Blockchain Technology: Disruptor or Enhancer to the Accounting and Auditing Profession

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Abstract

The unique features of blockchain technology (BCT) - peer-to-peer network, distribution ledger, consensus decision making, transparency, immutability, auditability, and cryptographic security - coupled with the success enjoyed by Bitcoin and other cryptocurrencies have encouraged many to assume that the technology would revolutionise virtually all aspects of business. A growing body of scholarship suggests that BCT would disrupt the accounting and auditing fields by changing accounting practices, disintermediating auditors, and eliminating financial fraud. BCT disrupts audits (Lombard et al.,2021), reduces the role of audit firms (Yermack 2017), undermines accountants' roles with software developers and miners (Fortin & Pimentel 2022); eliminates many management functions, transforms businesses (Tapscott & Tapscott, 2017), facilitates a triple-entry accounting system (Cai, 2021), and prevents fraudulent transactions (Dai, et al., 2017; Rakshit et al., 2022). Despite these speculations, scholars have acknowledged that the application of BCT in the accounting and assurance industry is underexplored and many existing studies are said to lack engagement with practitioners (Dai & Vasarhelyi, 2017; Lombardi et al., 2021; Schmitz & Leoni, 2019).

This study empirically explored whether BCT disrupts or enhances accounting and auditing fields. It also explored the relevance of audit in a BCT environment and the effectiveness of the BCT mechanism for fraud prevention and detection. The study further examined which technical skillsets accountants and auditors require in a BCT environment, and explored the incentives, barriers, and unintended consequences of the adoption of BCT in the accounting and auditing professions. The current COVID-19 environment was also investigated in terms of whether the pandemic has improved BCT adoption or not.

A qualitative exploratory study used semi-structured interviews to engage practitioners from blockchain start-ups, IT experts, financial analysts, accountants, auditors, academics, organisational leaders, consultants, and editors who understood the technology. With the aid of NVIVO qualitative analysis software, the views of 44 participants from 13 countries: New Zealand, Australia, United States, United Kingdom, Canada, Germany, Italy, Ireland, Hong Kong, India, Pakistan, United Arab Emirates, and South Africa were analysed.

The Technological, Organisational, and Environmental (TOE) framework with consequences of innovation context was adopted for this study. This expanded TOE framework was used as the theoretical lens to understand the disruption of BCT and its adoption in the accounting and auditing fields. Four clear patterns emerged. First, BCT is an emerging tool that accountants and auditors use mainly to analyse financial records because technology cannot disintermediate auditors from the financial system. Second, the technology can detect anomalies but cannot prevent financial fraud. Third, BCT has not been adopted by any organisation for financial reporting and accounting purposes, and accountants and auditors do not require new skillsets or an understanding of the BCT programming language to be able to operate in a BCT domain. Fourth, the advent of COVID-19 has not substantially enhanced the adoption of BCT. Additionally, this study highlights the incentives, barriers, and unintended consequences of adopting BCT as financial technology (FinTech). These findings shed light on important questions about BCT disrupting and disintermediating auditors, the extent of adoption in the accounting industry, preventing fraud and anomalies, and underscores the notion that blockchain, as an emerging technology, currently does not appear to be substantially disrupting the accounting and auditing profession.

This study makes methodological, theoretical, and practical contributions. At the methodological level, the study adopted the social constructivist-interpretivism paradigm with an exploratory qualitative method to engage and understand BCT as a disruptive innovation in the accounting industry. The engagement with practitioners from diverse fields, professions, and different countries provides a distinctive and innovative contribution to methodological and practical knowledge. At the theoretical level, the findings contribute to the literature by offering an integrated conceptual TOE framework. The framework offers a reference for practitioners, academics and policymakers seeking to appraise comprehensive factors influencing BCT adoption and its likely unintended consequences. The findings suggest that, at present, no organisations are using BCT for financial reporting and accounting systems. This study contributes to practice by highlighting the differences between initial expectations and practical applications of what BCT can do in the accounting and auditing fields. The study could not find any empirical evidence that BCT will disrupt audits, eliminate the roles of auditors in a financial system, and prevent and detect financial fraud. Also, there was no significant evidence that accountants and auditors required higher-level skillsets and an understanding of BCT programming language to be able to use the technology. Future research should consider the implications of an external audit firm as a node in a BCT network on the internal audit functions. It is equally important to critically examine the relevance of including programming languages or codes in the curriculum of undergraduate accounting students. Future research could also empirically evaluate if a BCT enabled triple-entry system could prevent financial statements and management fraud.

Dedication

In fond remembrance of my parents, who gave me everything they had for me to live and be what I am today. The seeds you watered in the dry seasons have blossomed, but you are no longer around to see them. May your gentle souls rest in peace.

My father, you lit the light of knowledge from which many people have benefitted. Your students are all over the world and proud of you. I have fulfilled your dream and I have taken the light of your knowledge beyond the shores of Nigeria and I have etched your name, OLADEJO, on the world map and history.

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List of Abbreviations

ACA	Academics
ACFE	Association of Certified Fraud Examiners
AAD	Accountants and Auditors
AAF	Audit and Assurance Firms
ARB	Accounting Regulatory Bodies
AI	Artificial Intelligence
AICPA	American Institute of Chartered Professional Accountants
AIS	Accounting information System
API	Application Programming Interface
ASBCs	Application-Specific Blockchains
BAAS	Blockchain as a Service
BCT	Blockchain Technology
BlockAudit	Blockchain Audit
Bb-TPS	Blockchain-based Transaction Processing system
BSIT	Blockchain Start-ups and Information Experts
CAANZ	Chartered Accountants Australia and New Zealand
CAQDAS	Computer-aided Qualitative Data Analysis Software
CBN	Central Bank of Nigeria
CPA Canada	Chartered Professional Accountants of Canada
DAB	Data Auditing Blockchain
DAO	Decentralised Autonomous Organisation
DLT	Distributed Ledger Technology
DPOS	Delegated Proof of Stake
ERP	Enterprise Resource Planning
ESMA	European Securities and Markets Authority
FAE	Financial Analysts and Other Experts
FDS	Fraud Detection System
GAAP	Generally Accepted Accounting Principles
GAS	Generalised Audit Software
GIGO	Garbage In, Garbage Out
GST	Goods and Services Tax
ICAEW	Institute of Chartered Accountants of England & Wales
ISO	International Standard Organisation
ISA	International Standards on Auditing
IoT	Internet of Things
MAS	Multi-Agent System
MNEs	Multinational Enterprises
P2P	Peer-to-Peer
PBFT	Practical Byzantine Fault Tolerance
PoC	Proof of concept
PoET	Proof of Elapsed Time
PoS	Proof of Stake
PoW	Proof of Work
QSR	Qualitative Analysis Software
RBNZ	Reserve Bank of New Zealand
TSA	Treasury Single Account
TOE	Technological, Organisational and Environmental Context
Intel SGX	Intel's Software Guard Extensions
UoW	University of Waikato
VAT	Value Added Tax
WEF	World Economic Forum
WHT	Withholding Tax

Chapter 1
An Overview of the Research Project

1.1 Introduction

This chapter provides an overview of the research project. The purpose of the study is to explore and provide empirical evidence on whether blockchain technology (BCT) disrupts or enhances the accounting and auditing profession. The discussions in this chapter include implications of BCT on accounting and auditing procedures, the effectiveness of its security architecture in fraud prevention, detection, incentives, barriers, and any unintended consequences of adopting the technology. The potential practical effects the technology could have on the accounting industry are highlighted. A cursory examination of whether the COVID-19 pandemic accelerated the adoption of BCT was also carried out.

The chapter begins with a discussion of the background to the research issue. The statement of purpose and research questions are detailed in the second section. The third section discusses the background to the research objectives and questions. In the fourth section, the research methodology and methods used in this study are briefly discussed. The fifth and sixth sections present the context of the study and outline the organisation of the thesis:

1.2 Background to the Research Issue

> The Middleman is dead,…The "trust factor" and the psycho-social implications of blockchain (Gaggioli et al., 2019), the all-pervasiveness of the BCT (Efanov & Roschin, 2018); blockchain auditing - accelerating the need for automated audit (Cangemi & Brennan, 2019); the software will eliminate the need for many management functions (Tapscott & Tapscott, 2017). Stakeholders can prepare financial statements independently in blockchain thereby reducing accountants' roles (Yermack, 2017); accounts and ledgers will be automated in a blockchain structure (ICAEW, 2018); and blockchain may affect all accounting record-keeping processes starting from transaction initiation to payment (Bible et al., 2017); and Bitcoin blockchain has displaced accountants as key providers of trust and financial insights with software developers and miners (Fortin & Pimentel, 2022)

Comments such as those above have drawn the attention of scholars, innovators, investors, government and the general public to the BCT phenomenon and indicate an increase in its significance as an emerging innovation. The number of articles, conferences and seminars devoted to BCT and its various applications has increased since the successful launch of Bitcoin in 2008. Innovation has been described as one of the major sources of disruption to organisations because competitors have access to additional cost-effective means of doing business. BCT is optimistically seen by some scholars and innovators as having the potential to disrupt many business models.

Academic scholars, IT experts, practitioners, and professional institutes such as the Institute of Chartered Accountants in England and Wales (ICAEW), Chartered Professional Accountants (CPA) of Canada, and the American Institute of Certified Public Accountants (AICPA) assert that BCT has the potential to disrupt the accounting and auditing fields. Similarly, Lombardi et al. (2021) conclude that BCT is disrupting auditing, and Fortin and Pimentel (2022) suggest Bitcoin blockchain is a new accounting regime that could upend the current functions of accountants. In the same vein, BCT triple-entry accounting is said to be capable of disrupting the accounting and auditing fields (Cai, 2021; Mantelaers et al., 2019b). Conversely, Coyne and McMickle (2017) argue that accounting ledgers have existed since time immemorial to track commercial transactions, and neither blockchain nor any new FinTech such as artificial intelligence (AI) or machine learning could replace transaction records. Schmitz and Leoni (2019) note that fraudulent or unauthorised transactions can still occur in a blockchain structure because the technology does not guarantee real-time transactions. However, some of these general statements point to the understanding of some writers of the potential implications of adopting BCT in the accounting industry.

The term 'accounting' covers several different activities: recording of monetary or barter transactions and collations of inventories as in bookkeeping, while, accounting itself is "where data is turned into information and is communicated to others" (Jack, 2017). Accounting involves the recording of transactions, analysing, summarising, and interpreting financial data for decision-making. Areas of specialisation in accounting include management, financial, audit and tax. A management accountant provides budgets and costings for a product for internal management use; a financial accountant provides financial statements of position and performance for external users such as shareholders and tax authorities (Smart et al., 2013, p. 2). Auditors are expected to examine the work of other accountants and report findings to management (internal auditors) or the shareholders (external auditors). A tax accountant ensures that an organisation's accounting and reporting system complies with tax regulations (Smart et al., 2013). Recently, professional accounting has expanded to include forensic accounting, quality assurance as well as social and environmental reporting, corporate governance and performance measurement (Jack, 2017, p. 3). In practice, accountants also provide business advice and in-depth analysis for companies with regards to technology, adoption of accounting software, contract, merging and business liquidation (Smart et al., 2013, p. 2). Some of these accounting duties can be undertaken manually or automated (a combination of manual or automation).

The concept of an accounting ledger was documented by Lucas Pacioli, a sixteenth-century Franciscan monk (Hargrave, 2019). The accounting profession relies on the use of ledgers to record and verify all transactions and provide information about the financial activities of an organisation (Felin & Lakhani, 2018). Computer-based accounting software such as Xero, SAGE50, Peachtree and other ERP systems can be used to process ledger transactions. However, with the advent of BCT, some writers believe that the technology can take over accounting roles including, the specialised areas such as auditing and taxation.

BCT, in principle, is a distributed append-only time-stamped data structure (Casino et al., 2019). The technology can be used to implement an open distributed ledger that is capable of recording, analysing data and detecting anomalies (without any intermediaries) by using cryptographic signatures to confirm transactions among the participating nodes (Cai & Zhu, 2016; De Filippi & Wright, 2018; Smith, 2018a; Tan & Low, 2019; Tapscott & Tapscott, 2017; Weber, 2017; Yu et al., 2018; Zhao et al., 2016). Morkuna et al. (2019) note that BCT provides a decentralised digital database of transactions using a network of computers for verification and validation of transactions. Databases work as a support for every website, platform, app, or other online services. Centralised intermediaries such as large internet companies or cloud computing operators such as Google, Facebook, Wikipedia, Microsoft, YouTube and Amazon (De Filippi & Wright, 2018) maintain the current databases. However, a BCT ledger is different from traditional centralised databases because it runs on multiple computers (Greenspan, 2016). Davidson et al. (2018) refer to BCT as a trustless[1] consensus engine that can create the correct state of a ledger. This trustless consensus engine means that the creation of a ledger in a BCT does not rely on an intermediary or centralised authority such as an auditor, an organisation, a stock exchange, or a government. However, this trustless mechanism could be an obstacle to the wider acceptance and adoption of BCT because it is important to have some element of controls over financial transactions (Alboaie et al., 2018).

