Using Information and Distributed Ledger Technologies to Combat Public Procurement Corruption: A South African Perspective

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Abstract— **Corruption has had a detrimental impact on the South African economy. The use of Information Communication Technology (ICT) in combatting corruption is undervalued in e-government contexts, while insufficient empirical data exists to gauge the effectiveness of distributed digital technology in combatting malfeasance. This study explores perceptions on the use of ICT in the procurement corruption investigation sector. Legal and factual perspectives of ICTs, and specifically on Digital Ledger Technology (DLT)'s usefulness in combatting public sector procurement corruption in South Africa was found to be limited. This empirical study found that most respondents in the corruption investigation field had encounters with it in the Public Procurement field of the Supply Chain Management (SCM) function. Human interference in the ICT system appears to be the main contributing factor in corrupting the system. Monitoring of user activity logs is recommended as well as strict regulations to prevent ghost users from corrupting ICT systems.**

Keywords— **Corruption fighting; e-government; Distributed Ledger Technology; Blockchain in Government.**

I. INTRODUCTION

DISTRIBUTED Ledger Technology (DLT) is a new and fast-evolving approach to record and share data across multiple ledgers and it allows for the sharing, recording and synchronization of transactions across a distribution of network participants [1]. In South Africa, anti-corruption agencies such as the Directorate for Priority Crime Investigations ("DPCI"), also known as the Hawks, and the Special Investigating Unit ("SIU") often finds themselves investigating alleged acts of malfeasance long after the deed has been done and proceeds thereof has been funneled elsewhere. A laborious search for documentary evidence to prove or disprove these allegations are often frustrated by the prescription law which prescribes that an investigation should generally not have happened three years after one became aware of it. Information and Communication Technology (ICT) has been misused in the form of corruption to benefit individuals and governments. This study focuses on ICTs and their potential use in fighting procurement corruption and seeks to understand whether DLT could assist in investigations of a procurement nature, and even prevent it from happening.

Corruption can be defined as a subversion of constitutional principles upon which the public procurement system is based. The government's failure to control and prevent public procurement corruption at all government procurement levels is regarded as a failure in its constitutional mandate [2].

This study evaluates whether current ICT applications are effectively used in the fight against procurement corruption and seeks to analyze how DLT can be used to impact the reduction of procurement corruption.

The research objectives of this study are:

- *The evaluation of the current effective uses of ICT in the fight against procurement corruption.*
- *Analyzing how DLT can be used to impact the reduction of procurement corruption.*

II. LITERATURE REVIEW

This section provides an overview of current literature on ICT's use to combat procurement corruption, its effectiveness and the legal frameworks that underpin its use. A theoretical review follows and a conceptual model that is used to guide the study is introduced.

A. ICTs employed to combat procurement corruption

Procurement corruption happens mostly during the process of procuring goods and services in that prices are often inflated or manipulated, or in awarding contracts to close relatives or friends [3]. This can happen when tenders are advertised, and tender bid committee systems are not properly constituted.

Reference [4] found it too early to assess applications powered by blockchain as tools to fight corruption but call for further experimentations, innovation, as well as rigorous research on the topic. They suggest governments should endeavor to digitize paper-based processes into blockchain applications if it is found to be of value, as well as improved transparency in conducting government to the citizen, government to business, and government to government electronic (e-government) services.

Blockchain is a digital ledger, in which data about transactions are recorded uniquely due to the distributed and decentralized nature of the blockchain [5]. Blockchain enables instant, synchronized replication, and shares the updated state of the ledger to the participants in the blockchain, the so-called "nodes", who should agree on the legitimacy of the transaction [5]. The new block in the chain

is linked to the previous which maintains the shared and agreed upon state of the blockchain [6].

Reference [7] refers to the eastern and southern African common markets' use of blockchain to implement real-time digital free trade area amongst buyers and sellers thereby increasing e-commerce transaction security with certification of origin generation and with assurance and security. The digital free trade area resulted in savings of approximately $450 million in eliminating administrative bureaucracy [7].

In their quest to answer whether emerging technologies are helping in the fight against corruption, [4] assessed the use and came up with empirical findings on the use of the following technologies and tools.

