Factors influencing blockchain adoption in the South African clearing and settlement industry

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Background: The adoption of and improvements in new technology in the South African capital market historically led to increased trade capacity and liquidity, which may be linked to the growth in market size.

Aim: In this study the aim is to investigate factors that will influence the adoption of blockchain technology in the South African clearing and settlement industry.

Methods: In this study semi-structured interviews to collect data among stakeholders in the clearing and settlement cycle/process of securities in the South African capital market are employed. Participants were identified through a combination of purposive, snowball sampling and targeted sampling using social media. Data were analysed using thematic data analysis with the aid of Atlas.ti software.

Setting: The South African capital market, with specific focus on the clearing and settlement of equity.

Results: This study identifies People, Organisation, Technology, Industry and Country (POTIC) as factors important in influencing blockchain technology adoption in South Africa. The study expands and contributes to traditional frameworks for adopting blockchain technology in the South African clearing and settlement industry by adding five factors: trust, load shedding, unemployment/layoffs, current infrastructure, useful life and educational campaigns.

Conclusion: The POTIC framework will be beneficial to the Johannesburg Stock Exchange (JSE) and Shares Transactions Totally Electronic (STRATE) when considering the adoption of blockchain technology for the integration of trade, execution and post-trade services to reduce the settlement cycle. In addition, when regulators need to formulate new regulations they will benefit from considering the POTIC framework.

Keywords: blockchain; clearing and settlement; South Africa; STRATE; CSD; equities; capital markets; JSE.

Introduction

The Johannesburg Stock Exchange (JSE) is the officially licenced exchange in South Africa, and Shares Transactions Totally Electronic (STRATE), in which the JSE has 44.5% shareholding, is responsible for the settlement of JSE securities transitions; it is South Africa's only Central Securities Depositories (CSD) (JSE 2021). The JSE was formed in 1887 and its purpose is to connect buyers and sellers interested in exposure to South African- listed companies quickly and efficiently (JSE 2019). The JSE introduced the Johannesburg Equities Trading (JET) in 1996, which improved the settlement cycle from two weeks to seven days, meaning that the settlement cycle changed from T+14 to T+7. The JET system was an order-driven, centralised, automated trading system that allowed dual trading and negotiated brokerage commissions that replaced the open outcry trading floor. The implementation of the JET system brought to light the shortcomings of the JSE's paper-based settlement system; namely, there were instances when up to 40% of all trades failed to settle (Mkhize & Msweli-Mbanga 2006). The electronic settlement of trades addressed the limitations of paper-based settlement by allowing for higher trade volumes while eliminating the risks of loss, theft or forgery of share certificates. This was evident in the increasing number of trades on JSE after automation; the number of trades on the JSE increased from about 2930 on an average day in 1995, to 6055 in 1997, and 29 050 per day in June 1998 (IOL 1999).

New technologies create opportunities to enhance and revolutionise current processes (Greco 2019). In 1997, STRATE was introduced; this system allowed for the replacement of paper

share certificates with electronic records of ownership, also referred to as dematerialisation (Mkhize & Msweli-Mbanga 2006). The implementation of STRATE solved most issues and problems linked to non-settlement in South Africa (Mkhize & Msweli-Mbanga 2006). Before implementing STRATE, South Africa was categorised as one of the worst emerging markets in terms of operational and settlement risk. Trading volumes on the JSE were averaging 4000 trades daily, very thinly compared to the 350 000 on average during a month in 2016 (STRATE 2016).

In 2002, the JET system gave way to the JSE Securities Exchange Trading System (SETS), which was implemented in partnership with the London Stock Exchange (LSE). The new system increased the transparency, liquidity of trading, and investors' confidence in the JSE; it also helped reduce trading thinly. Dicle and Levendis (2013) analysed the effect of the implementation of the SETS, the authors found that trading activity doubled, and trading became cheaper after the implementation of the system. Moreover, they argued that lower trading costs and increased activity led to significantly improved market efficiency at the JSE equity market.

There is evidence that the implementation of a more advanced trading platform enhances the overall liquidity of the market. Yilmaz et al. (2015) examines the effects of technological changes on the liquidity of stock markets using daily data of 361 stocks from 10 emerging market exchanges, namely Colombia, Indonesia, Johannesburg, Korea, Malaysia, Mexico, Russia, Shanghai, Shenzhen and Thailand. Their study found that technological upgrade decreases the bid-ask spread and increases trading activity. With specific reference to South Africa using, three years of data from 2005, it is found in the study that although trading turnover increased, volume and liquidity did not. The implementation of SETS was later followed by an improvement in the settlement cycle from T+5 to T+3 to align with international standards (JSE 2019). The T+3 settlement cycle came into effect on July 11, 2016 (JSE 2019).