Some researchers, (Cai, 2018; Casino et al., 2019; Du et al., 2019), note that BCT is among the latest FinTech innovations that can impact current financial intermediation. The ICAEW refers to it as a possible foundational change in how financial records will be maintained (ICAEW, 2018). This technology can transform the way business is conducted and render some business models irrelevant (Reyna et al., 2018; Wunsche, 2016), Swan (2015b, p. 10) notes that BCT can "reinvent all financial transactions such as stocks, bonds, crowdfunding and pensions". Schmitz and Leoni (2019) believe that BCT is capable of re-engineering the roles of accountants and auditors.

BCT is also referred to as Distributed Ledger Technology (DLT) which enables secure data sharing and recording of transactions in a distributed ledger (Y. Wang et al., 2019; Yu et al., 2018), and the tracking of both tangible and intangible assets such as cash, land and intellectual property (Gausdal et al., 2018). It can add value to the accounting profession through a reduction in the cost of preparation and reconciliation of accounts, and assure the ownership of assets (ICAEW, 2018; Singer, 2018). The Institute further states that the technology will enable easy and equal access of participants to the financial ledgers, ensure decisions reached are by consensus, and automation of transactions, with inbuilt protocols for the prevention of duplication of entries into a shared ledger (ICAEW, 2018). Unlike the existing accounting systems where a central authority such as a bank controls transactions or stock exchange with a centralised master register, there is no powerful central organisation in BCT (Staples et al., 2017; Yu et al., 2019). The

[1] The BCT is trustless. This means that it does not require third party verification (i.e. trust), but instead uses a powerful consensus mechanism with cryptoeconomic incentives to verify authenticity of a transaction in the database, which also makes it safe, even in the presence of powerful or hostile third parties trying to prevent users from participating.(Davidson, S., De Filippi, P., & Potts, J. (2016). *Economics of Blockchain*. http://dx.doi.org/10.2139/ssrn.2744751.

elimination of the central management authority could save costs, remove system outages and ensure the accuracy of ledgers (ICAEW, 2018; Schmitz & Leoni, 2019). Karajovic et al. (2019) argue that BCT will streamline redundant accounting practices, ensure the reliability of book-keeping with the use of triple-entry accounting, guarantee prompt tax payment and eliminate tax fraud. Thus, BCT has the potential to revolutionise how business is conducted.

The growing interest in the use of BCT has spurred the formation of some blockchain start-ups companies such as Factom and Scorechain which apply the technology to decentralised bookkeeping (Rückeshäuser, 2017), and create a partnership between existing organisations and blockchain start-up businesses. Additionally, Cai (2021) suggests that Ledgerium, zkLedger and Pacio are start-ups that have designed a BCT triple-entry accounting framework. Similarly, the potential impacts and effects of BCT on the traditional methods of doing business have recently become areas of interest to governments, academics, accounting professionals and the “Big 4” accounting firms (Biswas & Gupta, 2019; Cai, 2021; Kshetri, 2018; Yermack, 2017). For instance, Ledgerium is an Australian registered firm that has created a triple-entry ledger for handling payment as a third entry (Cai, 2021); Factom, a US registered firm, and Scorechain, a Luxembourg company, are among the start-ups providing BCT-based services for decentralised book-keeping (Rückeshäuser, 2017). Ethereum is one of the largest blockchain networks and the first to provide a platform for incorporating and executing a smart contract on a distributed blockchain system (Bible et al., 2017).

Manipulation, falsification, or elimination of created records on BCT is difficult because of the use of the consensus mechanism (Appelbaum & Smith, 2018; Baron, 2017). It is also a long-awaited technology with anti-fraud mechanisms (Karajovic et al., 2019; Rechtman, 2017; Sadu, 2018; Schmitz & Leoni, 2019; Wang & Kogan, 2018). Some scholars note that BCT could automate audit and standardise audit practice (M. Singer, 2019a; Woodside et al., 2017); reduce the role of auditing firms (Yermack, 2017); and eliminate the roles of accountants and auditors (Tapscott & Tapscott, 2017). Conversely, Coyne and McMickle (2017) note that the use of BCT as the accounting ledger is not feasible because “BCT-based digital currencies only exist within the blockchain, economic transactions exist outside of accounting record” (p.101). In the same vein, Tan and Low (2019) insist that accountants and auditors will still be relevant in a BCT-driven Accounting Information System (AIS) since the technology alone cannot guarantee that financial reports are true and fair. Additionally, Bible et al. (2017) argue that the mere recording of transactions on BCT does not provide a sufficient audit to prove that unauthorised, fraudulent or illegal transactions cannot be recorded on blockchain.

The outbreak of COVID-19 in 2019 and its devasting effects took the entire world by surprise. The pandemic has had a huge effect on global affairs (social, health, politics and economy), and the desire for a technological breakthrough has caused some studies (Khurshid, 2020; Sharma et al., 2021; Yang et al., 2021) to suggest that the pandemic will accelerate the adoption of emerging technologies like BCT. Many of these assertions are based on the theoretical applications of BCT; hence, there is a research gap that can only be filled with an empirical study of the disruption and the practical impact of BCT on accountants and auditors, as well as the effect of COVID-19 on the adoption of BCT.

BCT has become a contemporary issue. However, there are limited empirical studies as to the practical implications of BCT in the accounting and auditing industry. This study focuses on whether the technology disrupts or enhances (or both) the accounting and auditing profession. There are a few prototype BCT models designed for accounting transactions, but they require further practical validations. For instance, Wang and Kogan (2018) designed a prototype to demonstrate the functionality of the blockchain-based transaction processing system (BbTPS) in real-time accounting, continuous monitoring and fraud prevention. Cao et al. (2018) demonstrate how collaborative auditing using a federated blockchain can improve auditing efficiency and cross-auditor transactions through zero-knowledge protocols that preserve data privacy. Also, Yu et al. (2019) propose a decentralised big data auditing scheme for smart city environments leveraging BCT without the need for a centralised third-party audit in auditing schemes. These proposed theoretical models focus on the potential use of BCT rather than the actual use and implications. These studies mainly involve quantitative research. Also, studies by Faccia and Mosteanu (2019) and Ibañez (2021, May 27) attempt to validate how BCT-enabled triple-entry accounting will disrupt the double-entry system by creating a third shared ledger for all transactions.

Nonetheless, these demonstrations are yet to move from theoretical propositions to practical reality.

BCT is a topical issue, which has attracted significant attention from governments, scholars, IT experts and regulators, and top accounting firms. However, there is also scope for recognising the Dunning-Kruger effect in many of the general assertions, commentaries and attributes that are given to this technology by various writers. Dunning (2011) shows various reasons why people claim knowledge of topics about which they are uninformed or misinformed.

> "… people take cues from the social situation they are in and their general world knowledge to cobble together enough apparent information to form an impression. That is, people reach back or around to any knowledge they have that might appear to be relevant, and then use it to impose some meaning on the questions they are asked and then to form a judgment. That is, they do not use domain-specific information to inform their judgments (how could they, for no domain exists), but instead use more general knowledge—reach-around knowledge—that seems like it might be relevant to the task at hand" (Dunning, 2011, p. 258).

Dunning (2011) argues that many people have little understanding of how ignorant they are but assume with a false belief that they have adequate knowledge about specific tasks and certain issues. He asserts that people appear to be unaware of the gaps in their knowledge, and at best, their self-possessed knowledge in a specific domain is misguided and misinformed. Mahmood (2016) argues that the Dunning-Kruger Effect is noted in people's information literacy skills because people generally inflate their perceived level of skills in a particular domain. Cowan et al. (2019) note that very often participants overrate their level of understanding of an issue. From the reviewed articles and conducted interviews, it is worth mentioning that there are claims and counterclaims as to the potential capabilities of BCT by writers and participants, and with little or no empirical evidence as to whether the technology has any disruptive impacts on the accounting and auditing fields beyond its potential to facilitate a cryptographically secured distributed ledger system.

Australian Accounting Review (AAR) (2019) and Schmitz and Leoni (2019) could be said to recognise the Dunning-Kruger effect by pointing out that existing studies by scholars are based on the available studies from professional journals, online media and reports by the BCT enthusiasts. Risius and Spohrer (2017) lend credence to this argument by noting that “there is a paucity of knowledge regarding where and how blockchain is effectively applicable and where it can provide mentionable societal effects” (p. 385). AAR (2019) asserts that some reviewed papers on the blockchain themes are commentary pieces and suggest the need for empirical studies and descriptive evidence. As a result, academic and professional researchers have been urged to embark on empirical studies on the likely practical implications of BCT in the accounting and auditing field. Consequently, this study attempts to remain conscious of the Dunning-Kruger Effect of the research participants’ perspectives. To mitigate this effect, the study’s participants included experts from different fields and their views were cross-referenced with one another.

Bonyuet (2020) mentions that the audit team must have staff with the necessary technical skills. Financial professionals do not have to learn BCT or become programmers, cryptographers or database experts; Professionals require an understanding of the technology's impact on their profession and their clients (ICAEW, 2018). However, Bible et al. (2017, p. 12) assert that a CPA auditor needs an understanding of the technical programming language and the functions of a blockchain to act as an independent evaluator. This view is supported by Appelbaum and Smith (2018, p. 35) who state that “knowing how to set up different blockchain networks and platforms is an excellent skill to have for accountants”. Pimentel et al. (2021) argue that the lack of BCT technical know-how has hindered many auditors from providing auditing clients with blockchain financial activities. Understanding the basic algorithms behind BCT has been argued to enhance accountants’ working knowledge of BCT. This has caused some scholars (Kimani et al., 2020; Moll & Yigitbasioglu, 2019) to suggest the inclusion of BCT in the accounting and business school curriculum. The proponents of this view have not factored in how, in practice, technologies fade away with emerging innovation.

BCT is an important disruptive innovation warranting further study for both theoretical and practical reasons, in both the accounting industry and for its general applicability. Rîndaşu (2019) notes that the actual adoption in accounting is inadequately explored because the current reports do not give a concrete insight into the BCT-based accounting environment. Moll and Yigitbasioglu (2019) further acknowledge the need to undertake empirical research to identify what new skills and competencies accountants should possess to remain relevant in a digital age. A common belief is that BCT has the potential to revolutionise the accounting and auditing field. Despite this claim, the technology is yet to enjoy large scale adoption. To this end, this study empirically explores the disruption or enhancement that BCT brings to the accounting and auditing profession, the relevance of auditors, the higher technical skillsets required of accounting professionals, the effectiveness of BCT security against fraud, the unintended consequences of BCT adoption and the impact of COVID-19 pandemic on its adoption.

1.3 Research Objectives and Questions

The primary objective of this study is to critically examine whether BCT enhances or disrupts the accounting and auditing profession. To achieve this overall primary objective (PO), five sub-objectives (SO1-SO5) and eleven research questions (RQ1-RQ11) have been developed for this study (see Table 1).

1.4 Background to the Research Objectives and Questions

The rationale for this study emanates from the general assertions that BCT could eliminate the key functions of accountants and auditors, and prevent and detect fraud or anomalies. The desire to embark on this thesis further stemmed from my MSc dissertation where the reviewed literature gave conflicting views about the capability of BCT without proper engagement with practitioners from the blockchain start-ups, accounting and auditing fields, and academics.

For instance, the technology has the capability of integrating with the Internet of Things (IoT), Artificial Intelligence (AI), and Smart Contracts to undertake many tasks in different fields without any intermediaries (Atlam et al., 2018; Cong et al., 2018). Some studies have reported that blockchain cannot eliminate fraud on its own without the support of other technology (Cohen et al., 2017; Coyne & McMickle, 2017), while others suggest the technology has an inbuilt mechanism to check fraud and anomalies and even eliminate the roles of accountants (Alboaie et al., 2018; Baron, 2017). Kshetri (2017) argues that BCT's decentralised nature can prevent manipulation and forgery by malicious participants. The technology will change the roles of financial accountants from record-keeping to authentication of source documents and reasonableness of smart contracts, and external auditors from scrutinising major misstatements to the ascertainment of the genuineness and rationality of business transactions and events (Yu et al., 2019). However, most of these assertions are from the researchers' theoretical views relying on the unique characteristics of BCT. Thus, there is a research gap as empirical evidence is required to validate these assertions. The scarcity of empirical research into the practical implications of BCT for the accounting and auditing professions, coupled with the unique potential features of the technology supports the need to embark on this study. This study intends to fill this research gap by undertaking an empirical study on the extent of the disruption of BCT on the accounting and auditing profession.

