

Assessing the Readiness of the South African Public Sector to Embrace Blockchain Technology: Factors for Successful Adoption

Beatah Sibanda,¹ Benon Basheka,² Jan Van Romburgh¹

¹North-West University, South Africa

²Kabale University, Uganda

Correspondence: Beatah.Sibanda@nwu.ac.za

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Abstract

The recent rise in technological developments through the Fourth Industrial Revolution has impacted how businesses and governments globally operate, requiring a shift in strategies and governance systems. A study into one of these technologies reveals that blockchain technology could enhance the effectiveness and efficiency of operations in the public sector through its transparency-enhancing measures. Although countries globally may have adopted, or are in the process of adopting blockchain technology, South Africa is lagging. The study assessed the readiness of the South African public sector to adopt blockchain through an analysis of factors for successful adoption. The population comprised officials in four provincial departments in Gauteng province, South Africa. A quantitative research approach was adopted using close-ended questionnaires, descriptive statistics, and factor analysis. The results, contrasted with evidence from other countries, suggest that the South African public sector may not be ready to adopt blockchain. There is an urgent need to upgrade the current financial reporting systems, as the findings revealed incompatibility of blockchain with the current systems which could pose a significant challenge to the adoption process. Legislative requirements also emerged as a concern, as there is currently no legislation governing blockchain in South Africa. The study contributes to the literature by integrating existing theory and evidence from Gauteng government departments in illustrating the success factors and the readiness for the South African public sector to adopt blockchain technology, prompting the country to prepare adequately. The analysis sheds light on factors to be considered for successfully implementing blockchain technology.

Keywords: Auditor General of South Africa; Blockchain Technology; Corporate Governance; Accountability; Transparency; Technology Acceptance Model; Public Sector.

JEL Classifications: H1

1. Introduction

In the era of the international public financial crisis, public sector governance has become a vital and significant component for the survival of future generations. Globally, many countries have been affected by the declining economic status that erodes sustainable community development. In 2023, the International Monetary Fund projected that the world economic growth would decline from 3.5% in 2022 to 3% in 2023 and 2.9% in 2024 [1]. A declining economy calls for innovative ideas from the public and private sectors to boost economic growth. The public sector is undergoing critical changes in a quest to enforce good governance, placing pressure on governments to adopt innovations aligned with technological developments that accommodate the effects of technological changes as they occur [2]. The United Nations called for transparent governance in unprecedented times, using governance tools that ensured transparency and accountability in governmental actions [3].

Transparent governance could be achieved by advancing technologies used in the government sphere. These tools could be leveraged by advancing technologies used in the government sphere. The advancement of the information age creates an urgency for organisations, including the public sector, to align their governance strategies to technological developments [4]. Over the years, the overall South African economy, like other world economies, has declined. The economic decline is exacerbated by the public sector, which has long been battling transparency and accountability issues in managing public funds. This places South Africa in dire need of innovative ways to improve public sector governance. Attempting to address governance challenges, researchers have investigated how blockchains could improve governance through their transparency and security features.

A blockchain refers to a sequential database of secure information alternative to the traditional financial ledgers based

on the double-entry bookkeeping system [5, 6] and is famous for its transparency-enhancing measures. Transparency is achieved through a blockchain's ability to provide visibility to an entire transaction history as data stored in a blockchain cannot be altered or deleted. Data in a blockchain are recorded and stored in chronologically connected blocks, which make chains of blocks called blockchains [7]. The chronological connection implies that data are stored in a continuous sequential manner and cannot be deleted once captured or recorded. Blockchain technology has in the past been studied as an underlying technology that supports cryptocurrencies, leaving an open research area on how it could be used in other contexts outside cryptocurrencies, including the public sector [8]. Previous research posits that transparency in the public sector could be improved by accounting systems that allow for timely data publication in an open and decentralised network, such as blockchain technology [6]. The timely publication is achieved through the blockchain's ability to capture data in real-time, and the data becomes immediately available to all blockchain parties. Decentralised network because there is no central custodian to the blockchain platform, all parties to the blockchain platform can easily access the platform at the same time. While all blockchains may have their own advantages, public blockchains could be implemental in enhancing government officials' transparency in managing funds and accountability for identified transgressions, which could restore citizens' trust.