Evolving technology has reduced communication cost, transaction cost, and growth in trading in the global equity markets (Hasan, Malkamäki & Schmiedel 2003). This is evident in the adoption of automated trading platforms, which significantly benefited institutional and private investors by allowing private investors low-cost, independent access to the market (Poser 1992). Friday and Osundu (2014) reiterated the benefits of technology, arguing that technology fundamentally changed the global equity markets by lowering transaction costs and reducing asymmetric information; therefore, levelling the playing field for investors and issuers. And although technology has made it possible to link various stock exchanges together and provide access to a larger number of market participants at a lower cost (Solomon & Corso 1990), a substantial portion of the risks remains directly related to the length of time it takes for trades to settle (Priem 2020). Table 1 summarises the impact of technology on the JSE Equity market.

TABLE 1: Summary of the impact of technology on the Johannesburg Stock Exchange equity market.

Impact	Explanation
The anonymity of trades and traders	Anonymity provides more investor protection and privacy. This allows institutions and individuals to trade without revealing their information and identity, which results in a higher number of trades.
Increased trade capacity and liquidity	Having more investors and faster trades provides liquidity which in turn result in cheaper trades that lead to the increase trading activity.
A higher number of listed companies	A higher number of listed companies leads to higher volumes because of increased trading activity.
Shorter settlement cycle	Shorter cycles reduced settlement risk as the result of the reduced number of days between trade and settlement.

Source: Dicle, M.F. & Levendis, J., 2013, 'The impact of technological improvements on developing financial markets: The case of the Johannesburg stock exchange', *Review of Development Finance* 3(4), 204–213. https://doi.org/10.1016/j.rdf.2013.09.001

The study of the adoption of blockchain is in its infancy stage and has only recently begun to gain momentum. Studies focused strongly on the factors influencing the adoption of blockchain by discussing the technical characteristics of blockchain technology, such as open access, decentralised consensus, immutability and distributed verification. Furthermore, studies attempted to show how the adoption of blockchain may lead to more transparency, efficiency and disintermediation when applied to various industries (Lustenberger, Malešević & Spychiger 2021). Researchers have applied traditional technology frameworks and theories to the adoption of blockchain technology. These include the Technology Acceptance Model (TAM), the Diffusion of Innovation Mode (DOI) and Technology- Organisation-Environment framework (TOE). However, there are limited studies on clearing and settling, and more specifically in the context of South Africa. The study, therefore, aimed to investigate factors that could influence the adoption of blockchain technology in the South African clearing and settlement industry.

Blockchain technology

In this study the definition of blockchain is adopted from the Organisation for Economic Co-operation and Development (OECD) (2018:6), as follows: Blockchain technology uses cryptography, smart contracts, and distributed ledger design in order to create digital records of transactions, shared to a network of users. The digital records of transactions between users are stored in chronological order. In addition, blockchain technology allows access to all the members of the network to identical copies of the ledger. Networks may be open to all (permissionless to the public), open to authorised participants (permissioned to the public), open to a select group, who may have restricted access (consortium-based), or be restricted to network operators only (private-permissioned 'enterprise' network).

Blockchain is a decentralised digital ledger and a consensus mechanism used to confirm transactions to facilitate transparency of information to multiple parties in a way that preserves a high level of security and operational resilience (Lewis, McPartlan & Ranjan 2017; Manning 2016). Blockchain solves the issues experienced in the traditional distributed database by combining peer-to-peer networking and distributed consensus algorithms. Fekih and Lahami (2020)

emphasise that it is used to securely record transactions across many computers in a peer-to-peer network without the need for a third party. Blockchain achieves this by providing a (Joshi, Han & Wang 2018):

- A decentralised database network.
- Using consensus models.
- Transparency.
- Open source.
- Autonomy.
- Anonymity.

In the context of securities trading, the creation of a blockchain consists of four key elements (OECD 2018), including the trade; a record of the trade (via the shared ledger); a process of verification (via algorithmic and cryptographic consensus); and a method for storing the transaction (via encryption). Shared data structure is described as blocks, a chunk of data that includes a list of ordered transaction records (Yoshihama & Saito 2018).

If blockchain is adopted in the clearing and settlement industry, there will be four major benefits to the industry and its stakeholders. The trade and settlement could become one process because the dematerialised share certificates will be transacted without friction and at near-instant T speed. Secondly, replacing the myriad of ledgers maintained in the current system, with one single source of truth, could lead to a significant increase in efficiency. Thirdly, the reduction in settlement time has the potential to significantly reduce the cost of transacting. Lastly, smart contracts make it possible to embed automatic rules that will govern dividend and interest payouts, rights issues, proxy votes and other services (De Meijer 2016)

Theories of technology adoption

The DOI and the TOE frameworks are suitable for examining technology adoption on the organisational level, while TAM is on the individual level.

Technology acceptance model

The Technology Acceptance Model is utilised to predict the usage and acceptance of technology; TAM proposes that the perceived usefulness and ease of use of new technology are the two main determinants in explaining individual users' adoption intentions; when the perceived usefulness of a new technology is the extent to which potential users believe that using a particular system will enhance their job performance. Whilst the perceived ease of use is the extent to which potential users believe that adopting the new technology will require minimal additional effort (Lou & Li 2017).