Table 1. *Sub-Objectives and Research Questions*

Research Objectives	Research Questions
SO1: To explore how accounting practices will change in a BCT-based environment	**RQ1**: What accounting practices will change in a BCT-based environment?
	RQ2: What areas will BCT disrupt or enhance in the accounting and auditing practices?
	RQ3: What are the organisations currently using BCT or have adopted BCT for financial accounting and reporting purposes?
SO2: To examine the extent of the relevance of the auditors and what auditors are expected to audit in a BCT system	**RQ4:** To what extent are auditors relevant in a BCT financial system?
	RQ5: What are auditors expected to audit in a BCT accounting system?
SO3: To understand the effectiveness of BCT in the prevention and detection of fraud and the impact of garbage in, and garbage out.	**RQ6**: What mechanisms are in place in BCT for fraud prevention and detection?
	RQ7: What effect does garbage in and garbage out have on the effectiveness of BCT fraud prevention and detection mechanisms?
SO4: To examine the technical skillsets required by accountants and auditors in a BCT environment and the relevance of understanding BCT programming codes.	**RQ8:** What are the technical skillsets required by accountants and auditors in a BCT environment?
	RQ9: How relevant is understanding the BCT programming language?
SO5: To explore incentives, barriers and unintended consequences of the adoption of BCT in the accounting and auditing professions and whether COVID-19 has enhanced the adoption of BCT.	**RQ10:** What are the incentives, barriers and unintended consequences of adopting BCT as a FinTech solution?
	RQ11: How has COVID-19 enhanced the adoption of BCT?

Note. Source: Author

Addressing SO1, the study attempts to explain the traditional roles of accountants and auditors vis-a-viz the extent to which this technological innovation has disrupted or enhanced the accounting and auditing field. The study investigates if there are organisations that have adopted BCT for financial accounting and reporting purposes. Despite the unique features of BCT and the potential to enhance or disrupt accounting and auditing fields, there is little or no empirical evidence as to the practical implications of the technology in the accounting profession. Many of the existing literature's expositions are on the general applications of BCT. There were a few studies that designed BCT models for accounting use and proposed that BCT will not only facilitate triple-entry accounting but also lead to the demise of the double-entry accounting system. The relevant question remains as to whether accounting practices will change in a BCT-based environment, areas the technology will disrupt or enhance in the auditing and accounting profession, and which organisations are using BCT for financial accounting and reporting systems.

Addressing SO2, the thesis examines the extent of an auditor's relevance, and what auditors are expected to audit in a BCT system. Auditing is a specialised area in the accounting profession. The traditional auditing method of checking arithmetic accuracy, use of sampling procedures and reliance on management to ascertain financial records is considered unnecessary in a BCT environment (McCallig et al., 2019). Auditors are going to be eliminated (Ranta, 2015; Yermack, 2017) while some scholars assert that auditors are still needed in a blockchain (Coyne & McMickle, 2017; Martindale, 2016; McCallig et al., 2019; Schmitz & Leoni, 2019; Tankersley, 2018)**.** The buzz associated with the technology will likely continue, but the most important thing is to understand blockchain and align the organisation's needs with it (Felin & Lakhani, 2018). In BCT transactions, what are the auditors expected to audit, the chains or transactions, or both? Or will auditors become nodes within the technology architecture? This study examines whether auditors will still be relevant or eliminated in a BCT environment and whether it is chains or transactions (or both) that auditors are expected to audit.

To achieve SO3, the thesis attempts to understand the effectiveness of BCT in the prevention and detection of fraud and whether garbage in and garbage out (GIGO) has any implication on the BCT security system. In this digital age, any FinTech innovation that is capable of fraud detection and prevention often attracts attention because financial fraud has been on the increase (Appelbaum & Smith, 2018; Pearson & Singleton, 2008). In the same vein, BCT is a FinTech solution, and many writers assert that records cannot be altered thereby preventing and detecting fraudulent transactions (Cohen et al., 2017; Hood, 2017; Karajovic et al., 2019; Zhao et al., 2016). On the contrary, "lies encoded into the blockchain are still lies and they are immutable lies" (Bradbury, 2015). Similarly, BCT cannot detect fake transactions where such transactions were false from the beginning (R¨uckesh¨auser 2017 as cited in Schmitz & Leoni, 2019). Any software system with bad inputs will generate bad outputs, and this could become a challenging issue since entries into BCT are expected to be immutable (A. W. Singer, 2019). There is no consensus among the available studies as to whether BCT can detect fraudulent entries where those entries were fraudulent from the start. These divergent views require further study. The concept of GIGO in computing states that input determines output. Likewise, there is the need to examine if the self-auditing mechanism on BCT is not affected by the GIGO procedures. Thus, understanding possible fraud and anomalies, and the GIGO concept as it applies to BCT will assist in determining the limitations of the technology regarding its potential for fraud detection and prevention.

To realise SO4, the study explores whether accountants and auditors require specialised skill sets to operate in a BCT environment and the importance of learning BCT programming codes. Emerging technologies have caused scholars, industry practitioners, professional accounting bodies and academics to clamour for the need for accountants to embrace IT skill sets. Some studies (Andiola et al., 2020; CAANZ, 2020a; PwC, 2015; Sarkar et al., 2021; Stern & Reinstein, 2021) have suggested the importance of including big data analytics, Artificial Intelligence (AI), BCT and basic programming courses into accounting and professional studies curricula. Answering this clarion call, ICAEW has included blockchain in their professional qualification syllabus (ICAEW, 2018). Similarly, KPMG, in partnership with some universities in the US, started offering a Master of Accounting with data and analytic programs towards developing accountants for the digital age.[2] Despite these attempts by various stakeholders, the call for accountants to upscale their IT skills is unending. Consequently, learning the specialised skillsets that accountants and auditors require to function in a BCT environment from practitioners, accounting regulators, academics and other experts will provide a better assessment of the technical skillsets needed and the relevance of understanding programming language.

Addressing the last research sub-objective, innovations involve attributes, barriers, as well as intended and unintended consequences. The unintended consequences of using a computer device, the internet, cloud software and social media include

[2] https://www.pmgcampus.com/portal/32/assets/files/KPMGMastersBrochure.pdf

hacking, online fraud, phishing, child pornography, drug and human trafficking and terrorism. Bitcoin has been reported to have been used for some criminal activities such as payment of ransom, cross-border crimes, Ponzi schemes and money laundering (Bartoletti et al., 2018; Xu, 2016). COVID-19 took the entire world by surprise and its devasting effects have made people think of how to do things differently. Prior studies (Abd-alrazaq et al., 2021; Abd El-Aziz et al., 2021; Joel & Mijes, 2020) have suggested that the COVID-19 pandemic has accelerated the adoption of emerging technologies including BCT. This research was undertaken during the pandemic, and it was also impacted by its outbreak. Thus, the study may not be completed without considering if the pandemic has contributed to BCT adoption or not. Thus, this study evaluates the incentives, barriers, and unintended consequences of adopting BCT as a FinTech solution and whether COVID-19 has enhanced its adoption or not.

1.5 Research Methodology and Methods

Driven by the research objectives, the study employs an exploratory qualitative study based on interviews and the social constructive-interpretivism paradigm as a philosophical assumption. The use of qualitative strategy with interviews affords the participants the flexibility and freedom to express their views or ideas about BCT. Similarly, the open nature of qualitative research enables the researcher to explore some unexplored issues such as what activities auditors and accountants will perform in the BCT environment, organisations that have deployed the technology, the relevance of auditing and the possibility of auditors becoming redundant with the deployment of BCT, as well as the importance for accountants of learning BCT programming codes.

The study relies on the social constructive-interpretivism paradigm as a philosophical assumption. In the interpretive paradigm, the main focus of researchers is to make sense of the world around us and to create new, better explanations and interpretations of social words and contexts (Saunders et al., 2016). Social constructivists are of the view that reality is socially, culturally, and historically constructed (Bloomberg & Volpe, 2008, 2019; Lincoln et al., 2011). The research philosophical assumption is in line with the social constructive-interpretivism stance and assumes that multiple meanings, interpretations, realities and new understanding from the worldviews of participants will provide a better way to achieve research objectives.

An exploratory study is flexible and adaptable to change because the researcher can easily consider the discovery of new data and new ideas (Saunders et al., 2016). The authors further state that an exploratory study is useful where the focus of research is to clarify an understanding of an issue, problem, or phenomenon (Saunders et al., 2016). The flexibility in the exploratory study enables the thesis to incorporate new ideas as the research processes were unfolding.

Saunders et al. (2016) recommend five to 30 participants as a typical sample size, while Leedy and Ormrod (2013) suggest between five to 25 interviews as the sample size for purposeful sampling. However, Peterson (2019) contests these recommendations and suggests that sample size should be a function of accessibility, recruitment, logistics, research purpose, design and questions. Supporting Peterson’s view, Yin (2016) emphasises that the determination of sample size is flexible in qualitative research because nothing is cast in stone. The thesis initially set out to conduct interviews within the recommended textbook sample size of 30 interviews. However, the researcher was confronted with the difficulties of (a) finding participants with a basic working knowledge of BCT and (b) the unwillingness of many people to be interviewed. Nonetheless, the sample size for this study is 44 participants is considered appropriate because the researcher has surpassed the recommended number of participants by some scholars, and also observed data saturation. Some scholars (Guest et al., 2006; Peterson, 2019; Saunders et al., 2018) suggest that qualitative researchers should be aware of saturation points, as this is the point where there is no new additional information from the participants regarding the subject under investigation. Thus, the researcher observed saturated points at different stages for each research group (see Chapter 5.2.1 for more details).

The primary method of data collection was an in-depth qualitative interview. Semi-structured or qualitative interviews were conducted with the practitioners and scholars or writers of the reviewed articles after obtaining the approval of the University’s ethics board. The interview was used to corroborate and validate the information from the systematic review of documents. The study encompasses a detailed explanation of a context and its participants, followed by an analysis of the data for themes, patterns, and problems (see Chapter 5). Being a qualitative study, the study does not generalise beyond the experiences and perceptions of the interviews but brings to the fore an understanding of what BCT will disrupt or enhance in the accounting and auditing fields, the effectiveness of BCT against fraud or anomalies, technical skillsets required by accounting professionals, unintended consequences of adopting the technology and the impact of COVID-19 on its deployment.

The interview process started with the researcher testing Zoom and recording devices with two PhD colleagues and conducting two pilot interviews. The information obtained from 44 individual interviews formed the basis for the overall findings. Some interviewees agreed that their names could be attributed to their comments thereby waiving confidentiality, while others wished their identity to be preserved. Nonetheless, the identities of all participants remain confidential to avoid bias associated with the perceptions of pro or anti-BCT participants. All the interviews were video-recorded and transcribed verbatim, apart from three participants who sent in written answers. Respondent validation of transcripts was achieved by requesting feedback from some participants to proofread their transcripts to lessen the misinterpretation of their views. However, only one participant did not return his/her transcript. There are different ways to achieve triangulation in qualitative research and none of these approaches is superior to the another.

Fielding and Fielding (1986) recommended that triangulation could be achieved through respondent validation. The researcher ensured respondent validation by sending the interview transcripts to some respondents for review, therefore achieving data triangulation. Interviewing different participants across different disciplines and countries also assisted in achieving triangulation in this study. The development and refinement of coding categories were done on an ongoing basis in line with the study's conceptual framework as well as the search for discrepancies in the data.

1.6 Contribution to Knowledge

Lodhia (2019) argues that researchers must specify at least one major contribution to theory, practice, and policy. This study contributes to all the three areas. It enhances research literature in the emerging area relating to BCT, accounting and fraud. The research contributes to the knowledge and understanding of stakeholders by highlighting the differences between initial expectations and practical applications of what BCT can achieve in the accounting and auditing industry.

This study examines, with the adoption of BCT, whether the current services provided by accountants and auditors are still relevant or not, and if the technology can eliminate auditors' roles in the financial systems. The study further highlights how strong BCT mechanisms are for fraud prevention and detection and the roles accountants are expected to perform in a blockchain environment. For the accountants, audits and assurance firms, and professional accounting bodies, this study helps uncover critical areas in BCT that were not explored earlier and also highlights the technical skillsets accountants and auditors will require in a BCT environment. It also highlights the relevance to accounting professionals in understanding BCT programming languages.