Various uses of blockchain are envisioned for the public sector. For example, it could be used in financial reporting to enhance transparency and improve the trustworthiness of financial statements by recording and storing financial information in a system that cannot be altered [6, 9]. Han et al. [6] propose that blockchain could digitise documents, increase efficiency, reduce costs, reduce human error, and automate reconciliations. Many countries have either adopted or are in the process of adopting blockchain, which prompted the researchers to investigate the readiness of the South African public sector to adopt blockchain technology. Globally, Dubai is among the world's leading smart cities, which have appreciated how blockchain could transform their cities [3]. The United States has largely embraced blockchain, with nearly 48% of all blockchain startup projects being in the United States, and the country spending 4.2 billion US dollars in blockchain projects only in 2022 [10]. In the same manner, Brazil has implemented blockchain in their Public Digital Bookkeeping system, while Kenya, in Africa, is among the few countries that have adopted blockchain in validating records and transactions [11]. Despite these advancements, South Africa lags behind and is yet to appreciate the potential of blockchain technology in controlling public sector funds, to enhance efficiency and purge corruption [12]. The significance of blockchain technology in the public sector is that it could mitigate governance challenges [9] through its transparency and accountability-enhancing measures [13], a solution which South Africa urgently needs.

Despite this heightened popularity in literature, the adoption of blockchain technology is still at an early implementation stage, particularly in the South African context, and has yet to be studied in detail within the public sector [14]. The lack of empirical studies on its usefulness, particularly in the South

African context, creates some knowledge gaps that need to be addressed by researchers [8]. Accordingly, the study aimed to analyse the readiness of the South African public sector to adopt blockchain technology through an analysis of success factors for adoption, using evidence from Gauteng government departments in South Africa.

The Technology Acceptance Mode (TAM) was used as an underlying theory to determine the factors for adopting blockchain technology. TAM assumes that the behavioural intention to adopt a new technology depends upon two factors: perceived usefulness and perceived ease of use [15, 16]. It proposes a positive relationship between perceived usefulness and behavioural intention to use the technology [17]. In adopting blockchain technology, several studies have used TAM [17–19]. For example, Borhani et al. [20] posited that TAM was appropriate in examining blockchain technology as it is primarily end-user-oriented. Liu and Ye [19] combined the technical characteristics of blockchain with TAM to better understand the factors influencing user acceptance of this new technology, as with this study. TAM uses five dimensions: compatibility with current systems, relative advantage, complexity, trialability, and observability, which will be integrated into the reporting of results.

Blockchain has been identified in previous studies as a technology that can disrupt industries' and governments' operations [9, 14, 21], although it is still at an early implementation stage across many countries. Despite blockchain being at an early implementation stage across industries, previous studies posit that it could enhance operations of the public sector [8], through its potential to provide quality and reliability in managing government data [22]. An extensive analysis of the applications of blockchain technology from a governance perspective is limited [23]. Alshamsi et al. [24] believed that the low adoption rate of blockchain technology is one of the fundamental reasons researchers are conducting studies to determine factors that impact the adoption of blockchain technology.

The main categories of blockchains are private, public, and hybrid blockchains. The private blockchain is a closed network that verifies and authenticates transactions from invited, trusted, and selected parties only [7, 24]. The authentication implies that the blockchain owner has the authority to edit, delete, or override transactions on the blockchain network. Since different members have different access control authorisations, a private blockchain is partially decentralised [25]. A public blockchain allows anyone within the network to participate and view the underlying ledger [6]. The hybrid blockchain uses the characteristics of both private and public blockchains. A public blockchain would yield more advantages for government departments as public blockchains with no centralised authority are more secure. Liu et al. [25] reported that a large community of blockchain users makes it impracticable for a few entities to dominate the network and manipulate the ledger's contents. While public blockchains may have more transparency-enhancing features, the downside is scalability and high operational costs associated with the large number of users of the network.