Diffusion of innovation theory

The Diffusion of Innovation Mode theory explains how an idea, product, or service is adopted through a system over time. This adoption of innovation occurs at different rates with different people or organisations, ranging from early innovators to late laggards. The adoption rate is described in five major categories of adopters: innovators, early adopters, early majority, late majority, and laggards. The theory assumes that the adoption categories follow a normal distribution as follows:

- First 2.5% as innovators to adopt the technology.
- The second 13.5% are the early adopters.
- The third 34% are the early majority.
- The fourth 34% are the late majority.
- And finally, the fifth 16% are the laggards.

The five categories are mutually exclusive (Woodside, Augustine & Giberson 2017).

Technology- organisation- environment framework

The Technology- Organisation- Environment framework states that an organisation's technological, organisational, and environmental aspects may affect technology adoption (Tornatzky, Fleischer & Chakrabarti 1990). The framework focuses firstly on the perceived benefits, the complexity and compatibility of the new technology. The perceived benefits of new technology is based on the extent to which adopters of the new technology consider that the use of a system would enhance their performance. Complexity and compatibility indicate the extent to which the adopter of a new technology considers the technology difficult to use and whether it is in alignment with the values, past experience, and needs of an organisation (Alharthi, Cerotti & Far 2020).

Secondly, on the organisational readiness, top management support, and new technology knowledge (Alharthi et al. 2020):

- 'Organisational readiness can be defined as the availability of resources to adopt new technology.
- 'Top management support refers to the degree to which top management support provides adequate resources for the adoption of a new technology.
- 'New technology knowledge is the degree of knowledge managers have of technology'. (p. 16)

Lastly, the …

> [E]nvironmental aspects of an organisation are part of its business activities. It focuses on the regulatory environment and government support .The regulatory environment can be defined as the degree to which the organisation/government policies affect the innovations. Government support is the degree to which a government regulates its policies to assist institutions showing growth and development. (Alharthi et al. 2020:17)

Empirical studies on factors influencing blockchain adoption

The factors influencing the adoption of blockchain technology in the context of the securities trade with a specific focus on South Africa are found in De Castro, Tanner and Johnston (2020). The study employs a DOI and TOE framework. De Castro et al. (2020) find that there are three main challenges faced by developing countries: high costs of adoption, lack of regulatory framework, and lack of support from leadership, which may be categorised as external environmental factors. In the study it is also acknowledged that specific business

factors influence blockchain adoption, a view supported by Dick and Praktiknjo (2019), who determined that the adoption of blockchain is influenced by the complexity of the technology, its compatibility and the relative advantage the technology will provide, compared to current technology in the industry. Relative advantage is the additional benefit of adopting blockchain in relation to the prerequisite costs of switching to blockchain technology (De Castro et al. 2020). The Framework of De Castro et al. (2020) is illustrated in Figure 1 below:

Akaba et al. (2020) employed semistructured interviews with 12 stakeholders and experts in public procurement, private-sector procurement, blockchain technology and advocacy for transparency and the adoption of technology in the Nigerian public-sector procurement. Participants in the study identified barriers to the adoption of blockchain technology as poor infrastructure set up, lack of political will of the government to implement the necessary technology policies needed, lack of funding for a full implementation, resistance to change by public officials, and poor knowledge of blockchain technology by stakeholders involved in the process.

Clohessy, Acton and Rogers (2019) conduct a comprehensive review of the blockchain literature using the TOE framework and concluded that organisational readiness, top management support, and organisational size are the top three factors influencing blockchain adoption. Kulkarni and Patil (2020) find, through the application of TOE, that blockchain technology infrastructure, knowledge about blockchain technology, relative advantage, transaction cost, perceived security, organisational scope, consumer readiness, competitive pressure, government policies and bank partner readiness are the factors that affect the blockchain technology adoption in the banking industry in India.

Wamba and Queiroz (2020) analyse the blockchain diffusion stages in the Indian and United States of America (USA) supply-chain management industry. The study finds that the determinants of the intention to adopt blockchain were perceived benefits, top management support, absorptive capacity, blockchain trust for India, as well as perceived benefits and blockchain trust for the USA. The finding is supported by Liu and Ye (2021) who examine the interactive relationship between blockchain technology and the intentions of users to adopt blockchain technology. They find

that trust and the TAM constructs are significantly related, which indicates that the more the users trust blockchain technology, the more they perceive the value of this technology and the more they intend to use it.

Wong et al. (2020) employed TOE to investigate the significance of relative advantage, complexity, upper management support, cost, market dynamics, competitive pressure and regulatory support regarding blockchain adoption for operations and supply chain management among Small-Medium Enterprises (SMEs) in Malaysia. They find that regulatory support and upper management support were insignificant. Lustenberger et al. (2021) extended the TOE framework to include ecosystem readiness as the most important factor for adopting blockchain. Ecosystem readiness is characterised by three attributes: a large scope, stakeholders that are not yet collaborating in a trustworthy and regulated environment, and an organisation with market power leading the ecosystem (Lustenberger et al. 2021). The organisation with market power leading the ecosystem must further intentionally promote innovation by making the benefits of this new technology observable, putting pressure on the other ecosystem participants to adopt the new technology, and eventually by striving for regulatory certainty in the application and use of blockchain.