Additionally, the study contributes to theory and practice using the expanded Technological, Organisational and Environment (TOE) framework with a consequences innovation adoption context for the research objectives. The study reveals the differences between the initial expectations and the practical implications of BCT adoption in the accounting industry which could be considered as insights for policymakers and the general public. Every innovation, be it technology or an idea, has inherent unintended consequences. The consequences of innovation have been underexplored from the available literature on innovations Hence, this study contributes to policy development by highlighting the potential unintended consequences for stakeholders of adopting BCT. These unintended consequences will enable policymakers, regulators, and technology users to understand the associated risks with using blockchain.

1.7 Context of the Study

Contextual information that has theoretical implications on a result or is useful for future studies requires a researcher to give a detailed explanation as to "who was studied, where were they studied, when were they studied, and why were they studied"? (Johns, 2006, p. 403; 2017). Contextualisation enables users of any research to understand the yardstick for adopting its findings or theory (Bamberger,

2008) and helps convey the applications of research (Johns, 2006). Some scholars assert that context-driven research conducted within a particular environment can add value to universal management knowledge and indigenous management practice (Meyer, 2006; Puffer & McCarthy, 2007; Tsui, 2004). Context-driven research recognises the heterogeneity of research populations, cultures, and beliefs, and provides avenues for comparison or replication of studies from different geographical settings (Galvin, 2014).

Provision of contextual information by scholars is now important and this has made some journals of accounting, auditing, accountability, management and other disciplines such as accounting, ICT, Health, immunology, forecasting, psychology, software engineering and development emphasize contextualisation of research (Bamberger, 2008; Broadbent, 2002; Broadbent & Guthrie, 2008; Galvin, 2014; Goodwin & Wright, 1993; Hopwood, 1985; Johns, 2006, 2017). Galvin (2014, p. 3) states that “context-specific research can occur at the methodological level such as through measurement, the nature of the data, or the way the data is collected”. Furthermore, the context of a study is important to understand the analysis and explanation of empirical evidence (Liyanapathirana, 2018). Hopwood (1985) acknowledged that context should be an important aspect of any accounting research.

Geographically, the research was conducted in Aotearoa, New Zealand but the majority of the participants were outside the country. Besides participants from New Zealand, others were located in Australia, South Africa, USA, UK, Canada, Germany, Ireland, Italy, Hong Kong, UAE, Pakistan, and India. Having respondents from five continents: Europe, North America, Africa, Asia and Oceania, could be said to have added depth to the data and improved the applicability of the study’s research findings internationally. However, the participants’ BCT knowledge appeared to be more related to their general understanding of the technology, rather than from a geographical context.

1.8 Organisation of the Thesis

The thesis comprises nine chapters as follows.

Chapter 1: An Overview of the research project

This chapter provides an overview of the study and the contextual perspective of the background of the study. This includes an explanation of the research issue, a statement of purpose and research questions, research objectives, methodology and methods, contextualisation, and the organisation of the thesis.

Chapter 2: What is Blockchain?

This chapter explains BCT by reviewing the background of this technology that is increasingly being viewed as either a disruptor or enhancer of how business is conducted. Additionally, the chapter discusses BCT architectures, terminologies, protocols, types, features, limitations, alternatives and its general applications.

Chapter 3: Review of Literature: Implications of BCT for the Accounting Industry

This chapter presents an overall review of the literature on the history of accounting ledger systems including the triple-entry system and the implications of the BCT as it affects accounting and auditing. The chapter further examines the activities of the audit and assurance firms, particularly the Big 4 firms, to understand the extent of their engagement with BCT before analysing existing literature on BCT fraud prevention and detection. Discussions of technical skills required by accountants and auditors in a BCT environment and the relevance of accounting professionals learning BCT programming codes are provided.

Chapter 4: Theoretical Framework: TOE Framework

In this chapter, the Technological, Organisational and Environmental (TOE) framework was expanded to include a consequences of innovation adoption context. The expanded framework is used as a theoretical lens to explore the potential disruption of BCT in the accounting and auditing profession. The TOE further guides the analysis and provides an answer to the research questions.

Chapter 5: Research Methodology and Methods

This chapter explains the overall research methodological approach and methods adopted for the research. It discusses the justification for the selection of research philosophy, sample, and sampling procedures. It also discusses the interview processes and analysis of data using a thematic approach with the aid of NVivo software. Ethical considerations are highlighted and how the study meets the quality of qualitative research, as well as the limitations and delimitation of the study, are discussed.

Chapter 6: Interview Findings: BCT Impact on Accounting and Auditing Practices and Relevance of Auditors in a BCT Environment.

This chapter discusses the interview findings derived from the perceptions and understanding of the research participants which addresses the first five research questions. These findings address the research objectives and associated questions. Considering the first research question, the chapter explores BCT disruption of double-entry accounting systems, BCT-enabled triple-entry accounting systems and how the technology affects tax accounting management. Regarding the second research question, the chapter presents areas in which BCT could have a noticeable impact on the roles of accountants and auditors and reveals which organisations have adopted BCT for financial reporting and accounting purposes. The chapter highlights the relevance of auditors and the general understanding of the participants that both the chains and transactions will be audited in a BCT environment.

Chapter 7: Interview Findings: BCT Fraud Prevention and Detection and Technical Skillsets Required by Accountants and Auditors

Chapter 7 presents how effective the BCT security system is in the prevention and detection of fraud and anomalies as well as the impact of GIGO. This chapter illustrates how fraud and anomalies could take place in a BCT environment. It further elaborates on the specialised skillsets accountants and auditors need to use BCT and the relevance of understanding BCT programming to accounting professionals. The findings in this chapter answer research questions six to nine.

Chapter 8: Interview Findings: Incentives, Barriers, Unintended Consequences of BCT Adoption and Impact of COVID-19

This chapter analyses the findings from the participants concerning the attributes, barriers, and unintended consequences of adopting BCT as a FinTech. It also focuses on whether COVID-19 has significantly accelerated the adoption of BCT. Using the interview data, research questions ten and eleven are discussed.

Chapter 9: Conclusion and future research

This chapter summarises the research work and findings, provides recommendations and highlights any relevant future research areas. It describes how findings from this study make contributions to theory, practice and policy.

1.9 Summary

The purpose of this chapter was to provide background information on the study. The study was motivated by the limited empirical research and the general assertion that BCT will disrupt the accounting and auditing fields. This chapter highlighted the research objectives and questions. The primary objective of this study is to critically examine whether BCT disrupts or enhances accounting and auditing professions. To achieve this objective, eleven research questions were framed. The study employed an exploratory qualitative study with interviews using social constructive-interpretivism philosophical assumption.

The research was conducted in New Zealand, but participants were located on five continents and 13 countries. The study has made a significant contribution to the emerging field of BCT regarding its implications for the accounting and auditing profession. It has contributed to theory with the use of TOE framework lenses, and to policy by highlighting anomalies and fraud that could occur in a BCT environment, as well as outlining the unintended consequences of adopting the technology.

To provide the research setting for this thesis and as a part of the literature review, the next chapter explains blockchain, its architecture, unique features, and components.

Chapter 2
What is Blockchain Technology?

2.1 Introduction

This chapter reviews the literature on basic BCT key terminologies, consensus protocols and architectures. It explores different applications in industries other than accounting and auditing (Chapter 3 will focus on those). Chapter 2 explains the BCT concept, basic terminologies and applications. BCT is an evolving innovation that is not only growing at an exponential rate but also has diverse components (Agbaba, 2017; Appelbaum & Smith, 2018).

There are eight sections in this chapter. The first section provides an overview of blockchain and key terminologies. In the second section, consideration is given to the BCT consensus models and protocols. In the third section, BCT architectures, how they work and types of blockchains are explained. Fourthly, the unique characteristics of BCT are clarified. The fifth section highlights some of the limitations facing the adoption of BCT and some proposed alternative BCT applications are considered in the sixth section. The seventh section discusses the potential applications of the technology to some industries as outlined in prior studies. The last section provides a summary of the chapter.

2.2 Overview of Blockchain Technology

In his whitepaper, Nakamoto (2008) posits that he was motivated by an idea of an e-payment system where transactions are computationally impractical to reverse and built on cryptographic proof that permits parties to carry on the business transaction without relying on a trusted third party. Nakamoto is the founder of Bitcoin, a digital currency that has revolutionised the business landscape (Zachariadis et al., 2019). His paper introduced the term - chain of blocks - which has evolved over the years into the word blockchain (Bashir, 2018, p. 16). However, Agrawal (2019) notes that there were attempts to operationalise the use of digital currencies before Bitcoin, but these attempts were unsuccessful due to the double-spending challenge. Double spending occurs when an individual can spend the same money twice in a digital transaction. Nakamoto proposed a solution to solve the double-spending problem with a peer-to-peer (P2P) distributed timestamp server that produces computational proof of any transactions in sequential order and is secure from hacking, provided that honest nodes outnumbered the attacker nodes (Nakamoto, 2008). Like the traditional cash monetary system, Bitcoin resolves the double-spending issue by employing a confirmation mechanism and maintaining a universal ledger called a blockchain (Agrawal, 2019).

Narayanan and Clark (2017) claim that the term blockchain can be traced to papers written by scholars such as Stuart Haber, Scott Stornnetta and Dave Bayer in the 1990s. These researchers proposed the creation of documents with digital time-stamping which allows documents to be linked together like a chain and no alteration can be made by the document creator (Lastovetska, 2019; Narayanan & Clark, 2017). Haber and Stornetta (1991) propose the use of time-stamping for documents and events including any sequential financial transactions or electronic interactions such as stock or forex trades. They describe time-stamping as a method of certification that makes sure the date and time of the time-stamp affixed on a document are not forgeable (Haber & Stornetta, 1991). Bayer et al. (1993) note that the main tool used in specifying digital time-stamping schemes is a cryptographic hash function. Online storage of all transaction records is common in e-commerce and a reliable way to protect these records is through a cryptographically secure means of allocating serial or tracking numbers (Haber & Stornetta, 1997). Nakomoto acknowledges Haber and Stornetta's work in his white paper, but Narayanan and Clark (2017) are of the view that Nakamoto took his idea from the work of these researchers with little modifications. Undoubtedly, Nakamoto Satoshi is regarded as the founder of blockchain.

Previous research has established that the descriptions of the word blockchain are as vast as the number of writers on the subject, hence, different descriptions of the technology exist. This study attempts to understand BCT architectures and terminologies from the perspective of different writers because there is no consensus definition to date. ICAEW (2018) note that there are several meanings for the term 'blockchain'. Evans-Greenwood et al. (2016) state that Bitcoin is adequately defined and linked to a currency, but the definition of blockchain is now a marketing term that has been extended to where it no longer refers to a specific technology or solution. Narayanan and Clark (2017) support this view by noting that "blockchain has no standard technical definition but is a loose umbrella term used by various parties to refer to systems that bear varying levels of resemblance to Bitcoin and its ledger" (p. 43). Similarly, there is no standardisation of blockchain architectures because more than 6,500 active blockchain projects were counted on GitHub with different consensuses and protocols (Morkunas et al., 2019). However, taking a cue from the conception and operation of Bitcoin, it could be argued that the technology ought to be a decentralised distributed system.

Bashir (2017) notes that there are two different usages of blockchain; with or without an article, "a" or "the". Similarly, Morkunas et al. (2019) observe that "some confusion remains between the blockchain (with definite article) and blockchain (with no article), DLTs, and their applications" (p.295). According to Morkunas et al. (2019):

> **Blockchain technology**, or **a blockchain** (indefinite article), refers to the underlying technology: A network of computers and algorithms that process Bitcoin and many other distributed ledger applications. The **Blockchain,** a definite article, refers to the technology underpinning Bitcoin specifically (pp.296-297).

Blockchain can be understood either from a business or technical perspective. Bashir (2018) writes that, from a business perspective, the technology is regarded as a platform where transactions of value are exchanged among the participating peers without any central authority manning the database. Whereas from a technical lens, it is viewed as "a P2P, distributed ledger that is cryptographically-secure, append-only, immutable (extremely hard to change), and updateable only via consensus or agreement among peers." (Bashir, 2018, p. 16). Similarly, Beck and Müller-Bloch (2017) describe blockchain as a "distributed ledger or list of data records of transactions that may involve any kind of value, money, goods, property, or votes" (p. 5390). Blockchain is referred to as a "secured record of historical transactions, collected into blocks, chained in chronological order, and distributed across several different servers to create reliable provenance" (Angelis & Ribeiro da Silva, 2019, p. 308) with key features such as accessibility, reliability, veracity, transparency and disintermediation (CAANZ, 2017; Wunsche, 2016). Blockchain consists of blocks that are interlinked for processing transactions in which the chain expands as additional blocks are appended with inbuilt cryptography hash and digital signature (Ahmad et al., 2019; Du et al., 2019; Zheng et al., 2018).