Blockchain networks have several characteristics, such as decentralisation (the ability of the technology to function without a central authority), user anonymity (the identities of users are kept anonymous), and the consensus model (all users in the blockchain should consent to a transaction) that make them the best choice for secure and transparent transactions [7, 26, 27]. These characteristics are not exhaustive but differ according to the type and the use of which the blockchain is intended. Blockchain technology could be beneficial to the public sector in several ways which could foster transparency in financial reporting and accountability of public sector officials. To enhance transparency in the administration of funds and accountability of officials, blockchain could be useful in the following ways:

Improved record keeping: Many public sector organisations, as reported by the Auditor General of South Africa (AGSA), often lack proper record keeping and control, which causes low accountability. Blockchain could be relevant in improving the record keeping of public sector accounts as compared to the traditional methods of keeping and auditing government transactions [11]. The public sector engages in large volumes of information-sharing activities between agencies and citizens or other organisations, and such transactions must be recorded and maintained reliably and accurately through secure systems and processes [28]. Public blockchains could provide an integrated platform within government institutions to store records securely and decentralised [7].

Improved transparency: Using blockchain could improve public sector transparency and accountability through its trustworthiness and timeliness in recording information, reducing the need for auditors to review the reporting systems in government departments [29]. As a substitute for traditional auditing methods, blockchain could transform public audits by minimising corruption if all spending is transparently recorded [11].

Real-time accounting: Blockchain promotes real-time accounting, eliminating the need to update accounting records constantly and improving the trustworthiness of financial information since records on the blockchain cannot be destroyed [6, 9]. Harjit et al. [17] posited that corporate governance could be improved by adopting blockchain technology by providing an audit trail that is not tempered.

Decentralised structure: A public blockchain promotes decentralisation which implies shifting power and decision-making from a centralised unit to a distributed network. Successful decentralisation requires appropriate, transparent, and accountable legal frameworks, which blockchain promotes.

Improved security and privacy: Data on a public blockchain are stored across a network of computers, which enhances security through the unalterable record of transactions with end-to-end encryption, eliminating fraud and unauthorised activity. The time stamping (transactions are captured in chronological order) nature of the network provides a complete history of transactions stored permanently in their original form [7].

Reduced costs: Blockchain reduces costs in many ways, for example, by reducing the number of agencies to a transaction or information sharing, which reduces costs in turn [30]. Through its transparent, unalterable, and shared characteristics, a public blockchain promotes cost-effective transactions by eliminating third parties and reducing the value chain process [31]. While these factors are not exhaustive, their mention or investigation is critical in evaluating the relevance of blockchain technology. When a potential adopter becomes aware of an innovation and weighs its relative advantages, a decision needs to be taken whether to accept or reject, and this decision can either be optional, collective, or based on authority [32]. Similarly, the public sector should evaluate all factors that could guide the adoption of blockchain technology and decide if the potential benefits of blockchain technology could be instrumental in addressing their current governance challenges. The following section briefly describes the adopted methodology.

2. Methodology

A quantitative research approach, which tests theories by establishing relationships among variables that can be measured, numbered, and analysed using statistical procedures [33], was used. Precisely, a descriptive-exploratory research design was adopted because the study involved data collection and a description of factors considered appropriate for adopting blockchain technology. Data were analysed using factor analysis which is a statistical technique that reduces data to more minor variables. In computing factor analysis, data were loaded on the Statistical Package for the Social Sciences (SPSS) software to determine which questions from the questionnaire were loaded as factors.

The population comprised personnel in the Finance department in four provincial government departments in Gauteng. The sample was drawn from the reports of the Auditor General for the 2019/20 financial year, the year in which the study commenced. A systematic random sampling technique started by selecting a random number from the sampling frame [34], estimated at 187, as obtained from the organograms of the departments in the respective annual reports. Using a SurveyMonkey sample size calculator, a confidence level of 95%, a margin of error of 5%, and a population of 187, a sample size of 126 was calculated. However, since the researchers intended to conduct a factor analysis, a larger sample had to be employed. Many studies advocate for large samples when using factor analysis; for example, Jung and Lee [35] recommended a sample size of at least 200 for high-quality factor analysis. Since the target population of 187 was less than the recommended minimum of 200, the questionnaire was distributed to the entire population to ensure maximum responses. Data were collected using a closed-ended questionnaire in the form of a five-point Likert scale, with responses ranging from strongly disagree (1) to strongly agree (5), which were administered on SurveyMonkey, an online platform for administering questionnaires. To ensure adherence to ethical requirements of informed consent, the questionnaire was structured to require respondents to consent to the study.