Methodology

A qualitative approach was adopted for the study. Qualitative research is suitable for exploring a problem or issue and gaining a complex and detailed understanding through individuals' shared stories, voices, contexts, or settings (Creswell 2007). It allowed the researchers to describe the characteristics of people and events without using measurement or amounts to compare events (Thomas 2003). Semistructured interviews were used to collect data and discuss issues in unanticipated directions, with sessions recorded for ease of analysis and member checks (Fontana & Frey 1994). In addition, the semistructured nature of the interview also left room for the participants to add individual opinions and experiences in a non-constraining way (Lampard & Pole 2015).

Sampling method and size

In the study a combination of purposive and snowball sampling is employed to target sampling, using social media. The sampling techniques aimed to get a heterogeneous sample, by contacting individuals involved in different areas of the South African clearing and settlement industry, and/or have a job role in the securities trading value chain. This approach enabled the researchers to describe and explain key themes that will emerge in the collection of data (Saunders, Lewis & Thornhill 2016). The researcher contacted participants through the following channels:

- Email, participants with whom the researcher had previous working relationships.
- LinkedIn.
- Referrals from other participants.
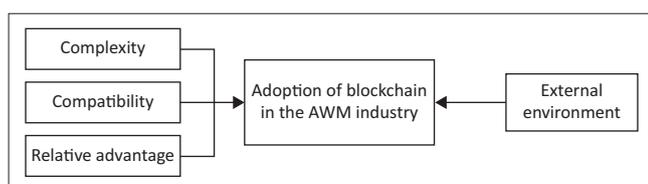
Source: De Castro, P., Tanner, M. & Johnston, K., 2020, 'Perceived factors influencing blockchain adoption in the asset and wealth management industry in the Western Cape, South Africa', in *International Development Informatics Association Conference*, pp. 48–62, Springer, Cham.

AWM, Asset and Wealth Management.

FIGURE 1: Factors affecting the adoption of blockchain in the Asset and Wealth Management industry.

LinkedIn is a platform that connects professionals in various fields; it provided the researcher with the ability to target appropriate participants. This method of finding participants is also referred to as targeted sampling using social media. This approach is appropriate in research fields where participants would, in ordinary circumstances, be hard to reach (Dusek, Yurova & Ruppel 2015). The researchers viewed this approach as appropriate for the study as individuals in the securities value chain are generally hard to reach. Purposive sampling is used when the research involves a difficult-to-reach population. Once a portion of the population is reached, the researchers may use initial participants as a spring board to reach more members of the population. This referral process is known as snowballing (Creswell & Plano Clark 2011). A list of the participants for this study, as well as the organisation in which they work, is to be found in Table 2.

The sample met the inclusion requirement as follows:

- Pre-trade stage – individuals working in asset management both public and private assessment management in the form of analyst, as well as individual investors, were included.
- Order-routing stage – individuals working in the banks (which are CDS participants, were included) the assessors refers to them as the 'eight entities' supervised by STRATE.
- Trading stage – senior individual from JSE was included in the study.
- Post-trade stage – senior individual from STRATE was included.

Some asset managers also have brokerage divisions, and although no individual from a specific brokerage firm was included, individuals from asset management ranged from analysts, traders, portfolio managers and in-house brokers. The roles of the participants are not disclosed, because the

TABLE 2: Participants' descriptors.

Participant identifier	Participant qualification	Type of organisation	Industry experience (in years)	Role
1	LLB	CSD	12	Manager
2	CFA, CA(SA)	Asset management	15	Chief Investment Officer
3	CFA	Asset management	5	Analyst
4	PhD, Master's Degree in Digital	Bank	11	Manager
5	MSc Information Engineering	Stock exchange Bank	10	Manager
6	BCom Statistics	Bank	5	Manager
7	CA(SA)	Bank	20	Manager
8	PhD, CFA	Academic and Bank	15	Professor
9	TOGAF® 9 Certified	Bank	10	Manager
10	MSc Engineering	Asset management	10	Fund Manager
11	PhD	Academic	10	Senior lecturer
12	CFA, MCom	Asset management	10	Senior trader

LLB, Bachelor of Law; CFA, Charted Financial Analyst; CA(SA), Chartered Accountant (South Africa); TOGAF, The Open Group Architecture Framework; CSD, Central Securities Depositories.

study aimed to protect their privacy and maintain anonymity, especially that of STRATE and JSE employees. Individuals from related or supported organisations, such as regulators, were not considered because they are not in the securities value chain.

The interviews were by appointment and conducted online due to COVID-19 lockdown restrictions and precautions. The average duration of the sessions was 45 min. The semi-structured e-interviews were hosted and recorded via Zoom and Microsoft Teams. The interviews were conducted from November 2020 to March 2021.

