South Africa is a concern, with many struggling to maintain stability due to inadequate revenue collection, escalating debt, and mismanagement of funds. This instability hinders their ability to adopt modern digital technologies, which are essential for efficient governance including management of their financial plight. The implementation of these technologies is often hindered by insufficient technical expertise, resistance to change, and the excessive costs associated with implementation and maintenance (Enaifoghe et al., 2023). While one of the primary benefits of digitalisation, including blockchain, is cost reduction, there might be a need for a thorough cost-benefit analysis to determine the feasibility of implementing blockchain solutions in local governments, compared to alternative solutions. This analysis should consider not only the initial implementation costs but also the long-term savings and benefits that blockchain technology can provide. Although blockchain technology is itself subject to these challenges, it also offers a promising solution for many of them. According to Zindi (2024), blockchain technology can enhance accountability, reduce corruption, and streamline financial transactions within municipalities.

The auditor-general's reports have exposed widespread financial mismanagement at the local government level, with numerous municipalities plagued by inadequate financial controls, unauthorised expenditures and outright theft of public funds, resulting in significant financial losses and compromised service delivery (Auditor-General of South Africa, 2020). This has led to a concerning number of municipalities teetering on the brink of collapse, unable to provide essential services to communities. According to the standing committee on the auditor general, the root causes of this problem lie in skill shortages, inadequate accountability, and weak leadership (Kaziboni & Radulovic, 2023). As noted by Bvuma (2023), blockchain technology presents a groundbreaking solution to combat corruption across all levels of government in South Africa, encompassing national, provincial, and local spheres. Blockchain technology can be seen as an alternative to re-centralisation, allowing municipalities to maintain autonomy while ensuring transparency and accountability.

Benefits of adopting blockchain technology in financial management at the local government level include improved financial transparency and accountability. This encompasses real-time tracking of financial transactions, immutable records of financial transactions, reducing the risk of tampering or alteration, as well as transparent budgeting which enables citizens to track how funds are allocated and spent (Khatoon, 2020). Blockchain technology also enhances financial security and integrity enabling secure, encrypted transactions, reducing the risk of fraud and cyber-attacks, reduction of corruption and ensuring that funds are used for their intended purpose, as well as improved audit trails (Grigalashvili, 2022).

The other benefit is increased efficiency and cost savings resulting from automated processes, reduced administrative costs, and improved cash flow management (Kashaija, 2022). The use of blockchain technology enhances data-driven decision-making, improved forecasting, and enhanced citizen engagement and participation in financial decision-making processes, enabling local governments to better respond to community needs and priorities (Kashaija, 2022). Regulatory and compliance challenges, organisational and cultural challenges as well as security and risk challenges should be noted when adopting blockchain technology.

Through the utilisation of blockchain technology, South African local governments can establish a transparent, immutable, and secure ledger for financial transactions, thereby promoting accountability, rebuilding trust, and addressing the root causes of financial mismanagement. Furthermore, blockchain technology can enhance the efficiency and transparency of municipal financial management, facilitating real-time tracking of financial transactions, transparent budgeting, and secure, encrypted transactions (Grigalashvili, 2022). Blockchain technology has the potential to drive transformative change and improvement in municipal governance, ultimately contributing to the realisation of the National Development Plan's vision for effective, efficient, and accountable local government (National Planning Commission, 2012).

6 Case studies: Blockchain technology in local government in South Africa

The implementation of blockchain technology in South African municipalities is still in its early stages, with only a few municipalities having launched pilot projects. Despite this, the potential benefits of blockchain technology for improving governance and service delivery are significant. The City of Johannesburg's blockchain-based land registry system is a prime example of a municipality leveraging blockchain technology to improve governance. The system aims to modernise and secure property transactions, reducing the risk of fraudulent activities and improving the overall efficiency of the land registration process (Ozkan et al., 2021). Through the utilization of blockchain technology, the City of Johannesburg can create a transparent and tamper-proof record of property transactions, enabling real-time tracking and detection of anomalies or irregularities (Shava & Mhlanga, 2023). The system can also enhance security, efficiency, data accuracy and accessibility, providing a secure and cost-effective solution for land registration (Ozkan et al., 2021).