A total of 152 responses were received, yielding a response rate of 81%. This was regarded as excellent because self-completion questionnaires are generally expected to yield lower response rates than interview-based studies [36]. A lower response rate results in questioning the representativeness and the external validity of the findings where random sampling is used [34]. Data were collected under two categories: level of management and years of experience. The rationale for collecting data on experience levels was to enable the researcher to determine the attitude towards adopting blockchain technology in different categories. Table 1 depicts the social demographics of the respondents.

Table 1: Social demographics

Position	Frequency	Percentage (%)
Chief Director	12	7.9
Director	25	16.4
Deputy Director	24	15.8
Assistant Director	45	29.6
Non-manager	46	30.3
Total	152	100

Source: Survey data.

Data were analysed using SPSS software version 27 for descriptive indicators and exploratory factor analyses. To identify the number of factors to expect from the variables, exploratory factor analysis was applied. The principal component analysis extraction method was used to extract factors with eigenvalues greater than 1.0 as depicted in Table 2 below. A component matrix displays the correlation of each variable item with its component. From the table, all the extracted statements had a component loading above 0.5, thus implying that the correlation was high.

Table 2: Component analysis

Item	Component
1. Blockchain will most likely foster accountability in the recording of transactions.	0.88
2. Blockchain is likely to improve the financial reporting system in our organisations.	0.86
3. Blockchain will improve the efficiency of the audit process.	0.83
4. In my view, blockchain will improve record keeping of the department.	0.81
5. Blockchain will improve transparency of transactions.	0.81
6. Blockchain is likely to eliminate delays in the recording of transactions.	0.79
7. Blockchain will increase the speed of financial reporting.	0.77
8. Blockchain is safe and secure for storing financial information.	0.76
9. I consider blockchain to be useful to the department.	0.75
10. I consider blockchain technology to be a relevant system for financial reporting.	0.75

11. Blockchain will decrease approval processes and increase efficiency in financial reporting.	0.74
12. Blockchain technology can improve governance in the department.	0.74
13. I understand what blockchain technology is about.	0.71
14. Blockchain technology will result in the timely detection and correction of errors.	0.69
15. Blockchain will reduce the overall risk of financial misstatement.	0.69
16. There is a possibility that blockchain will reduce the risk of fraud.	0.68
Cronbach Alpha	0.94
Mean	3.93
Standard deviation	0.603

Source: Survey data.

To ensure the sample's adequacy and the variables' suitability as factors, the Kaiser–Meyer–Olkin (KMO) and Bartlett's Test of Sphericity were used. The KMO value should vary between 0 and 1 and be at least 0.6 to indicate an adequate sample size [37]. This was considered appropriate as it was consistent with the exploratory and descriptive research description by Saunders et al. [38] A statistically significant Bartlett test of $p < 0.05$ shows adequate correlations among the variables to continue with the analysis [39]. From the results, Bartlett's test of Sphericity was highly significant at $p < 0.05$, implying that the null hypothesis of lack of adequate correlation among variables was being rejected. The principal component analysis method was used with a varimax rotation to extract variables with eigenvalues more than 1. All tests were conducted at a level of significance of 95%.

The Cronbach's alpha test was used to confirm the internal consistency of the measuring instruments. For a reliable instrument, Cronbach's alpha values should range between 0 and 1, with values closer to 1 indicating high reliability, while values closer to 0 indicate low reliability [37]. According to Hancock and Mueller [40], the validity and reliability of the measuring instrument are essential as it confirms the consistency of the measurements. A Cronbach's coefficient of 0.7 is considered reliable and should be acceptable for the internal consistency of a measuring instrument [37]. The average of the mean scores was 3.6, while the median average was 3.8. This further confirms that respondents agreed with the questions. The average of the standard deviation is 0.91, which further illustrates that the responses were closer to the mean. The questionnaire administered is provided in appendix 1, and the results of the descriptive study are presented in the following section.