Data analysis

This study employs content and thematic analysis; this approach involves a detailed examination of human conversation (Neuendorf 2002:1). The data analysis was carried out by using thematic content analysis based on the guidelines of Braun and Clarke (2006), as well as Erlingsson and Brysiewicz (2017). The qualitative analysis utilised by the researcher entailed the six-phase, thematic analytical process defined by Braun and Clarke (2006). The steps were as follows:

- Familiarisation with the text.
- Code the text.
- Generate themes.
- Review themes.
- Define and name themes.
- Writing up.

Tools of analysis

Interviews were recorded, transcribed and analysed with the aid of the Atlas-ti software. The findings are presented in the next section under different emerging themes.

Findings
Blockchain needs to prove itself

Blockchain technology would first need to prove itself before it could be accepted into the mainstream industry, as stated by one participant:

> 'Blockchain has to prove itself against existing technology.' (Participant 2, CFA, CA[SA] [CIO, asset management])

Participants had this view because they had 'doubts about blockchain's efficiency' and whether the technology could be trusted compared to existing systems. Participant 5, in line with the literature was of the view that people prefer to use a system they trust:

> 'General trust of the system is important because people prefer the trusted and old ways of doing things … people may question the trust until it has been proven that it's working.' (Participant 5, MSc [manager, Stock exchange])

It is evident that the lack of trust will delay the adoption of blockchain, as described by another participant:

'We are still operating in the traditional way of doing business. People need to trust the new system … that's one thing which can delay the adoption.' (Participant 8, PhD, CFA [professor, Academic & Bank])

Due to the lack of a proven record, there is concern about blockchain's actual efficiency; furthermore, blockchain technology experienced a decrease in speed as volume increases within the cryptocurrency space. Moreover, there are concerns about blockchain's ability to support transactions and trade volumes that are not cryptocurrency-based:

'My concern is, would the platform be able to support non-crypto currency transactions?' (Participant 6, BCom [manager, bank])

A good track record and empirical evidence to show the benefits of adopting blockchain, compared to current systems, will strengthen trust in the technology.

Trust

A commonly known factor influencing any technological adoption is a user's ability to trust the technology. Trust is a factor that will influence South Africa's adoption of blockchain, mainly because there is no incentive to abandon the current system:

'The current CSD environment has been in play for decades. We already have a system of trust, there is no incentive to abandon that trust system for a trustless system. We have already invested so much money and effort into building those trust mechanisms.' (Participant 2, CFA, CA [SA] [CIO, asset management])

The study identifies *trust* as a factor that will influence adoption in South Africa, mainly because there is no incentive to abandon the current system, which has been in play for decades. Shares Transactions Totally Electronic has a proven record of reliability; users trust it, and there is no incentive to abandon that trust system for a trustless system. The trust in the existing structures negatively influences the adoption of blockchain technology. This limiting factor may be resolved by educational campaigns as recommended by participant 8:

'Mistrust can be resolved through education around on [sic] the technology.' (Participant 8, PhD, CFA [professor, Academic & Bank])

Fear of and resistance to change

A major influencing factor identified in the study is people's fear of change. People prefer to stick to the status quo and not to make disruptive changes:

'It's an intangible factor, but fear, fear of the unknown.' (Participant 6, BCom [manager, Bank])

Fear of change results in resistance to change:

'Major factor will be resistance to change.' (Participant 9, TOGAF® 9 Certified [manager, bank])

Participant 9 expands on this by giving reasons why there may be resistance to change in the industry. Current market players (intermediaries) will lose revenue, and employees their jobs.

'Many institutions will stand to miss out on some revenue. There's a chance that some employees may lose jobs as well.' (Participant 9, TOGAF® 9 Certified [manager, bank])

Participant 8 attributes the resistance to change to education levels and the ability to trust:

'The divergent nature of how educated our people are, especially in South Africa, we would have a group of people who can easily adopt it and work efficiently. But we have got another group of people who are not well educated, that may not be able to use the blockchain technology, yet they have a lot of resources and a lot of money.' (Participant 8, PhD, CFA [professor, academic & bank])

Fear, lack of trust and resistance to change are linked to the lack of knowledge and skills. This can be combated by education campaigns and skills transfers aimed at stakeholders responsible for micro-infrastructure, such as individuals working within the JSE and STRATE, the regulators, other intermediaries (banks and brokers), and end-users (buyers and sellers).

Switching cost

It will be costly to switch over from current systems to blockchain, the switching cost is a factor that influences the adoption of the technology:

'Switching costs between old technology and new technology … we know how expensive IT is, it's a huge cost.' (Participant 1, LLB [manager, CSD])

The benefits derived from adoption must outweigh the switching cost. Relative advantage of blockchain adoption and the cost to move a current platform to blockchain will influence adoption. This is because blockchain adoption is accompanied by capital investment. Affected institutions will have to make these investments whilst providing services on existing platforms.