- *Digital public services* enable internal supervisors to monitor officials' activities; these can reduce corrupt behaviors rooted in the principle-agent.
- *Crowdsourcing platforms*: these allow citizens to report corruption incidences by using the internet or telephone.
- *Whistleblowing tools* are platforms that enable people to report wrongdoing by public officials, usually designed for gathering detailed reports of individual cases of grand corruption to support a criminal prosecution.
- *Transparency portals* are online platforms usually run by governments or NGOs that publish information on government operations.
- *Distributed ledger technology (DLT) and blockchain* refer to a decentralized and synchronized database maintained by a peer-to-peer network where each user holds a copy of the blockchain. All information is transmitted, verified, and saved in the distributed ledger as blocks that cannot be changed or deleted [4].

Whether the technologies in everyday use contribute to the success of ICT-enabled initiatives as an anti-corruption strategy will largely depend on implementation, education, culture, and infrastructure, among others [8]. Another factor related to its success is citizen acceptance of ICTs because environmental barriers to ICT adoption can be transnational.

B. DLT employed on the African continent

Digital Ledger Technology (DLT) is seen as a new and fast-evolving approach to record and share data across multiple data ledgers. Single layered ledgers with shared permissions that are accessed and edited by vetted participants on a network are not new but the concept of a decentralized, distributed and immutable ledger was realized for the first time through DLT [1]. DLT has great potential to provide increased public sector accountability [4]. DLT technology has found allies on the African continent in John Magufuli, the President of Tanzania, in 2015; he is a strong proponent in fighting corruption. Nigeria's customs service also uses blockchain technology to assist in the reduction of corruption and increased its revenue collection while Ghana used blockchain technology for the creation of trackable landowner records for unregistered landowners who do not have title deeds [7]. In Kenya, blockchain technology is applied in the financial services sector through micro-lending facilities that enable trust and cooperation among

farmers [7]. The Ethiopian Government applied blockchain technology to track coffee exports by implementing genetic sampling of the coffee to identify its origin (the farm on which it was produced), species type, the pesticide used in its production, as well as its exposure to the different chemicals to authenticate the coffee [7].

C. E-government and corruption

E-government can be defined as the application of ICT in delivering government services to its citizens, the business community and across government [9]. Blockchain technologies brought about indirect benefits which include a reduction in bureaucracy, the reduction of paper use, reducing transacting costs, and the reduction and control of corruption which in turn changes a governance eco-system with increased trust from citizens [10]. An exposition of the key features in blockchain and their justified use in e-government is tabulated in Table 1 [10].

Table 1: Features of BCT and use in e-government [10].

Feature	Justification
Reduction of human errors	Advance authentication of user devices with identities before accessing the network
Increase in public trust	All network participants are authenticated, and individuals have control over their information
Great scalability	New devices and users can be added to the network automatically following the consensus mechanism because the system can easily scale up.
Improving reliability	Data can only be altered when all participants agree so because of the consensus protocol and data being stored in multiple locations.
Increasing resiliency	The system is resilient to malware, DoS, and DDoS attacks because Single point of failures is avoided
Improving auditability	All transactions remain unchanged in the network making it easy to trace back the history.
Greater verifiability	Validation of transactions by peers participating in blockchain addition
Information ownership	Individual responsibility for authorizing access to their information
Improving access to information	Multiple location storage of information which enhance speed and ease of access
Increasing data quality	Validation in advance of all transaction record in storage on the system with authentication required
Great transparency	All nodes in the network share the same copy of the blockchain is shared by all nodes in the network and transactions are consensus based
Reduction of operational costs	No third party needed in processing transactions
Improving efficiency and speed	All records are subjected to the accessibility privilege and all new transactions are distributed to all participating nodes

Project Khokha (an isiZulu word, meaning 'pay') is an experimental DLT initiative that was introduced by the South African Reserve Bank (SARB) early in 2018, to serve as a mechanism for managing wholesale payments settlement between banks [11].