3. Results

Prior to adopting blockchain technology, an evaluation of its usefulness is critical as per TAM. Respondents perceived

blockchain as a useful technology that would yield benefits for the South African public sector, such as improved record keeping and efficiency of the financial reporting and auditing processes. Respondents believed that blockchain could enable permanent record storing that would address the concerns of the AGSA as they have continuously reported poor record keeping within government departments. The improved record keeping supports the findings of Marcella [41] who suggested that blockchain could permanently store government records. Although blockchain technology has the potential to improve the governance of departments, its implementation could be challenging due to limited knowledge and perceived reluctance from potential users. TAM suggests that users will adopt a technology if they perceive it useful and easy to use. While respondents perceived blockchain as useful, they also perceived it as a technology that could not be easy to use, as the results revealed limited availability of skills for blockchain technology. Nearly 90% of the respondents reported limited knowledge of blockchain technology. Skill is critical to any system and must be in place before any organisation considers adopting a new system. Countries that thrive in blockchain technology have invested enormously in skills development. For example, Germany's success in blockchain is leveraged through commitment to research and development by partnering with leading universities and research institutes in the country which are actively involved in blockchain projects [10]. Without skill, implementation barriers could hinder the adoption of a new technology [42]. Lack of skills poses a major barrier to the adoption of blockchain technology. To mitigate skills shortages, in the United States for example, institutions such as Stanford University and University of California Berkley are offering blockchain courses [43], while such courses are limited in South African Universities. This limitation places training or skills development as an essential factor in the adoption process. Without the required skill, the perceived ease of use of blockchain would be low, as users would view it as a system that is challenging to use.

Secondary to skill is the compatibility of blockchain technology with current financial systems used by the department. Compatibility with existing systems and infrastructures is crucial, as blockchain would need to be integrated into the government's current technologies. South Africa may need to substantially upgrade infrastructure to successfully adopt blockchain technology. From the results, 55% of the respondents believed that blockchain technology would be compatible with the department's settings, while 13% were neutral, and 32% disagreed. Although more than half of the respondents perceived the current systems as compatible, this finding contradicts the findings of the AGSA, which reported during the COVID-19 pandemic the lack of agility in the information technology systems in responding to the required changes. Marengo and Pagano [44] also identified infrastructure readiness as vital and a limiting factor for countries like Sri Lanka and South Africa.

Another limitation revealed is the absence of legislation guiding the adoption of blockchain technology in South

Africa. The results revealed that legislative requirements are essential in adopting blockchain technology. About 41% of the respondents reported that departments did not have frameworks in place for adopting new technology. Consistent with the literature, adopting blockchain would require governments to place appropriate legislative frameworks [45] to provide uniform guidance across all departments. While several studies have debated legislation regarding blockchain, the conclusion has been that a comprehensive regulatory response to blockchain does not yet exist [7, 27, 46, 47]. A comprehensive regulatory environment is a pivotal aspect that sets the stage for blockchain leadership. Countries have recognised the potential of blockchain and have established clear and supportive regulations. For example, Singapore is recognised as a leader in blockchain due to its progressive regulatory framework, while Canada's proactive government and thriving startup ecosystem have placed it as a blockchain powerhouse [10]. Without a regulatory framework, South Africa is not ready to adopt blockchain technology.

The results, however, revealed uncertainty regarding a framework for adopting blockchain technology as almost an equal number agreed and disagreed with this. Without a framework in place, the implementation of blockchain technology may be futile due to a lack of guidelines in the implementation process.