Current information technology infrastructure's useful life

Many companies have invested a great deal of money into their current infrastructure and systems and these would need to run their course before blockchain adoption:

'The current obstacle is that everybody is invested so heavily in their current IT infrastructure that nobody will throw all of that out for blockchain right now.' (Participant 2, CFA, CA [SA] [CIO, asset management])

It is more likely that blockchain technology will only be considered when it is time for an update as blockchain technology is not better or faster than the systems that are currently in place:

'Institutions are not going to switch – if they have just invested a whole lot in an old technology recently. It is an obstacle for them to adopt it, because they are first going to want to depreciate the old investment that they made, get their money's worth before changing over.' (Participant 1, LLB [manager, CSD])

Therefore, replacing new infrastructure would mean that the total return and use was not extracted from that infrastructure. In addition, if blockchain is phased in, new investment in blockchain would be running parallel to the undepreciated assets of the existing infrastructure. This would have a negative impact on profits and, therefore, discourage adoption.

Regulation

Financial market regulation is purposed to protect consumers in the economy and to help markets achieve high degrees of efficiency. The vital role played by the financial system dictates that financial institutions need to be regulated:

> 'Securities market is highly regulated. People put their lifesavings into securities, invested – the pension funds are all invested in the equities market. So government is very stringent about who can play in that market. Everybody who participates is highly regulated.' (Participant 2, CFA, CA[SA] [CIO, asset management])

In its current form, the regulatory environment does not adequately cater for, or focus on blockchain technology and the scope in which it can be used:

> 'The current regulation is configured for the current system.' (Participant 3, CFA [analyst, asset management])

If the adoption of blockchain technology was to occur in a way that leads to creating a new eco-system outside the current securities trading value chain, current regulation would prohibit this to provide investor protection. The study found that new regulations and laws will have to be created if blockchain technology is adopted in order to maintain consumer protection:

> 'Regulation must provide investor protection. However, regulation is known to lag behind innovation and change.' (Participant 4, PhD [manager, bank])

This is supported by Participant 11:

> 'Regulation is generally a step behind technological advancements. So what you might see is technology leading the regulatory framework and the regulatory framework just trying to catch up.' (Participant 11, PhD [senior lecturer, academic])

Therefore, new regulations and laws will have to be created if blockchain technology is adopted. New regulations must maintain the core purpose of regulation, which is to protect market participants. The current scope of regulations is limited to the current systems and technologies and does not consider blockchain's specific qualities, such as transparency and decentralisation.

Blockchain knowledge and educational campaigns

Knowledge and expertise about blockchain technology will influence the adoption of the technology. Those who understand blockchain will be better positioned to adopt, than those who have little to no expertise. The lack of knowledge and education regarding blockchain technology leads to hesitancy to adopt it.

> 'There might be a little bit of confusion and lack of understanding about blockchain, which could lead to hesitancy to adopt something along those new technological lines.' (Participant 12, CFA, MCom [senior trader, asset management])

In addition:

> 'Blockchain being an emerging technology we may just have a few individuals who understand it, who can execute it or put it into practice. The skills element might also be a problem in adoption.' (Participant 5, MSc [manager, stock exchange])

Participant 3 focuses on the issue that South Africans do not like change, and makes the suggestion that this is due to a lack of knowledge:

> 'South Africans tend to stick to what we know, because of lack of knowledge.' (Participant 3, CFA [analyst, asset management])

For adoption to take place, all stakeholders will need to have some understanding of the technology. Stakeholders are not limited to organisation, but also include the general public, who have very little knowledge of and expertise in blockchain:

> 'The public generally knows very little about the technology.' (Participant 9, TOGAF® 9 Certified, [manager, Bank])

Stakeholders' lack of blockchain knowledge will influence adoption, a broad understanding of the technology's benefits and functionality would motivate user-driven adoption. The gap in knowledge could be bridged through educational campaigns. This will help to improve stakeholders' knowledge and broad understanding about blockchain technology:

> 'Education about it and how it could benefit, and education to every stakeholder in the industry, the banks, the regulators, the clearinghouses, all of that type of various different players, as well as the sell side, the buy side and why it's important, like the benefits of it.' (Participant 12)

Teaching stakeholders about the technology will reduce misconceptions and resistance to change and lead to a higher desire to adopt the technology. The nature of the South African economy is that it is divided into two groups, those that are financially literate and those that are not:

> 'Most of our population is less developed and you would like to drive the adoption from the numbers on that side, instead of from the institutional base.' (Participant 5, Msc [manager, stock exchange])

For adoption to be driven by end-users, the portion of financially educated users would have to increase.

Confidentiality issue

The confidentiality issue pertains to the fact that some people would like to keep their identities hidden while trading, requiring encryption and decryption, complicating regulatory matters:

> 'Confidentiality can be a positive on one side, but a negative in the sense … because all of a sudden information is encrypted. It always needs somebody to decrypt it to know exactly what's

happening. Without that knowledge, you will be fighting with the regulators to do with the issues of knowing your client and the money laundering issues.' (Participant 8, PhD, CFA [professor, academic & bank])

This factor is linked to current regulation and the requirement to protect individual information. Some users may not be comfortable with the implied transparency that comes with adopting blockchain and, therefore, will resist its adoption:

'Current set up, some people want to remain anonymous, and they don't want people to know their trades.' (Participant 11, PhD [senior lecturer, academic])