Nonetheless, some scholars note inconsistencies in the definitions of terminologies in blockchain (Hanson et al., 2017; Maull et al., 2017) and further emphasise the need to address the issue of definition. Hanson et al. (2017) report that the International Organisation for Standardisation (ISO) has mandated Standards Australia to draft an acceptable global definition for blockchain technology.

This study adopts the definition of BCT offered by Bashir (2018) as the working definition. This definition is adopted because it is not only comprehensive but also includes generic features that make blockchain a unique technology. Some of these unique features such as disintermediation, immutability, transparency, and audit trail could be factors behind some writers' view that BCT can disintermediate audits and reduce the bookkeeping roles of accountants. Thus, it is important to highlight some key terminologies associated with BCT.

2.2.1 Key Terminologies

As a result of these numerous descriptions of the term blockchain and associated terminologies, it is important to start this section with a working definition before delving into some terms relating to blockchain. The study takes into consideration both technical explanations and users' perspectives in describing blockchain architecture and terminologies. Technically, many of these terminologies are more related to Bitcoin which remains the reference point in BCT itself.

2.2.2 Working Definition of Blockchain

Blockchain is a P2P, distributed ledger that is cryptographically-secure, append-only, immutable (extremely hard to change), and updateable only via consensus or agreement among peers (Bashir, 2018, p. 16).

2.2.3 Bitcoin

Bitcoin (BTC) is digital cash that is transacted via the Internet in a decentralized trustless system using a public ledger called the blockchain (Swan, 2015b, p. vii). Bitcoin is a P2P payment system invented by an unidentified programmer, or group of programmers, under the name of Satoshi Nakamoto (Staples et al., 2017). It is a P2P network of nodes that record and distribute transactions, and each transaction has input and output (Miers et al., 2013). Unlike different fiat currencies backed by law such as NZ$, US$, EUR, GBP and Nigerian Naira (₦), Bitcoin is yet to enjoy such legal backing.

2.2.4 Crypto-assets

Crypto-assets are digital cash or currencies used for buying and selling products and services over the internet. An internet-based form of currency or medium of exchange allows for instantaneous transactions and borderless transfer of ownership (Hanson et al., 2017). A cryptocurrency is a unit of value native to blockchain and its functionality is limited to an exchange of value (Massey et al., 2017). It is also used as an incentive for participants in blockchain or for compensating blockchain miners (see Section 2.2.7). For instance, cryptocurrencies Bitcoin, Dogecoin, Ether, Litecoin, Peercoin, Ripple, and Stellar, are all types of native coins in a blockchain network. The two main types of blockchain tokens are currency and tokens (Chen, 2018).

2.2.5 Blockchain Tokens

Unlike cryptocurrency with limited functionality, blockchain tokens can be used to denote currencies and other assets of value such as securities, properties, loyalty points, and gift certificates (Chen, 2018). Massey et al. (2017) posit that smart contracts can enable the developer to create a token on top of the blockchain protocol which manages the transfer and tracking of each token's value. In the Ethereum network, a token standard called ERC-20 is being used to aid the seamless interoperability of token. However, it has been noted that exchanges and other third-party platforms may find it difficult to integrate a token that is not ERC-20 compliant (Tikhomirov et al., 2018).

2.2.6 Nodes

In the bitcoin P2P, nodes are equal and they can take on different roles depending on the assigned functions: routing, mining, wallet services and the blockchain database (Antonopoulos, 2014). Nodes are all the participants in the blockchain-shared database (Bible et al., 2017). Nodes have memory and processors and can transmit and receive signals among themselves. A node can propose and validate transactions, perform mining, and engage in securing a blockchain network, thus a node is capable of multi-tasking. Nodes can be honest, faulty, or malicious. A node that exhibits irrational behaviour is called a Byzantine node, a name coined from the Byzantine Generals Problem (Bashir, 2018 p. 12). In the Ethereum network, each full node administers the Ethereum Virtual Machine (EVM) for the seamless execution of smart contracts (Swan, 2015b). Auditors or forensic accountants will likely be interested in any activities of malicious nodes.

2.2.7 Miners/Mining

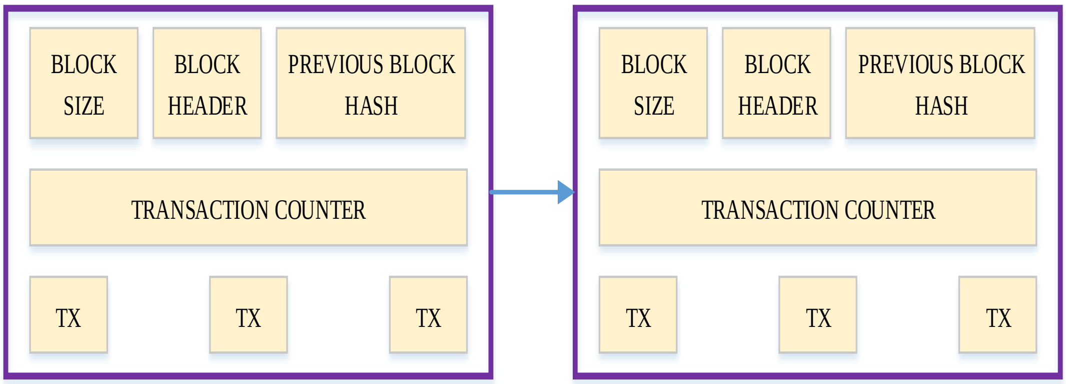
Miners are specific nodes that perform the block validation process before adding anything to the blockchain structure. Miners are responsible for the synchronisation of a network, validation of blocks and transactions, creation of new blocks as well as fetching of rewards (Bashir, 2018). They can be called the police of the network.

Mining is the process of adding new transaction items to the ledger (Yu, et al. 2018). It serves as an incentive to the miners for validation and verification of transactions and blocks as well as helps to secure the blockchain network by verifying computations (Bashir, 2017). Mining centralisation can happen when a pool succeeds in controlling over 51% of the network by producing over 51% hash rate of the Bitcoin network, and this can lead to a double-spending attack (Bashir, 2018, p. 177). Mining centralisation is technically difficult in a BCT (Chopra et al., 2019), but it is possible where miners collude to undermine the validation process for personal gains (Agrawal, 2019)

2.2.8 Block

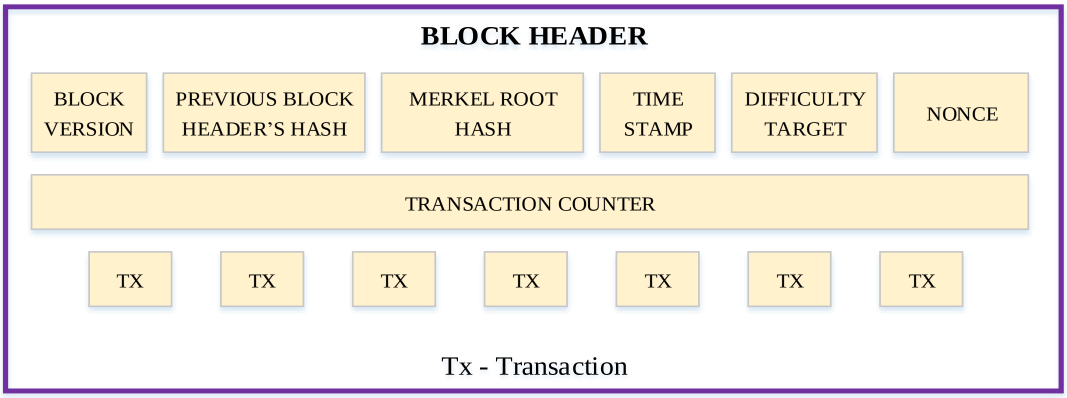
Block is a data structure used for keeping a set of transactions that is distributed to all nodes in the network. A block in a blockchain is a container of transactions where each block has a timestamp and a connection to the previous block (Hanson et al., 2017). A block in a blockchain architecture is "an aggregated set of data, and each block can be identified using a hash function" (Ferrag et al., 2019, p. 2188). A formed block keeps a hash function of the previous block to ensure that all data are securely connected or linked together. Each block is recognised by a hash in the chain and is connected to its previous block by referencing the previous block's hash (Bashir, 2018, p. 163). The blocks are added to the blockchain in a linear chronological order (Swan, 2015). Using the Bitcoin proof of work protocol, the structure of a block is shown in **Figure *1***, while the structure of a block header is represented in **Figure *2***. A block contains a block header and block body. The block body consists of a transaction counter and transactions (Zheng et al., 2017). These components are needed to populate, maintain and make the ledger irreversible (Stratopoulos & Calderon, 2018; Stratopoulos & Calderon, 2020).

Figure 1. *Structure of a Block*



Note. Source: Adapted from Bashir (2018)

Figure 2. *Block Header*



Note. Source: Adapted from Bashir (2018)

2.2.8.1 Block Header

The block header is the most important and comprehensive component of a block and contains vital information such as block version, previous block, Merkel root, timestamp, difficult target, and a nonce (Bashir, 2017, p. 239; Ferrag et al., 2019). Block version shows the block validation rules to follow; the previous block's header hash (a 32-byte size with a double Secure Hash Algorithm-256 (SHA) hash of the previous block's header); timestamp which is the epoch Unix time [3] of the time of block initialisation; and the difficulty target is the current difficult target of the block or network (Bashir, 2018; Zheng et 2017). SHA is the hash function and mining algorithm of the Bitcoin protocol that is used for important functions such as file integrity checks, the creation and management of addresses, P2P file sharing, password storage and transaction validation (Bashir, 2018).

[3] Unix epoch time is the current time expressed as seconds in universal time commencing from 1 January 1970. Time stamp which connotes time the miner has commenced hashing the header.

2.2.8.2 Genesis Block

The genesis block is the first created block in any blockchain structure that is hardcoded at the time the blockchain was first commenced. It is the foundational block to which other blocks are connected and does not have a link with any previous block. All other validated and confirmed blocks originated from the genesis block (Bashir, 2018). It is also known as block zero.

2.2.8.3 Nonce

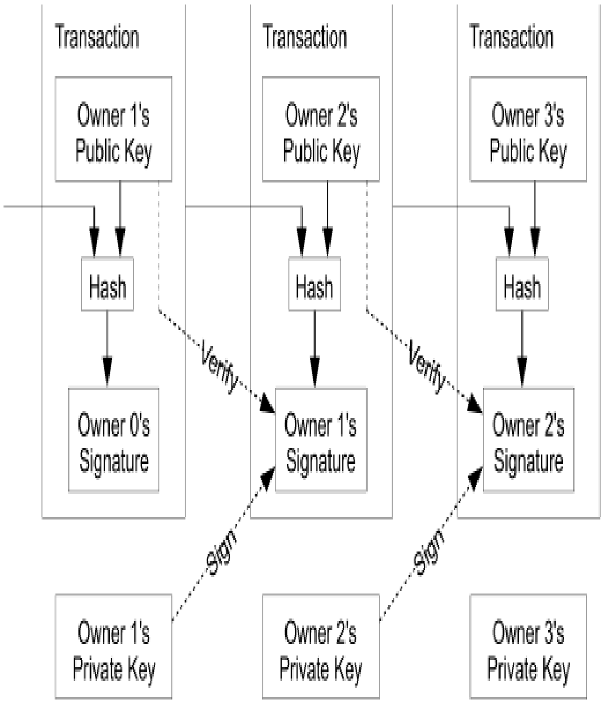
Nonce is an arbitrary number in which miners alter the header hash repetitively to create a hash that satisfies the network difficulty target. It is a generated number that can be applied only once and used in cryptographic operations to provide replay protection, authentication, and encryption (Andoni et al., 2019; Asolo, 2018; Bashir, 2018).

Every Ethereum account contains a nonce which is used to keep track of the total number of executed account transactions (Murthy, 2017). A nonce is used for replay protection and it enables the network to determine the sequential execution order for processing of the transactions.