Reference [12] explain the complex and confusing nature of people, business and government approaches to

Blockchain Technology (BCT) and their hesitant misconception and association with the bitcoin cryptocurrency. Blockchain technology has applications that do not only include cryptocurrencies. Reference [4] contrasts the use of emerging technologies in the fight against corruption and empirically finds that the use of digital public services can be beneficial if it is realized through appropriate infrastructure, regulations, finance, and trained staff availability. Other findings relate to Distributed Ledger Technology (DLT) and blockchain where blockchain's anticorruption impact is seen to be largely untested and that it also poses a challenge to data security and regulation that could enable the transfer of corrupt funds.

The risk of corruption in public procurement is worsened by the increased reliance on public officials in the procurement process, known as the agency problem [13]. Blockchain technology provides a unique method of joining previously unknown parties in database generation and maintenance on a complete and distributed basis [14]. A blockchain framework model can be derived from introducing IoT into traditional objects, converting it into smart objects with key applications related to logistic management functions.

D. Corruption

Corruption, is generally understood as the misuse of public office for private gain, can be a principal (citizens) agent (government officials) problem, where citizens are perceived to be the principals and government officials acting agents on citizens' behalf [4]. As such the principal-agency theory was considered to establish the framework for this study. However, this model is often used by economists in situations where the principal through his/her position induces the agent, to perform tasks that favors the principal and not necessarily those of the agent [15]. However, in an investigation scenario, enabling agents sometimes possesses more power in terms of information and discretion of a political nature on the distribution of resources, which potentially makes room for corruption.

South Africa has been besieged with corruption and malfeasance which recently gained prominence with the commissioning of a State Capture enquiry emanating from a Public Protector report by the same name. With promises of a new dawn and a general onset of corruption fatigue in society, the question on whether corruption can be stopped and if the criminal justice system is still a deterrent remains.

Limited studies have been conducted into the legal and factual perspectives of DLT's usefulness in combatting public sector procurement fraud, as well as legal barriers to its potential use in South Africa. Despite all the media attention that blockchain receives in South Africa, the technology is still in its infancy and its embryonic nature has meant that there has been limited government regulation and scant legal academic exposition on the topic [5]. Blockchain is viewed as a data structure that makes the digital ledger of transactions it hosts tamper-proof while cryptography allows access to add securely to the ledger. Due to these features blockchain can arguably make it possible to reduce or eliminate integrity violations such as fraud and corruption [16]. However, most fraud are committed where human interventions with technology occurs.

E. Conceptual Framework: TOE

This study was underpinned by the Technology-Organization-Environment (TOE) framework for organizational technology adoption [17]. In this study, TOE was used as a guide to interpret collected data for analysis purposes, not for theory development [18]. Factors that influence the use of ICT have been studied by various scholars. Extant literature on the Technology Organization and Environment theory (TOE) provides a broad applicability and possesses explanatory power across several technological, industrial, and national/ cultural contexts [19]. The technological context of the TOE framework relates to the availability of technology to an organization, with a focus on the characteristics of technologies that influence their adoption [21]. The organizational context describes the characteristics of an organization which includes the organization size, its degree of centralization, formalization, the complexity of its managerial structure and the quality of its human resources as well as the amount of slack resources available internally [21]. Factors external to the organization present constraints and opportunities to technological innovation. This external environmental context is the place in which an organization conducts its business within the context of the industry, its competitors, government regulations and relations [20].

III. RESEARCH METHODOLOGY

The study adopted a qualitative approach and sought to evaluate whether ICT is used effectively to combat public procurement corruption. The population sampling was drawn from within the procurement investigations' space. The purpose of this research is exploratory and seeks to establish whether DLT is an effective ICT to combat the scourge of corruption in South Africa.

The sample size for this study was based on practical implications namely the COVID-19 restrictions in place at the time. The total number of investigators dealing with Public Administration investigations in the Public Service Commission is fourteen (14) for both the national office, as well as the nine provincial offices. The collection of data was initiated with an anonymous linked open-ended questionnaire developed with the TOE framework as a guide. The survey instrument aimed to elicit responses on the participants' experiences in using ICT as a tool to investigate procurement corruption. It also sought to understand whether current ICTs are effective and in line with the factors regarding the availability of technology in the TOE framework. A second section of the questionnaire sought to introduce DLT as an ICT to respondents with the intention to evaluate whether they conceive it to be a potential tool for use within the ICT environment to combat

procurement corruption. The questions related to whether the innovative use of ICT to combat public procurement corruption is being considered by management.