Illicit activities and fraud

Fears of blockchain technology being used for money laundering and other illicit activities could influence the adoption of the technology:

'Blockchain technology can easily be used to perpetrate illicit trades if someone chooses then to be anonymous.' (Participant 5, MSc [manager, stock exchange])

Participant 9 identified the risk of money laundering that comes with the unregulated nature of blockchain technology, specifically how it currently operates in facilitating crypto-currency transactions. The system does not legally require buyers and sellers to disclose personal information whilst in the current securities trading value chain, banks require individual to disclose personal information and monitor activities in order to deter money laundering:

'Money laundering risk … in the current system you have KYC (know your customer) requirements, which is not a requirement on cryptocurrency platforms.' (Participant 9, TOGAF® 9 Certified [manager, bank])

Participant 8 adds that there is continual vetting of buyers and sellers in the current system, which helps regulators feel in control, reducing fears of money laundering. If blockchain is adopted, money laundering laws would have to be revised:

'Currently we do continuous vetting, where when we try to make a transaction, there's a vetting happening and with this I feel like the regulators might just think that they are losing a grip on such things. Because there's fear of things like money laundering, people can just now – they won't know who is doing the transaction.' (Participant 8, PhD, CFA [professor, academic & bank])

Participant 7, however, was of the view that the transparency and auditability functions of blockchain would reduce illicit or fraudulent activities:

'Blockchain technology would minimise fraud, minimise errors of transactions – yes, I look at it as more of an enhancement.' (Participant 7, CA [SA] [manager, bank])

From the above, the study concludes that the regulators desire to monitor and control money laundering and other financial crimes may inhibit adoption if users can hide their identities.

Monopoly nature of current industry

Competition drives innovation and progress, and without competition, there is no need to keep up or innovate. The STRATE having a monopoly would serve as a limiting factor to blockchain adoption:

'[…B]ecause there's no competition, there's no rush for things to be done.' (Participant 6, BCom [manager, bank])

Therefore, according to Participant 12:

'An increase in competition will encourage technology adoption … increased competition is also beneficial for innovation.' (Participant 12, CFA, MCom [senior trader, asset management])

The study, therefore, contends that because STRATE has a monopoly, the organisation has no incentive to drive blockchain adoption as one of the stakeholders in the industry. Although they have the capacity to innovate on account of their profitability, they have little incentive to do so as the entire, highly profitable market is at hand.

Power supply

The amount of electricity needed to run a network or system on blockchain technology will negatively influence blockchain adoption in a country with constraints to electricity production:

'The power which is equivalent to running Nigeria, for example, running a settlement system on blockchain would equivalent to running Nigeria for those 10 minutes, that's a lot of power and that is costly.' (Participant 8, PhD, CFA [professor, academic & bank])

For the last decade and a half (since 2007), South Africa has been battling for the sustained provision of power. The power utility, Eskom, has been rationing electricity supply in an initiative referred to as load shedding. Power interruptions influence the adoption of the technology as the lack of power supply would disrupt trading:

'Transactions may be impacted.' (Participant 5, MSc [manager, stock exchange])

Participant 8 reiterates this by stating the impact of load shedding on the verification process:

'Taking into consideration load shedding and scalability, the verification process will be impeded.' (Participant 8, PhD, CFA [professor, academic & bank])

It can be concluded that inconsistent power supply in South Africa will have a negative influence on adoption.

Layoffs

Government is concerned about the unemployment rate. If blockchain is adopted and intermediaries are eliminated from the industry, people who work in those companies, will lose their jobs:

'Employees employed within the settlement value chain can lose their jobs.' (Participant 3, CFA [analyst, asset management])

In addition, adoption of blockchain will have a negative impact on employment according to participant 9:

'Blockchain adoption may lead to the collapse of institutions and loss of jobs.' (Participant 9, TOGAF® 9 Certified, [manager, bank])

Participant 10, although in agreement about job losses, distinguishes between the impact on the industry and specific job roles:

'Blockchain is a threat to specific job roles, but not to the industry. The benefit for the industry is improved speed and efficiency in transactions. Although certain roles will be eliminated, new functions will be created.' (Participant 10, MSc [fund manager, asset management])

The study finds that potential job losses/ layoff in an environment in which unemployment is already high, will negatively influence the adoption of blockchain technology as government and other social stakeholders would not want to increase unemployment.

Discussion

Existing models are limited in that they do not address the scope of this study which is the adoption of blockchain technology in the clearing and settlement industry in South Africa. The Technology Acceptance Model is limited because it focuses on explaining adoption at the individual (end-user) level, while the TOE framework is targeted at the organisation level. Although DOI theory encompasses both TOE and the TAM factors, it is limited, because it does not emphasise external factors (Oliveira & Martins 2011). Blockchain Adoption Model addresses, to some extent, the external factors, which are categorised as ecosystem factors, but fails to consider industry and country-specific issues Lustenberger et al. (2021).