2.2.8.4 Transaction

The transaction is the smallest building block of a BCT system (records, information, etc.). Transactions are the core of the Bitcoin ecosystem and are not encrypted and openly noticeable in the blockchain. Blocks are made up of transactions and these can be viewed using any online blockchain explorer (Bashir, 2018). Nakamoto states that the transaction commences with individual owners transferring the coin to the next by digitally signing both a hash of the previous transaction and the public key of the next owner before adding it to the end of the coin (Nakamoto, 2008). This is diagrammatically represented in ***Figure 3***. Where a transaction requires minting new coins, there is no input, and no signature are required. However, transactions must be endorsed by the sender with a personal private key with a reference to the previous transaction where a transaction involves sending coins to another Bitcoin address or user to affirm the coin's source.

Figure 3. *Blockchain Transaction Analysis*



Note. Source: Nakamoto (2008)

2.2.8.5 Ethereum Transactions

In the Ethereum blockchain, an account is a basic unit, and each user must have an account because it is the medium for sending a transaction to the blockchain. The two types of Ethereum accounts are Externally Owned Accounts (EOA) and Contract Accounts and each of these accounts has public and private keys for its operations. EOA enable users to send direct transactions on the network using a duly signed private key, while the Contracts Accounts send internal transactions based on the codes of that contract when there is a need to call another contract (Rouhani & Deters, 2017). There is no signature field for internal transactions. Internal transactions are stored outside the blockchain platform, while external transactions are publicly available in the blockchain (Chen et al., 2020).

Transaction is described as “a single instruction code which sends a message from EOA” (Rouhani & Deters, 2017, p. 71) and they are signed data packages holding messages with vital information (Chen et al., 2020). Like Bitcoin, the Ethereum blockchain starts with a genesis block, followed by other transaction processes, the creation of a new block and a new state. The administration of transactions is done by a decentralised network of nodes using a proof of work consensus protocol to check mismatches resulting from attacks or failures (Bartoletti et al., 2020). Transactions commence from EOA either by sending Ether or triggering a new contract using the senders' account private key (Rouhani & Deters, 2017) and users can initiate a function by sending a transaction to the Ethereum nodes which must include the miners' execution fee (Bartoletti et al., 2020). Payment is deposited by each user for the estimated amount of gas[4] the computation will utilise, and a partial refund is given to the user after a successful execution (Tikhomirov et al., 2018).

For instance, ABC company using the Ethereum transaction network proposed to purchase a Motor Vehicle (MV). The company starts with a transaction (Purchase of MV) from the EOA by triggering a contract for MV with a Car Vendor (see Figure 4). To validate this transaction, ABC company is expected to sign its private key. Similarly, the repair of vehicle is assumed to be done internally, so the company can undertake this repair through internal transactions which do not require the signing of the private key. It should be noted that fund transfer, contract invocation and creation can be undertaken through both internal and external transactions. Unlike users of Bitcoin where users have multiple addresses with the capacity to create a new address to receive unspent transaction output, a transaction of Ethereum is one-way traffic, that is, a transaction is from a sender to one receiver (one input and one output at a time) (Chen et al., 2020). Thus, there is no concurrent transaction on Ethereum because EOA has a unique address and is the root of all weakly connected components (WCC) is EOA. ***Figure 4*** depicts Ethereum transactions using the purchase and repair of MV as basic examples. However, how some of these transactions will pan out in practice is still evolving.

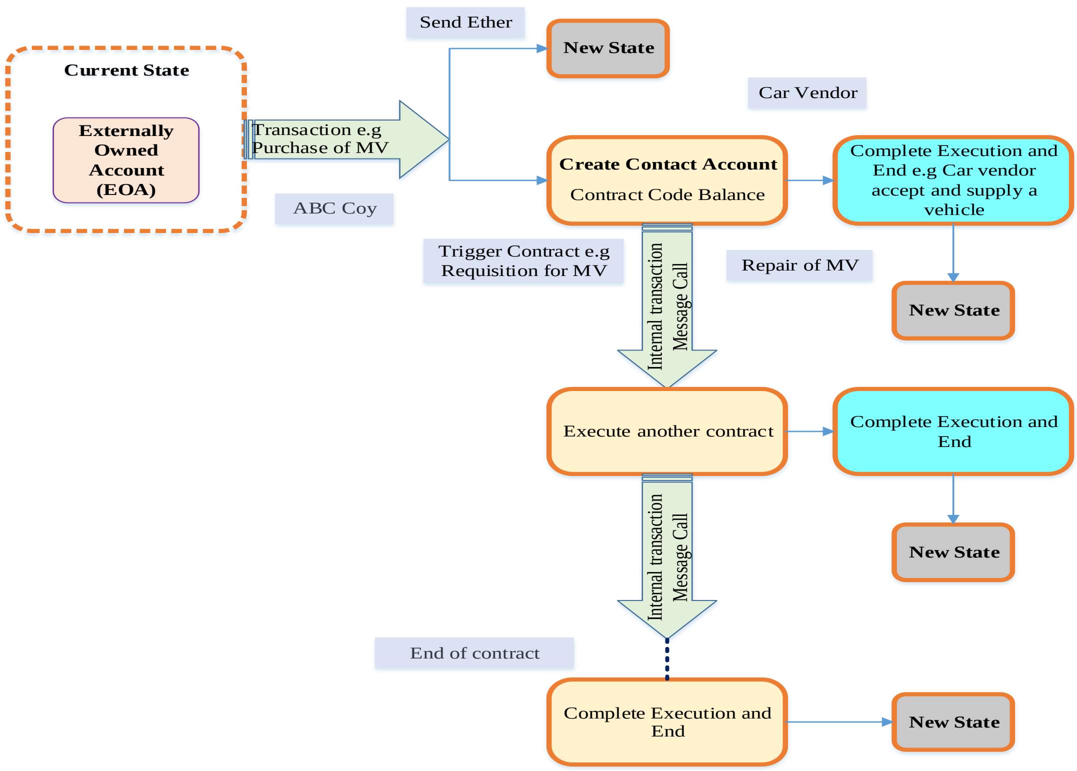
2.2.9 Hash/Hashing

A hash is "long string alphanumeric data, which is created by encrypting the data within the block based on a pre-designed cryptographic algorithm"(Cai, 2018, p. 992). A hash is any function that can be used to map data of arbitrary size to data of fixed size (Hanson et al., 2017). Hash is an easy means of identifying individual blocks in a blockchain structure. A hash is attached automatically to a newly created block and any subsequent adjustment to a block will affect the hash-key

[4] Gas is the unit cost for each Ethereum virtual machine (EVM) operation. It is the cost to perform a transaction by miner on the network and it is determined by the supply and demand factors.

(Lastovetska, 2019). The hash from the previous block enables the creation of a chain of blocks which is regarded as the pillar behind blockchain architectural security.

Figure 4. *Ethereum Transaction Diagram*



Note. Source: Rouhani and Deters (2017, p. 72)

In summary, hashes assist to identify any modifications to blocks and represent the original content of the source or original file. Each block hash is generated with the help of a cryptographic SHA 256. The common types of hash algorithms are Message Digest algorithm-5 (MDA-5) and SHA. (see Section 2.2.8.1). Examples of SHA include SHA-0, SHA-1, SHA-2, SHA-3 or Kecca (Bashir, 2018, p. 105).

Hashing is "running a computing algorithm over any content file (a document, a genome file, a GIF file, a video, etc.), the result of which is a compressed string of alphanumeric characters that cannot be back computed into the original content (Swan, 2015b, p. 37). For instance, every human genome file, no matter how large the file size, could be transformed into a 64-character hash string as a unique and private identifier for that content which cannot be computed backwards.

2.2.10 Hash Function

Hash function is used for the creation and verification of a digital signature. It is a computational function required for mapping a random-length binary string to an affixed-length binary string, technically, it must be a collision and pre-image resistance (Taleb, 2019, p. 51). It is also a mathematical algorithm that takes an input and transforms it into an output (Pilkington, 2016). The values returned by a hash function are called hash values, hash codes, digests, or simply hashes (Hanson et al., 2017, p. 62).

2.2.11 Merkel root

A Merkel root in a BCT network is the hash of all the hashes of all the transactions in a block. Merkle root is a hash of all of the nodes of a Merkle tree (Bashir, 2018). Merkle trees are used for efficient and secure validation of large data structures and verification of transactions. In BCT, the Merkle root is found in the block header section of a block, and it has all information about every single transaction hash available on the block. Using the Merkle root and Merkel tree mechanism enables faster verification of transactions instead of undertaking the arduous task of verifying individual transactions (Bashir, 2018, p. 19; Kento, 2020).

2.2.12 Chain

A chain is a sequence of blocks in a specific order. The longest chain in the network is often the valid chain because it is the one held by most of the network's nodes (Bhargavan et al., 2016; Stratopoulos & Calderon, 2018; Stratopoulos & Calderon, 2020). Nakamoto affirms that the longest chain not only serves as proof of the sequence of events witnessed but proof that it came from the largest pool of central processing unit (CPU) power (Nakamoto, 2008). Undoubtedly, nodes always accept the longest chain as the correct one and keep working on extending it.

Ethereum Virtual Machine (EVM) executes one transaction at a time, and transactions are not executed concurrently (Rouhani & Deters, 2017). Ethereum is ranked as the largest blockchain that runs on smart contracts, and Ethereum smart contracts are a product of any high-level language such as Solidity which is compiled into bytecode (Chen et al., 2020). The bytecode runs on the blockchain when it is invoked after being launched on Ethereum. Miner nodes are responsible for finding a valid block and broadcasting to the network in line with the Ethereum set block gas limit[5] (Murthy, 2017). The proof of work

[5] The block gas limit is dynamically adjusted by miners. In each block, miners can increase or decrease the block size by a maximum of the previous block size divide by 1024. This is defined in equations 45 to 47 in the formal Ethereum protocol specification and implemented by all Ethereum clients

commences after the miners choose the transactions to add to the block and the transactions are validated. The valid block is added to the blockchain after the miner node broadcasts it to other nodes.

2.2.13 Fork

Fork is when a blockchain is split into two different versions: soft or hard fork (Hargrave, 2019, p. 261) and it occurs with the introduction of changes in the Bitcoin protocol. A ***soft fork*** is backwards compatible because only the previous valid blocks are no longer acceptable, while a ***hard fork*** invalidates previously valid blocks and requires all users to upgrade to the latest version (Bashir, 2018, p. 165). The soft fork can easily be resolved quickly when miners work together to agree on one block, while a hard fork, due to miners' disagreement results in the creation of entirely different blockchain platforms. Blockchain forks bring threats to the blockchain consensus protocols (Ferrag et al., 2019). It should be noted that new transaction items are occasionally included as a soft fork, while a major change to the Bitcoin protocol or block structure often leads to a hard fork (Bashir, 2018).

2.2.14 Use Case

"In software and systems engineering, a use case is a list of actions or event steps, typically defining the interactions between a role (or actor) and a system, to achieve a goal" (Staples et al., 2017**).**

2.2.15 Decentralised Applications/Web

Decentralised applications (Dapps) are blockchain-powered apps that run on distributed networks of computers and execute the terms of a contract or group of contracts using cryptography (Hargrave, 2019; Swan, 2015b). Dapps are cryptographically secured records, autonomous and decentralised applications with no entity controlling the majority of their tokens and with a consensus-driven protocol (Andoni et al., 2019; Swan, 2015b). Dapps use tokens or cryptocurrencies. An example is a Decentralised Autonomous Organisation (DAO) built on top of Ethereum.

Decentralised web (DWeb) is the entire ecosystem of Dapps just as the Web is the entire ecosystem of websites.

2.2.16 Digital signatures

Digital signatures enable the identification of the origin and sender of a message in the blockchain network by providing authentication and non-repudiation of data origin (Bashir, 2018). Eddy (2016) states that a digital signature confirms the originator of the message and serves as a tamper-proof signature envelope that ensures the contents remain unchanged. The transaction's originator uses their private key to digitally endorse transactions before broadcasting to the network because digital signatures authenticate ownership of transferred assets. The genuineness of the broadcast transactions is further verified by other network users before they can become valid or accepted (Bashir, 2018).

Having briefly explained some relevant terminologies, the next section takes a look at the BCT consensus algorithms and their architecture.

2.3 BCT Consensus Models

Consensus is a set of rules and arrangements to carry out blockchain operations. BCT consensus-validated data is beyond peer recommendations because it is supported by group consensus/agreement based on the highest level of data authenticity, accuracy, and quality (Swan, 2015). Swan further mentions that consensus data is data that originates from crowd-voted confirmation of quality, approval and accuracy with the aid of a seamless automated mining mechanism in the blockchain.