Decentralised governance emerged as another critical element in adopting blockchain technology. Concerns on decentralisation suggest that the ability to govern and control the department's affairs is a crucial matter, and departments may be unwilling to transition from the traditional methods of governing departments. This confirms the findings of Zwitter and Hazenberg [48] who reported that traditional modes of governance posed a threat to the technological benefits of blockchain technology as over-regulation reduces the potential benefits yielded by this technology. This was also attested by Brennan et al. [29], who highlighted that decentralisation threatens government power as a regulator in the public sector. The results indicate that respondents perceived that adopting blockchain technology could strip government departments of their governing power, suggesting that control over the department's affairs is crucial in governing departments. The desire to retain control limits the functioning of blockchain technology as the full benefits of the technology are leveraged when there is no central actor within the blockchain ecosystem [7]. Decentralised governance closely links to management attitude, and respondents agreed that management attitude is essential in adopting blockchain technology. Previous researchers also noted the role of management attitude and proved that management support was significant in enabling blockchain technology [49]. Although decentralisation posed a threat to officials, the overall management attitude towards adopting blockchain seemed positive with 86% of the respondents indicating a positive attitude towards adopting the blockchain.

While there may be challenges regarding the implementation of blockchain, it could be instrumental in improving

information sharing across departments. The AGSA observed that sharing information across government platforms was a challenge which blockchain could address. As Marcella [41] reported, blockchain could permanently store government records, which respondents of the study seemed to agree on. This would address the concerns of the AGSA as they have continuously reported on poor record keeping within government departments. This is consistent with the literature as it was observed that the issue of record keeping could be addressed by the built-in audit trail which blockchain provides since all transactions would be recorded in chronological order and time-stamped manner [26]. Blockchain could also provide an integrated platform within government institutions to store records securely and decentralised [7].

The study analysed the relevance of blockchain technology by focusing on factors for adopting blockchain technology using a quantitative approach. An integration of quantitative and qualitative approaches could have enhanced the results by obtaining more information on the government's views towards adopting blockchain technology. Only four government departments in one province participated in the study, limiting the generalisation of the study's findings as the results are specific to one province.

4. Conclusion

Blockchain has the potential to enhance governance in the South African public sector through its transparency features which foster accountability. Countries that have leveraged the benefits of blockchain are thriving and have improved their governance mechanisms. This study is relevant in this digital era, where technology changes societies and businesses functioning. The South African public sector needs to align with these changes to serve society better. Blockchain can potentially improve transparency and accountability, a challenge that the South African public sector has dealt with for a long time. The data collected tested the TAM, and the results revealed the appropriateness of this model in adopting new technology. The results provide the South African public sector with success factors for adopting blockchain technology namely, legislative requirements, governance factors, availability of skill, compatibility and technical factors, and management attitude. Legislative requirements to govern blockchain technology are not yet established in South Africa. Countries that have recognised the potential of blockchain have established clear legislative regulations, which South Africa still needs to do. The results further revealed that government departments would adopt blockchain if they perceived it useful and relevant to financial reporting. The usefulness was manifested in that respondents believed blockchain would improve the overall financial reporting of government departments. Furthermore, as reported by the AGSA, it could be instrumental in improving record keeping, a challenge with which most departments have battled. In this digital age era, aligning business processes with prevailing technologies is vital, hence the relevance of blockchain technology, as suggested by this study.

The identified success factors prompt South Africa to intensify work on advancing blockchain technology. This could be achieved by increasing awareness through work and educational programs, as the findings revealed limited skills in blockchain technology. Several countries have partnered with academic institutions in advancing knowledge and research on blockchain. The United States and Germany are examples of countries advancing blockchain knowledge through academic institutions, and South Africa could introduce similar courses in their academic institutions. There is an urgent need for government departments to upgrade the current financial reporting systems, as findings revealed that the incompatibility of blockchain with the current systems could pose a significant challenge to the adoption process. Although blockchain may be instrumental in improving governance, the South African public sector is not ready to adopt blockchain technology. South Africa still needs to progress work on blockchain readiness through working towards achieving the identified success factors. Future studies could develop a framework for adopting blockchain technology to guide the public sector.

Competing interests:

None declared.

Ethical approval:

The Economic and Management Sciences Research Ethics Committee (EMS-REC) North-west University gave ethical clearance for the study, and all participants were required to sign an informed consent form indicating their voluntary participation in the study. The identities of the respondents were withheld to ensure confidentiality.

Author's contribution:

BS designed and coordinated this research and prepared the manuscript in its entirety, while BB and JV played a supervisory role.

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