The NVivo data analysis tool was used to analyze data as well while memoranda and summaries of all data was recorded. The questionnaire responses were subjected to thematic analysis to find patterns in the data used in conjunction with the conceptual framework. The six-step framework for thematic analysis was seen as the best tool [22]. These steps are familiarization with the data; initial code generation; initial theme generation; reviewing themes; refining, defining and naming themes; and producing the final report.

This research was approved by the University of Cape Town's Ethics in Research Committee.

IV. FINDINGS

In this section the data collected from the nine participants who responded to the semi-structured questions in the anonymous survey are presented. The findings point to a call for better ICT training for investigators, infrastructure investment by doing away with outdated mainframe technology and embracing new technology. The participants are experienced investigators based mainly in Gauteng Province with affiliation or membership to the Association of Certified Fraud Examiners (ACFE). The section is divided into three sections which include the demographics of respondents, the empirical findings on the current use of ICT and its effectiveness and DLT as an ICT option to prevent procurement corruption.

A. Demographics details

During the study period, the COVID-19 pandemic put paid to almost all person-to-person research activities. Thus, an open-ended survey was used instead of interviews. The mean years of experience among respondents were an average of fifteen years as indicated in Table 2 above, with a 75% majority being members of the Association of Certified Fraud Examiners. Respondents were unanimous in defining procurement in the supply chain management function as a source of corruption encountered, in line with extant literature [23].

Table 2: Sample Demographics

P#	Exp (yrs)	Prof?	Losing C-battle?	SCM function where C occurs	RSA lags continent?
P1	15	Yes	Yes	Tenders	Unsure
P2	15	Yes	No	Procurement	N/A
P3	16	No	Yes	Local Govt.	No
P4	15	Yes	Yes	Procurement	Yes
P5	20	No	Yes	Cover quoting	Yes
P6	28	Yes	Yes	Purchasing	N/A
P7	1	No	Yes	Procurement	Yes
P9	14	Yes	No	Procurement	50%
Legend: Exp = Experience (in years); **Prof** = Professional membership					

Seventy-five percent (75%) of respondents share the view that the battle against corruption is being lost. This is strongly evident in responses from (participant 6) who stated "***Yes. Although there are several law enforcement agencies that are actively fighting corruption, the little success of the outcomes is not effective to deter people/officials to commit corruption. So, my answer to this is yes. If officials that are in senior positions are rot, the rest (officials) will also become rotten. If law enforcement and the NPA do not do their part, then justice will not prevail***" and (participant 7) with a view that "***the battle has long been lost. Incompetent staff with a tainted employment record are appointed & the corruption continues***". These views are in contrast with (participant 9) who believes that "***South Africa is slowly getting rid of corruption. But there are some cases that are not solved as a result of lack of knowledge in ICT and DLT***". The data responses support the literature as reflected in the global corruption barometer on the perception that corruption has increased in South Africa [24].

B. Current use of ICT and its effectiveness

In this section we address the first research objective: evaluation of the current effective uses of ICT in the fight against procurement corruption. It is widely accepted that ICT integration leads to open and interactive governments that can develop more responsive policies, improved decision-making and a reduction in corruption and bribery [25]. It is against this background that the responses on the public procurement of goods and services through the National Treasury's Central Supplier Database as the best use of ICT to combat corruption can be understood as not supported because respondents placed their emphasis on current control measures. This is evident in the responses of (participant 6) whose statement that "***No, not at all. The issue has nothing to do with any database. It is all about control measures that must be adhered to, segregation of duties, accountability, integrity, and management that plays a role. The issue is that no one wants to take accountability or discipline their colleagues due to several reasons, which I am not willing to discuss***" and (participant 7) who stated "***No, there has to be a better mechanism & control, allowing a decentralized approach, not impacting service delivery. Software red flagging public servants with interests in enterprises, doing business with the state, for example***".

On analysis of the data, it is evident that the respondents such as (participant 5) believe that "***registered suppliers can also be part of corrupt activities***" while (participant 4) believes "*There are more advanced ways to combat corruption in South Africa*". While the data shows a negative view on the reliance on this database system to combat procurement corruption.