A consensus algorithm forms one of the key mechanisms in the creation of new blocks and appending them to the blockchain (FAO & ITU, 2019). A consensus algorithm is a set of instructions performed autonomously by each party in the system (Ahmad et al., 2019). It is a pre-determined mechanism used by all participating nodes for the exchange of values and validation of transactions (Bible et al., 2017).

In a BCT, the different nodes reach consensus in a distributed ledger using approaches such as Proof of Work, Proof of Stake, Proof of Elapsed Time, Proof of Storage, Delegated Proof of Stake, Practical Byzantine Fault Tolerance, Proof of Activity, Proof of Value (Andoni et al., 2019; Appelbaum & Smith, 2018; Cachin, 2016; Chakraborty et al., 2018; Lin et al., 2018; L. Wang et al., 2019; Zheng et al., 2018; Zheng et al., 2017). A summary of some of these consensus models or algorithms follows.

2.3.1 Proof of Work (PoW)

PoW is the first practical BCT consensus protocol with the invention of Bitcoin (Bashir, 2017; Cai, 2018). It requires that sufficient computational resources have been used by a miner to construct a valid block to earn incentive tokens. In PoW, a node is randomly selected regularly to create a new block and this competitive selection is done in proportion to each node's computational capacity (Bashir, 2017, 2018). The scheme involves adding a nonce and computation of the hash output of the block header which does not give room to miners to influence or guess the possible result except through hit and miss (Andoni et al., 2019). PoW mining protocols are also regarded as crypto-economics in nature (Davidson et al., 2016). A crypto-economy is described as a decentralised economic system where all transactions are recorded in a public ledger and undefined by geographic boundary, legal or political system. The economic agents or transactions are constrained by the use of cryptographic schemes instead of centralised trusted third parties (Babbitt & Dietz, 2015). Economic agents can be human, autonomous firms or contracts, or controlled clients. For instance, Bitcoin, Litecoin and other cryptocurrency blockchains including Ethereum rely on the use of PoW. However, Ethereum has proposed to introduce Serenity, a final version of proof of Stake-based blockchain instead of PoW (Bashir, 2018).

To safeguard the network, most of the nodes, at least 51%, must reach a consensus before a new block can be validly added to blockchain (Cai, 2018). PoW has a strong defence to withstand any collusion attacks on a blockchain network such as spam, denial of service and Sybil attacks (Bashir, 2018; Narayanan & Clark, 2017). Sybil attack occurs when a hacker is running multiple nodes on a BCT system. However, the major drawback of this protocol is high energy consumption which makes it commercially unviable for a large-scale operation (Appelbaum & Smith, 2018).

2.3.2 Proof of Stake (PoS)

PoS is also referred to as virtual mining where users are mandated to show both possession of a certain number of coins and proof of stake in the same coins (Bashir, 2017). This scheme uses a lottery principle to select approving nodes based on the possessed stake or value by the participants (Appelbaum & Smith, 2018). It splits stake blocks proportionately to the current wealth of miners rather than dividing blocks according to the mining power of miners (Pilkington, 2016). The benefits of the PoS scheme are that it is difficult to acquire large amounts of digital currency and it saves computational resources (Bashir, 2017). However, the acquisition of a large amount of currency will allocate manipulative power to the bigger stakeholder at the expense of others thereby earning themselves the right to produce the next node and getting more control of the network (Appelbaum & Smith, 2018; FAO & ITU, 2019). Additionally, Zheng et al. (2017) maintain that PoS is vulnerable to attack since the mining cost is almost zero. PoS is also seen as against the spirit of the BCT trustless consensus mechanism (Bravo-Marquez et al., 2019). Other types of PoS are Proof of coinage, Proof of deposit, Proof of burn, and Proof of activity.

2.3.3 Delegated Proof of Stake (DPoS)

DPoS is an “innovation over standard PoS whereby each node that has a stake in the system can delegate the validation of a transaction to other nodes by voting” (Bashir, 2017, p.29). Zheng et al. (2017) suggest that in DPoS stakeholders elect their representatives for block generation and validation. Features such as rewards or incentives, cost of energy and other requirements are embedded in each algorithm (FAO & ITU, 2019). DPoS is used in the bitshares blockchain.

2.3.4 Proof of Elapsed Time (PoET)

A PoET scheme relies on the trusted computing model as a mechanism to fulfil proof of work requirements by making use of Intel’s Software Guard Extention (Intel SGX) architecture to provide a Trusted Execution Environment (TEE) (Bashir, 2018; Zouina & Outtai, 2019). PoET is a consensus algorithm that uses random selection and waiting time to appoint a node for the creation of a new block. Nodes request a wait time from the code running within the TEE and any node with the shortest wait time becomes the leader and is saddled with the task of creating the new block (Zouina & Outtai, 2019). Its strength lies in its ability to reduce high power and resource utilisation, and the use of a fair lottery system for mining. The use of Intel SGX renders this scheme unattractive because it is not practicable for many users to possess the requisite knowledge of this software (Appelbaum & Smith, 2018). Similarly, the major challenge of PoET is the overreliance on Intel SGX which was reported recently compromised (Zouina & Outtai, 2019).

2.3.5 Proof of Storage

Proof of Storage, also known as proof of irretrievability, permits outsourcing of storage capacity because it requires the storage of a huge amount of data (Bashir, 2017; 2018). Miners need to store a pseudo, randomly selected subset of large data to undertake mining. According to Bashir (2017; 2018), this protocol was invented by Microsoft Research, and it offers a useful advantage of distributed storage of archival data. Other proposed variations of these schemes include Proof of Space, Proof of Replication, Proof of Space-Time, and Proof of Data Possession.

2.3.6 Practical Byzantine Fault Tolerance (PBFT)

PBFT achieves state machine replication which provides tolerance against Byzantine nodes. (Bashir, 2017). Hyperledger Fabric utilises PBFT to reach a consensus because PBFT can deal with about one-third of malicious byzantine replicas. To ensure seamless participation in a network each node must be known to other participants (Zheng et al., 2017).

2.3.7 Proof of Activity (PoA)

PoA combines the features of both PoW and PoS. This protocol ensures uniformity in the selection of a stakeholder in a pseudo-random manner (Bashir, 2018). The combination of PoW and PoS results in its capacity to achieve consensus, a high level of security, and energy efficiency. However, this consensus method still has the inherent weakness of high energy consumption associated with PoW.

2.3.8 Proof of Deposit (PoD)

In PoD, a security deposit must be provided by all nodes in a network before they can undertake mining activity and the creation of blocks (Bashir, 2018). Tendermint distributed ledger technology uses a PoD consensus algorithm which requires no proof of work mining. Swan (2015) suggests that this approach can help to resolve the security challenges of the “nothing at stake” (which encourages malicious nodes to attempt to double-spend), thereby improving the operability and security of the network.

2.3.9 Proof of Value (PoV)

PoV uses P2P evaluation and reputation systems to identify the perceived value of the nodes’ contributions and allocate influence based on the contributed value and the overall set of parameters in a network (Davidson et al., 2016). This approach emphasizes anything that is believed to add value to the network by shifting the attention from algorithms to human relations and offering rewards or incentives following individual active involvement and contributions to the network values (Pazaitis et al., 2017). PoV is created by Backfeed to provide a rewarding blockchain platform for the development of meritocratic systems and alternative economies for online decentralised communities such as Wikipedia, CouchSurfing, Investopedia, OpenStreetMaps, Free, and Open-Source Software to enhance cooperation based on values to the community (Davidson et al., 2016; Pazaitis et al., 2017).

2.3.10 Proof of Authority (PoAu)

PoAu involves assigning a special right to some members in a blockchain network to act as miners or transaction validators (Andoni et al., 2019). PoAu is a modified version of the PoS consensus algorithm in which miners' or validators' identity is their stake in the network. Members in this approach put their trust in some authorised nodes and a validated block is recognised when most of these authorised miners append their signatures. For instance, a participant can be tasked with creating all blocks. Andoni et al. (2019) note that due to its centralised approach, PoAu is more suitable for regulatory agencies and specific use cases where integrity and security cannot be placed at risk. It is also popular among energy utility firms.

2.3.11 Proof of Existence (PoE)

PoE is an open-source application founded by Manuel Araoz as an online service to authenticate the existence of documents and authorship using a trusted blockchain timestamping mechanism without compromising the security and privacy of both the authors and documents (Swan, 2015). It can be used for hashing items such as art or software and to prove ownership of any particular file and document at a specific point in time (Chopra et al., 2019). Stored documents are retrievable and computationally impracticable to duplicate or forge the file's signature of the previous documents which can provide reliable documentary evidence in a legal matter. POE blockchain can be used by attorneys, public administrators, organisations, and clients to prove the existence of vital documents and digital assets such as bonds, wills, powers of attorney, deeds, staff records, health care directives, promissory notes and for different legal and civic functionalities without revealing the contents of the files (Chopra, 2019; Swan, 2015).

In a PoE, transactions are mined into a block as the document's cryptographic hash in which the block timestamp becomes the timestamp of the document, and the content of the document is encoded into the blockchain using the hash key. It is the hash that is available through the private key that is stored on the blockchain and not the original document. How the PoE function works is summarised as follows:

> "First, you present your document (or any file) to the service website; you're then prompted to "click or drag and drop your document here." The site does not upload or copy the content of the document but instead (on the client side) converts the contents to a cryptographic digest or hash. Algorithms create a digest, or a cryptographic string that is representative of a piece of data; the digest created by a hash function is based on the characteristics of a document. No two digests are the same, unless the data used to compute the digests is the same. Thus, the hash represents the exact contents of the document presented" (Swan, 2015, p. 39).

The PoE protocol helps authors, developers, and inventors to protect their works, but the major challenge is the loss of private keys which can spell doom for the holdersSince the creation of Bitcoin's PoW with its inherent strength and weaknesses, there have been attempts to create other consensus protocols to enhance the application and workability of blockchain in different scenarios. These approaches are employed to reach consensus among nodes; however, each approach has inherent strengths and weaknesses (Palm et al., 2018). Allocation of special mining power or right to a few nodes is a monopolistic tendency that may compromise the decentralised control that blockchain is known for (Tschorsch & Scheuermann, 2016). Some of the identified problems are: PoW consumes a lot of mining energy, PoS consumes less energy but is susceptible to attack, and DPoS can be easily manipulated (Zheng et al., 2017). Some proposed alternative consensus algorithms reinforced the PoW or combined the features of PoW and PoS while some produced new protocols such as PoD, PoV, PoAu and PoE.

Palm et al. (2018) show that some distributed ledger systems do not use blocks to store transactions. For example, Swirlds, IOTA and R3 Corda used graph-like ledgers instead of popular chains of blocks for storage of transactions. Similarly, the PoV protocol incorporates a monitoring and reward system based on P2P contribution, merit and set parameters in a decentralised system thereby facilitating evolving alternative economies (Davidson et al., 2016). Additionally, Swan (2015) suggests that the PoD protocol, which requires no PoW mining except for miners to post bond deposits to the blockchain network, will make miners responsible, checkmate fraudulent behaviour and forking of blockchain difficult. However, PoAu is not different from a centralised system where trusted intermediaries call the shot.

Tschorsch and Scheuermann (2016) posit that the significant contribution of Bitcoin to commerce is based on the degree of decentralisation, which was considered impossible before, coupled with the creative concept of mining used to secure the ledger and achieve consensus. Notwithstanding, the blockchain cryptography issue persists (L. Wang et al., 2019). Some use cases are currently being developed to address these cryptographic concerns. It could be argued that the ongoing effort to improve the blockchain cryptographic proof will enhance overall blockchain architecture security because validation and verification of transactions are a function of the cryptographic proof protocols.

2.4 BCT Architectures

The architecture of BCT is a function of the intended use case and operation, and the technology is composed of network users and validators (Andoni et al., 2019). User nodes are capable of initiating or receiving transactions and keeping a copy of the transaction ledger, while validators are the network miners. The management of the entire BCT system is not by an individual, but on consensus by all nodes on the network. Every node certifies that all transactions and specified procedures are followed to ensure the validity of data and security. Where two nodes concurrently broadcast different versions of the next block, other nodes work on the first version received and save the other for future consideration, particularly if it becomes longer. This type of situation is resolved when the next PoW is found and one branch of the chain becomes longer; the longer chain is automatically adopted by the network because it is considered to be the authentic chain (Nakamoto, 2008).