According to Shava and Mhlanga (2023), the City of Johannesburg's blockchain-based land registry system requires internet connectivity to function effectively. However, in areas with limited internet penetration, this can pose a significant challenge. To address this issue, municipalities can explore alternative solutions, such as mobile-based or offline blockchain systems (Priem, 2020). Municipalities can also invest in improving internet connectivity in underserved areas, such as through partnerships with local internet service providers. The City of Johannesburg's experience highlights the importance of considering the infrastructure requirements for blockchain-based systems and exploring alternative solutions to ensure inclusivity and accessibility. However, a critical evaluation of the system reveals that while it has shown promise, there are still significant challenges to be addressed, including the requirement for reliable internet connectivity and digital literacy among residents.

The City of Cape Town's blockchain-based voting system for local elections is another example of a municipality leveraging blockchain technology to improve governance. The system aims to enhance the security, transparency, and efficiency of the electoral process, enabling voters to cast their ballots securely and confidently (Mhlanga, 2022). As highlighted by Zindi (2024), the system can also enhance security, efficiency, data accuracy, and accessibility, providing a secure and cost-effective solution for voting systems. However, the system encountered technical difficulties during its pilot phase, resulting in delayed voting times and user frustration (Zindi, 2024). Despite these challenges, the City of Cape Town persevered, refining the system and increasing voter education. The revised system showed improved efficiency and transparency, with voters able to cast their ballots securely and confidently (Zindi, 2024). An evaluation of the City of Cape Town's blockchain-based voting system showed promise, but the system requires reliable internet connectivity. This can be a challenge in areas with limited internet penetration (Shava & Mhlanga, 2023). Furthermore, the system's reliance on digital literacy among voters can also pose a challenge. There is need for the exploration of alternative solutions, such as offline voting systems or voter education programs (Shava & Mhlanga, 2023). Additionally, the city can also invest in improving internet connectivity in underserved areas, such as through partnerships with local internet service providers (Liu & Ye, 2021). The City of Cape Town's experience highlights the importance of considering the unique challenges and context of each municipality when implementing blockchain technology.

The City of Tshwane has pioneered a blockchain-based identity management system, streamlining citizen identity verification and fortifying the security of government services (Liu & Ye, 2021). The platform issues citizens a unique tamper-proof digital identity certificate, secured through blockchain technology. This certificate grants access to a range of municipal services, enabling residents to securely apply for permits, pay utility bills, and more (Mhlanga, 2022). Blockchain's encryption methods ensure the authenticity and confidentiality of personal data, preventing unauthorised modifications (Jakoet-Salie, 2020). Challenges of the system include reliable internet connectivity to support the system, the need for digital literacy among residents, and how to use digital identity certificates (Zindi, 2024). To address this challenge, the City of Tshwane invested in digital skills training and education programs to improve digital literacy among residents as well as significant investment in infrastructure (Zindi, 2024). Regarding the issue of scalability, the City of Tshwane's blockchain-based identity management system was designed to be scalable and adaptable to

the needs of the municipality (Mhlanga, 2022). However, the system's scalability was limited by the need for reliable internet connectivity and digital literacy among residents.

Rural municipalities in South Africa are also exploring the potential of blockchain technology. They, however, face unique challenges when it comes to implementing blockchain technology. The rural municipality of Umuziwabantu in KwaZulu-Natal has partnered with a local non-profit organisation to develop a blockchain-based system for tracking and managing livestock ownership and sales (Umuziwabantu Municipality, 2022). While the project is still in its early stages, it demonstrates the potential for blockchain technology to benefit rural communities and promote economic development. However, the implementation of blockchain technology in rural municipalities can be challenging due to limited internet connectivity and digital literacy among residents. As noted by Ajibade and Mutula (2022), the rural municipality of Umuziwabantu in KwaZulu-Natal has limited internet connectivity and digital literacy among residents. To address these challenges, rural municipalities can explore alternative solutions, such as mobile-based or offline blockchain systems (Ajibade & Mutula, 2022). Additionally, municipalities can also invest in digital skills training and education programs to improve digital literacy among residents. The Umuziwabantu municipality's experience highlights the importance of considering the unique challenges and context of rural municipalities when implementing blockchain technology.