Reference [26] found that attitude was the most decisive factor in explaining the behavioral intention to adopt ICTs such as e-government services in South Africa and this is

confirmed by the data that ICT applications are not optimally used to assist in investigating procurement corruption. This was evident in responses from (participant 3) who stated that "*ICT use is primarily not utilized due to my peer's lack of knowledge of the exploitative capabilities of ICT in the investigation space*", (participant 4) "*No not really. Investigators are not necessarily tech savvy*" and (participant 9) who held that "*most of the investigators lack knowledge on how to use ICT applications*". (Participants 6 & 7) pointed to the need for training: "*The lack of knowledge and embracing new technology*" and lack of innovation "*government red tape & outdated server mainframe technology*", respectively.

The data on participants' perception on whether ICT applications are used effectively in the South African public procurement space elicited negative responses from respondents. (Participant 6 & 3) expressed as examples personal incidents related to "*SAP as an example. It has many controls in place, but in my view, if a person/official is corrupt, no ICT system will prevent it as it will take a human to control/manipulate the system, unless there are user activity logs in place. However, ghost users can be created that will make such a system useless*" and "*The current use of ICT is ineffective in assisting me in the fight against corruption because I have asked for analysis software countless times with no success*". The response from (participant 6), "*It depends what systems and policies are in place and if they employ the correct people to deal with such investigations*" is supported by literature. Reference [20] contends that the technological context of the TOE framework relates to technological availability to an organization with a focus on the characteristics of technologies that influence their adoption. Accordingly, [21] indicate that the availability of technology was a choice, but the need of technology itself was the reason to implement the software in the technological context of the TOE model.

C. Digital Ledger Technology as an ICT option

In this section we address the second research objective: Analyzing how DLT can be used to impact the reduction of procurement corruption. The research points to a need for training. As participant 13 notes: "*Training. Most of the decision makers would agree that DLT is needed but the problem is who can train our corruption busters, where can we find people that are experienced in using it, etc*" but for less bureaucracy: (participant 4) "*Training. Most of the decision makers would agree that DLT is needed but the problem is who can train our corruption busters, where can we find people that are experienced in using it, etc*" and in favor of DLT adoption with better regulations (participant 4) "*Yes, but within a regulatory environment*"

The advantages of blockchain is that it provides a platform for connecting multiple decision makers with multiple sources of information and generates a richer informational landscape for Operational Management (OM) applications which compliments other ways of collecting and sharing information such as proprietary networked systems, smart sensors, internet, mobile apps while other advantages are the low cost associated with adding new nodes, its data encryption and its record validation [27]. They also note possible disadvantages of using blockchain technology, namely that information may be used for unintended purposes, the difficulty of deleting false records and the difficult management of privacy and access rights. Reference [25] notes the possibilities that Africa can derive from an increased uptake of frontier technologies such as the Internet of Things (IoT), big data and blockchain to address agricultural, health care, educational and social protection needs.

Concerning the respondents' knowledge and understanding on the use of ICTs such as DLT to combat procurement corruption: respondents were gauged and while the concept was not well understood by some with (participant 3) noting "*I have a very vague understanding of DLT. The name perhaps suggests it is software that allows access to an accounting ledger from different access points. However, I have no idea what Blockchain or Ethereum contracts are*", "*ICT technology that can financially profile employees and prospective suppliers. Computer technology that enables a government vetting agency to trace suspicious payments easily*" and (participant 6) who thinks that "*it is similar to the ledger that banks hold to monitor all the digital transactions we make using fiat currency*", it (DLT) received support for implementation from most respondents but only "*within a regulatory environment*" and the "*retraining of investigators*" according to (participant 4). However, (Participant 3) notes that "*User access to ICT should be restricted as much as possible in the public sector until work ethics are improved*".

The data suggests that respondents were divided on the capabilities of DLT as an implementable ICT, and suggest more awareness and training to happen before its implementation and use, as noted by (participant 6) "*Not if people are not 100% trained or aware of such a application/system but I believe that we have the ability to excel if we embrace the technology*".