This study identifies People, Organisation, Technology, Industry and Country (POTIC) as factors important in influencing blockchain technology adoption in South Africa. The study expands and contributes to traditional frameworks for adopting blockchain technology in the South African clearing and settlement industry by adding five factors: trust, load shedding, unemployment/layoffs, the useful life of current infrastructure and educational campaigns. The South African clearing and settlement industry is trusted and has a good track record. Shares Transactions Totally Electronic has a proven record of reliability; users trust it, and there is no incentive to abandon that system of trust for a trustless system. The 'trust' in the existing structures will have a negative influence on the adoption of blockchain technology. In empirical studies Wong et al. (2020), as well as Wamba and Queiroz (2020) argue that trust in the context of the supply chain does not affect the behavioural intention to adopt blockchain. Contrary to them, Liu and Ye (2021) assert that the more the users trust blockchain technology, the more they may perceive the value of it and the more they intend to use it.

Load shedding and the inconsistent supply of electricity have a negative influence on adoption. Unemployment is a significant consideration in the South African economy; government, labour unions and other stakeholders would oppose innovations that would increase unemployment. This will lead to delayed adoption of blockchain technology. The useful life of current infrastructure was an element not identified in literature but added by participants. Participants highlighted that the industry recently invested in infrastructure that is not yet outdated. Thus, replacing this infrastructure would mean that the full return and use were not extracted from that infrastructure. Educational campaigns could address issues of fear, lack of trust, resistance to change, lack of knowledge and skill. The study proposes that these campaigns should be aimed at stakeholders responsible for micro-infrastructure, such as individuals working within the JSE and STRATE, namely, the regulators, other intermediaries (which include banks and brokers) and end users (buyers and sellers).

The POTIC framework defines people, as current and potential stakeholders and users in the system, the public. The organisation is defined as a business in the securities value chain and clearing and settlement industry. Technology is defined as blockchain technology. The industry is defined as the clearing and settlement industry, the environment in which the clearing and settlement happens. The country is defined as the geographical location in which the industry is homed; in this case, South Africa. The sub-factors of each category are summarised in Table 3: People, Organisation, Technology, Industry and Country propose that the adoption of blockchain technology in South Africa is influenced by the factors in the first column; once the technology is adopted, it will lead to overall improved efficiency which is measurable, this is illustrated in Figure 2.

Conclusion

The POTIC framework will be beneficial to the JSE and its subsidiary STRATE when considering adoption of the blockchain technology for the integration of trade, execution and post trade services to reduce the settlement cycle.

TABLE 3: Theoretical factors.

| Adoption factor category	Factor
People Factors	Resistance to/fear of change
	Knowledge of/expertise in blockchain
	Trust
Organisational factors	Speed of adoption
	Funding
	Switching cost
Technology factors	Compatibility
	Complexity
	Perceived relative advantage
Industry Factors	Regulation
	Monopolistic nature of the industry
	Confidentiality issue
	Current infrastructure useful life
Country factors	Power supply/load shedding
	Educational campaigns
	Unemployment/layoffs
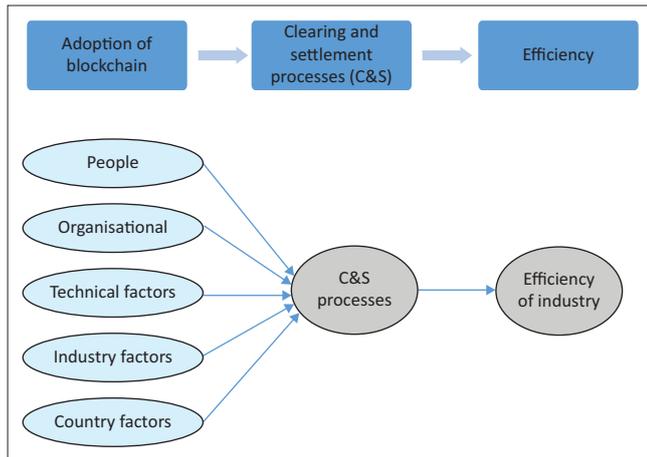
FIGURE 2: People, organisation, technology, industry and country framework: factors affecting the adoption of blockchain in the clearing and setllement industy.

In addition, when regulators need to formulate new regulations, they will benefit from considering the POTIC framework. The researchers recommend the inclusion of regulators' perspectives and views, such as participants from the South African Reserve Bank and Financial Sector Conduct Authority who are outside the securities value chain. This recommendation is based on the findings in the study that the regulatory environment and the current regulation are factors that will influence the potential adoption of blockchain.

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Competing interests

Authors' contributions

Authors contributed as indicated in the discussion section.

Ethical considerations

Participants were asked to share information with the full knowledge that it is to be included and published in this study. Participants signed a consent letter or form to indicate their willingness to participate in the study. Any information collected from participants will not be made public without permission their. No information will be published about the identities of any specific individuals, the organisations they work for or are affiliated with. The researcher received ethical approval to conduct the interviews and collected data, using a questionnaire from the Department of Finance and Investment before conducting them. 20SOM20. 16 November 2020.

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Data availability

Data can be made available by the authors on request.

Disclaimer

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