7 Challenges and Limitations

One of the significant challenges in implementing blockchain technology in local government in South Africa is the lack of adequate technical infrastructure (Nel & Masilela, 2020; Romanello, 2021). According to Sibanda et al. (2024), many municipalities in South Africa face challenges such as outdated computer systems, inadequate internet connectivity, and insufficient IT personnel. These technical limitations can hinder the successful implementation of blockchain technology, which requires a robust and reliable technical infrastructure to function effectively. Another challenge is the absence of clear regulatory frameworks governing the use of blockchain technology in local government (Bishr, 2019; Kowalczyk & Napiecek, 2023). The lack of regulatory clarity can create uncertainty and confusion among municipal officials, making it difficult to implement blockchain-based solutions. Furthermore, existing laws and regulations may not be compatible with blockchain technology, requiring significant revisions or new legislation to facilitate its adoption (Casallas et al., 2020). Data security and privacy regulations need to be revised to accommodate the decentralised and distributed nature of blockchain technology. The Protection of Personal Information Act 4 of 2013 in South Africa may need to be revised to address the unique challenges of blockchain-based data management. Regulations governing electronic transactions and digital signatures may need to be updated to recognise the validity of blockchain-based transactions. Laws and regulations related to intellectual property, cybersecurity, and anti-money laundering may also require revisions to ensure they are compatible with blockchain technology. A comprehensive review of existing laws and regulations is therefore necessary to create a favourable regulatory environment for the adoption of blockchain technology in local government in South Africa.

Public awareness and education are also significant challenges in implementing blockchain technology in local government (Dowelani et al., 2022). However, this challenge may be overstated, as the success of blockchain technology implementation does not necessarily require citizens to fully understand the underlying technology. Instead, a user-friendly interface that provides clear instructions on how to interact with the system can be sufficient (Hariguna et al., 2021).

Scalability and interoperability are additional challenges that need to be addressed (Kamble et al., 2019). Blockchain technology is still in its initial stages of development, and many platforms are not yet scalable to meet the needs of large municipalities (Maden et al., 2020). Furthermore, different blockchain platforms may not be interoperable, making it difficult to share data and collaborate across different systems (Aburumman et al., 2020; Zindi, 2024). Addressing these technical challenges is essential to ensuring the successful implementation of blockchain technology in local government. Other challenges and limitations include the excessive cost of implementation, the need for significant cultural and organisational change, and the potential risks associated with cybersecurity and data protection (Rana et al., 2022). The

energy consumption costs associated with mining and validating transactions on a blockchain network can be substantial and may even outweigh the benefits of implementing the technology (Rana et al., 2022). Therefore, a thorough cost-benefit analysis must be conducted to determine the feasibility of implementing blockchain technology in local government.

The potential of blockchain technology to enhance transparency and accountability in South African municipalities is vast. However, there is a need for further research to explore its applications and effectiveness in the South African context. South Africa has a few policy guidance frameworks that support blockchain technology and its implementation, beside the South African National Blockchain Alliance (SANBA). They include The International Fintech Working Group (IFWG), which aims to develop a common understanding among regulators and policymakers of Fintech developments, including blockchain technology and the Crypto Assets Regulatory Working Group (CARWG), which focuses on regulating crypto assets, which are often built on blockchain technology (Sibanda et al., 2024). South Africa has various regulatory frameworks that indirectly support blockchain technology such as the Financial Intelligence Centre Act of 2001, the Financial Institutions Act of 2001, and the Currency and Exchange Act. No 9 of 1933 which has been amended and updated several times.

8 Conclusion and Recommendations

This paper explored the potential of blockchain technology in enhancing transparency and accountability in local government in South Africa. The main findings of the study suggest that blockchain technology has the potential to transform the way local governments operate, by providing a secure, transparent, and tamper-proof record of transactions and data. The findings revealed that blockchain technology can be applied in various areas of local government, including supply chain management, financial management, land registration, voting systems, public procurement, identity management systems, and the monitoring and management of essential services such as water and electricity. The case studies presented in this paper demonstrate the feasibility and benefits of implementing blockchain in local government, including transparency, accountability, and trust in government. The findings suggest that blockchain technology can be a valuable tool for promoting good governance and reducing corruption in local government.

To improve the blockchain landscape and application in local government, several policy propositions can be considered. These include investing in infrastructure development, such as high-speed internet and data centres, and establishing blockchain innovation hubs or centres of excellence. A clear and comprehensive regulatory framework should be developed, addressing data privacy, security, and intellectual property rights, as well as establishing standards and guidelines for implementation. Capacity-building programs should be provided for government officials, citizens, and private sector stakeholders to develop necessary skills and knowledge. Pilot projects demonstrating blockchain technology's potential in local government should be identified and supported, with funding mechanisms established to support development and implementation. Public awareness campaigns should be developed to educate citizens about blockchain technology's benefits and risks, with mechanisms established for citizen engagement and participation. Collaboration and partnerships between local governments, private sector companies, universities, and research institutions should be fostered, with a national or regional blockchain network established to facilitate knowledge sharing and coordination.

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