Some respondents think that DLT can make an impact in the fight against corruption in the public procurement sector but point to practical dilemmas that may ensue. (Participant 3) has doubts about DLT use and notes that if "*my understanding of the term is correct, I doubt whether it would positively impact the fight against corruption in the public sector*" because "*DLT applications in South Africa could prove to be disastrous because it would enable public procurement corruption instead of preventing it*". This view is somewhat shared by (participant 9) who states that "*it is not as effective as it could be because with few investigators who capable of using ICT technology*" and (participant 7) who notes that it can "*Definitely assist with record keeping, especially where evidence was destroyed but may not completely eradicate*" public procurement corruption. Data suggests that some respondents prefer a

neutral wait-and-see stance like (participant 6) who cautiously noted "*Yes and no. What if the transaction is sent to a blockchain ledger in another country and they will not give their cooperation*" and therefor "*don't think we are ready for this*" technology.? Respondents could not be drawn on whether DLT will have an impact on corruption and were for the most part unsure of recommending the introduction of DLT in public procurement.

V. DISCUSSION

This section discusses the above empirical findings in the light of previous literature and the South African context.

A. Current use of ICT and its effectiveness

The research shows that South Africa lags the rest of the continent when it comes to pioneering the use of effective use of ICT. This is confirmed with a clear response from (participant 9) who indicated that while "*South Africa is the most sophisticated country in Africa. Most of the cyber crimes are committed here and as a pacesetter, South Africa could have implemented DLT long time ago*".

Reference [25] notes the disruption that the innovation and technology development brought on traditional practices ensured an important interactive role between Government and its people. This can be seen in the following South African case studies of e-Government services to prevent corruption. They are:

- The South African Revenue Service (SARS) e-filing system of tax collection and tax administration,
- The smart identification card system with better security features launched by the Department of Home Affairs,
- The National Traffic Information System (NATIS): Car and License Registration functionality for the registration and renewal of motor vehicle services where users reside,
- The State Information Technology Agency (SITA) developing a Government-to-Government (G2G) and Government-to-Citizens (G2C) system. The (G2G) systems which include the Basic Accounting System (BAS), Logistic Management Information System (LOGIS), National Population Register (NPR), Social Pension Fund (SOCPEN), Police Crime Administration System (CAS) and the electronic National Transport Information System (e-Natis). G2G systems developed include Government Websites, Batho Pele Gateway, Department of Labour (DoL) U-Filing and Department of Health (DHA) "Trace and Trace, and
- The mobile telephone penetration that has reached 100% in South Africa and there has been advancement in development of mobile innovations. Mobile applications supporting e-Government services include the Find & Fix mobile application by the Johannesburg Road Agency (JRA) that enables the public to report potholes, faulty traffic signals, storm water drains, manhole covers, and other infrastructure issues related to JRA.

The increased use of ICT service delivery improves efficiency of public institutions, offers wide accessibility to all citizens, promotes transparency and accountability, and also mitigates against corruption. Prior to April 2016, all government departments maintained their own database of suppliers, individuals, and companies from whom it procured goods and services. Due to nepotism, cronyism, fraud and corruption within this public procurement system, the National Treasury called for the establishment and regulation of suppliers, individuals, and companies on its Central Supplier Database (CSD) from which all public procurement was vetted and administered. The CSD system, which came into operation in 2016, allowed for a single registration as a supplier with no physical requirements to submit proof of business registration and tax clearances. However, the change in technology relied on a centrally located mainframe system that required (mostly) slower internet network connectivity, requiring longer access to the database because of increased traffic to a limited set of data. This often resulted in manual retrieval, if data is lost.

Literature confirms that the success of ICT-enabled initiatives as an anti-corruption strategy will largely depend on implementation, education, culture, and infrastructure, among others [8]. Reference [21] includes all aspects related to technology and IT availability, as well as the human resource and IT infrastructure to this anti-corruption strategy.

B. Digital Ledger Technology as an ICT option

The most important feature of DLTs are in the control that several network participants have instead of one entity or participant [1]. This contrasts with the project of centralizing the South African National Treasury Central Supplier Database (CSD). The CSD was centralized because of the corruption that infiltrated its provincial sections. It was viewed as a single layered ledger with shared permissions that were accessed and edited by vetted participants on a network. In contrast the concept of a decentralized, distributed and immutable ledger technology was realized for the first time through DLT [1]. Some of the respondents feared the use of DLT applications in South Africa may aid public procurement corruption instead of assisting in combatting public procurement corruption while a majority was in favor thereof. This is evident in the response from (Participant 3) who noted that "*DLT applications in South Africa could prove to be disastrous because it would enable public procurement corruption instead of preventing it*". The individual influence factor of the TOE theory was also observed.

Technological factors in the TOE theory were observed where respondents pointed to "*outdated backend main frames & server*" use in when comparing South Africa to the rest of the continent in using of DLT to combat corruption. The data indicates Environmental factor influence to DLT adoption where respondents perceived the lack of knowledge (training), bureaucratic red tape, and outdated technology as barriers to the adoption of DLT to combat public procurement corruption.

The only inference to the possible adoption of blockchain technology in South Africa is found in the experimental

Project Khokha that was initiated in the banking sector by the South African Reserve Bank (SARB) [11]. The aim of the DLT project was to reduce costs associated with reliability and inefficiencies related to availability against cyber-attacks or equipment failure. By replicating the clearing of money transfers and settlements through a permissioned blockchain network the SARB wanted to assess whether the technology improved performance, scalability, and confidential payments of real time simulated payments. Even though the project was successfully modelled its potential was acknowledged by being awarding the distributed ledger initiative by Central Banking Publications.

The barriers to blockchain adoption include the incumbent governments' reluctance to create immutable, transparent records of their activities if such technology will constrain their scope for private gain through corruption. The promised implementation of blockchain to curb procurement corruption will depend on the strength of a South African public and private institutions and their integrity.

Permissioned blockchains require safeguards to terms and policies of organizations and involves the incorporation of pre-approved nodes while permissionless blockchain (public or decentralized blockchains) can be used by anyone who can create and access the blockchain and publish the self-executing contract (smart contract). Therefore, as in the organizational context of the TOE model the adoption of DLT will be hampered. The anonymous nature of cryptocurrencies makes them vulnerable to money laundering and illicit financial regulatory activities, such as drug and human trafficking as well as terrorism which frustrates regulatory prosecutorial efforts. Legality of and uncertain regulations regarding blockchain transactions blockchains' distributive nature gives rise to conflicts of law, jurisdictional issues due to the locations of the nodes and the concurrent liabilities.

VI. CONCLUSION

This research study had as its aim the evaluation of the potential use of distributed digital ledger (DLT) as an ICT tool to detect and possibly prevent public procurement corruption. The study focused on DLT implementation and perceived barriers of its use in a public and private sector environment. Individual user factors such as employing competent people to deal with such investigations and that those investigators were not necessarily tech savvy were identified as a barrier to adoption of DLT in combatting public procurement corruption. The study also discovered that respondents were not knowledgeable on the use of Ethereum contracts in contractual arrangements in the procurement process. A lack of training was identified as a problem due the lack of experience and knowledge in using ICT to prevent and investigate corruption. While some respondents believed that South Africa is the most sophisticated country in Africa, most respondents perceive it

to lag the rest of Africa in DLT adoption and as a pace setter could have implemented DLT long time ago.

Individual user factors in the TOE framework model that was used point to implicated individuals that corrupt ICT systems, even those with enforced user logs. Government policy will have to be updated to enforce the monitoring of user activity logs as a measure to combat corruption and particularly to prevent the creation of ghost users which have the potential to render any ICT system useless.

This study has some limitations. Literature on the use of DLT to combat procurement corruption are limited, particularly in the South African environment. A low response rate to the anonymous semi-structured questionnaire was experienced and the cross-sectional nature of the study did not lend itself to observing data over longer period. A longitudinal study would allow for correlational research of variables over a longer period. This would also negate the effects and limitations that COVID-19 placed on researchers to conduct conventional data collection methods in observable setups.

While this qualitative study cannot generalize its findings, it recommends that public procurement corruption can be prevented to a larger extent by an interim government policy enforcing the monitoring of user activity logs as a measure to combat corruption and to assist in preventing corruption in the interim. Furthermore, it is suggested that government initiates action on white paper discussions on the introduction of permissioned DLTs in its procurement system, including its National Treasury Central Supplier Database system.

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