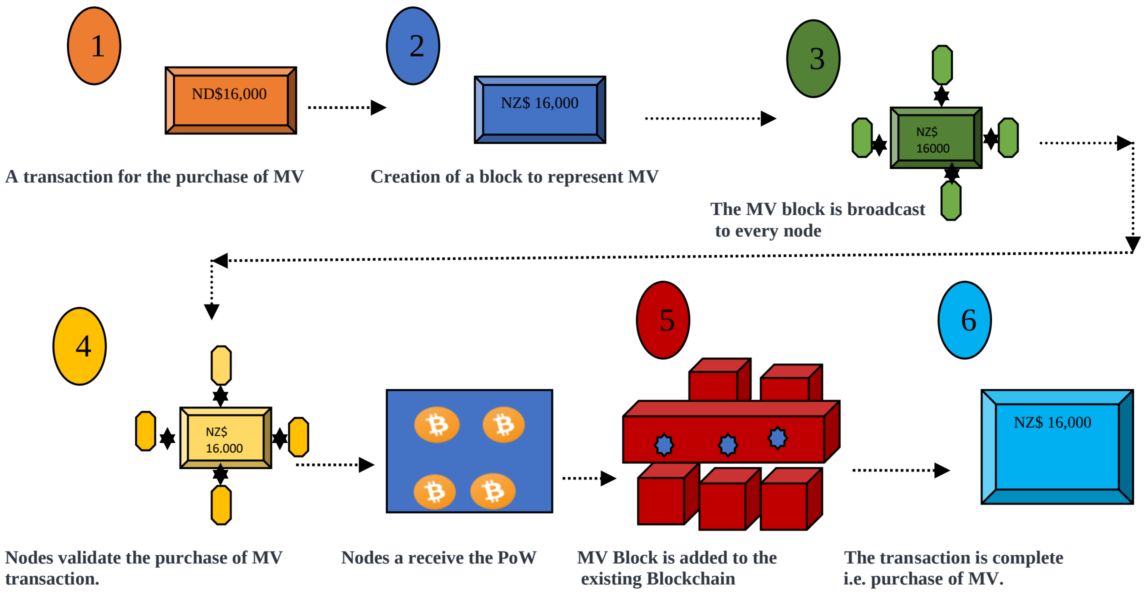
According to Nakamoto, the steps to run the network involve:

> (1) New transactions are broadcast to all nodes. (2) Each node collects new transactions into a block. (3) Each node works on finding a difficult PoW for its block. (4) When a node finds a PoW, it broadcasts the block to all nodes. (5) Nodes accept the block only if all transactions in it are valid and not already

spent. (6) Nodes express their acceptance of the block by working on creating the next block in the chain, using the hash of the accepted block as the previous hash (Nakamoto, 2008).

It should be noted that a new transaction broadcast is not required to reach all nodes at the same time but should reach as many nodes as possible. Nakamoto notes that block broadcasts accommodate dropped messages which makes it easy for any node to request the missed block later. ***Figure 5*** demonstrates how the PoW blockchain works, using the purchase of a motor vehicle (MV) as an example.

Figure 5. *Hypothetical Diagram of the Purchase of MV on the PoW Blockchain*



Note. Source: Author

BCT structures are categorised into three types - public, private and consortium - depending on the configuration of the system, access modality and method of validation (Andoni et al., 2019; Lastovetska, 2019). In another study, Andoni et al (2019) found that BCT can be classified further as specific or general-purpose based on their development purpose, and as open or closed source depending on the applicable rules of governance and protocol operating system. For instance, Ethereum is built for multi-purpose applications and Bitcoin is mainly for cryptocurrency operations. A public blockchain is opened to all internet users, while in a private blockchain access is restricted to registered members.

2.4.1 Types of Blockchain

Different types of blockchains have been identified as a public, private, consortium, permissioned, permissionless, semi-private, hybrid, tokenised and tokenless

(Alboaie et al., 2018; Appelbaum & Smith, 2018; Biswas & Gupta, 2019; Palm et al., 2018; Rîndaşu, 2019). De Filippi and Wright (2018) note that most blockchain-based protocols are open-source software. Appelbaum and Smith (2018) assert that despite that it is an open software that can be installed on computers not all are freely available to be downloaded. For instance, although Bitcoin Blockchain is free of charge, others like Factom charge a fee for every data point added and some are built purposely for commercial use e.g., Ripple. It is necessary, therefore, to explain the different types of blockchains.

2.4.1.1 Public Blockchains

Public blockchains which drive Bitcoin and Ethereum are available for anyone to join without restrictions (De Filippi & Wright, 2018; Deloitte, 2016b; Walch, 2015). It is a public P2P platform that identifies participants by pseudonymous public/private keys and the consensus is reached by all participating nodes on a blockchain (Hanson et al., 2017; X. Wang et al., 2019). Public blockchain facilitates competition, innovation, and productivity because of the low or no entry barriers to the participants (Staples et al., 2017; Veuger, 2018). However, the non-verification of these participants in the public blockchain has been said to create problems such as money laundering, terrorism financing and tax avoidance (Staples et al., 2017). From the extensive systematic review of money laundering literature, Tiwari et al. (2020) classify this problem into six categories: the anti-money laundering framework and its effectiveness, the effect of money laundering on other fields and the economy, the role of actors and their relative importance, the magnitude of money laundering, detection of money laundering, and new opportunities for money laundering. Rapid advances in technology are also seen as a gateway to opportunities for money laundering (Tiwari et al, 2020). From these classifications by Tiwari et al, it could be argued that the Bitcoin blockchain is one of the new opportunities for money laundering. This is because it is one of the emerging technologies that has created Bitcoins and other cryptocurrencies. However, this research did not delve into the operations of Bitcoins and other crypto-assets because it is beyond the scope of the study.

Similarly, Bashir (2017) posits that the transparent nature of public blockchain makes it unsuitable for industries such as law, finance, and health where privacy is very critical. In contrast, Zachariadis et al. (2019) believe that audits will be easy on blockchain since it is publicly open with a visible record of transactions. For instance, in practice, organisations are at liberty to grant credit facilities or discounts to customers as they deem necessary. It is not certain how this discretionary power will operate if a public permissionless blockchain is deployed for managing an activity like sales distribution since all transactions are in the open. Example of open-source blockchain includes Ethereum, Ripple, and Factom (Appelbaum & Smith, 2018).

2.4.1.2 Private Blockchains

Private blockchains belong to individuals or consortiums with a restriction on eligible users (Appelbaum & Smith, 2018; Rîndaşu, 2019). The imposition of controls on access verification enables private blockchains to solve some issues of regulation that face public blockchains (Staple et al., 2017). Private blockchains are suitable in specific areas and arrangements only because participants are only required to validate transactions and do not engage in mining activities (Bashir, 2017). Privacy and confidentiality can be guaranteed in a private blockchain, thereby making it useful in finance and other sectors where privacy is important. Examples of private or consortium blockchains for supply chain management are a partnership between Fonterra and Wave, IBM and British Airways, FedEx, Maersk, and UPS. Multichain is an open-source private blockchain (Appelbaum & Smith, 2018). Also, in recent years, there has been a rise in the number of start-ups working on BCT projects, offering solutions and consultancy (Bashir, 2018). Zachariadis et al. (2019) postulate that it may be difficult to have key financial services like cross-border payments, securities clearing and settlement on a public blockchain that is accessible to all participants. Consequently, it can be argued that the formation of a private blockchain may negate the essence of the technology's foundational features of openness, decentralisation, and transparency.

2.4.1.3 Hybrid Blockchains

A hybrid blockchain is a combination of private and public blockchains (Alboaie et al., 2018). A set of identified nodes are assigned for authentication in a consortium blockchain (Sial, 2019). The public blockchain is also referred to as permissionless, and the private or consortium is regarded as a permissioned blockchain (Palm et al., 2018).

2.4.1.4 Permissionless Blockchain

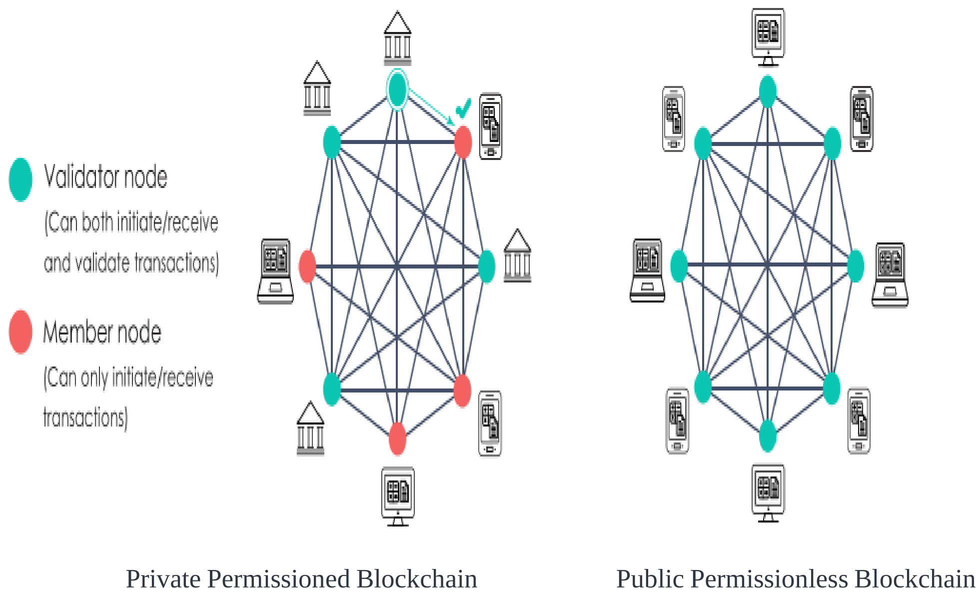
Any node can become a processing node or miner in a permissionless blockchain. In a permissionless ledger, each participant has a copy of the ledger on their nodes and agreement is reached based on the distributed consensus mechanism since ledgers are not owned by anyone. It is easy for anyone to download a copy of the BCT ledger as a pseudo-validator and become a miner using the PoW protocol. Frøystad and Holm (2020) argue that the ledgers are useful only for on-chain assets such as Bitcoins and not useful for off-chain assets. On-chain assets are items that are endogenous and produced within the ledger, while off-chain assets are non-native assets outside the control of validators. Any dispute could only be resolved by an external party. This type of ledger could be attractive to the public particularly because of its openness, transparency, and fewer regulations. It could be considered a risky platform for financial institutions and the like where privacy and security of data are paramount. However, Lemieux (2017b) notes that in a permissionless blockchain, there is an element of centralised governance since updating of the BCT codebase is still being carried out by some core programming developers.

2.4.1.5 Permissioned Blockchain

The governing bodies in a permissioned BCT regulate who becomes a miner or validator. In permissioned ledgers, participants are known and trusted, thus they use an agreement protocol to maintain records instead of distributed consensus mechanism (Bashir, 2017) and modification of BCT can be undertaken strictly by the validator nodes (Andoni, et al 2019). Frøystad and Holm (2020) state that the right of access to examine this BCT could be made available to public or authorised agents such as government-approved auditors. Most of the formed consortium blockchains are experimenting with the permissioned BCT model. The main benefits this approach is said to offer include privacy, reduction in energy transaction costs, and seamless validation transactions. Some studies suggest that many business applications tend to favour private or permissioned blockchains (Bible et al., 2017; Carson et al., 2018). Wüst and Gervais (2018) assert a permissioned blockchain shares some commonalities with a centralised database because it is easy to replicate the traditional banking system of operations using a permissioned ledger (Frøystad & Holm, 2020). Examples of permissioned BCT are R3 Corda and Hyperledger Fabric.

However, permissioned BCT leans towards a centralised and highly regulated system that is fraught with anomalies and fraud, and against the spirit of the distributed consensus propounded by Nakomoto's Bitcoin blockchain. Succinctly put, decentralisation is at risk since system and protocol development are controlled by a few groups of wallet providers, developers and miners (Zohar, 2015). According to Bashir (2018), there is no hard and fast rule that a permissioned BCT must be privately operated because it can be a public blockchain with regulated access control. The classification of public permissioned and private permissionless BCT structures is diagrammatically represented in Figure 6.

Figure 6. Blockchain Architectures



Note. Source: Frøystad and Holm (2020, p. 13)

2.4.1.6 Tokenised Blockchains

Tokenised blockchains are standard blockchains that use a consensus process through mining to create a cryptocurrency for their operations (Bashir, 2018). Tokens are proofs of digital rights (M. Xu et al., 2019). Joel and Mijes (2020) believe that tokenised blockchain will help rebuild society after the COVID-19 pandemic because the technology enables the division of assets into the smallest unit, allowing individuals to invest according to their capacity thereby contributing to building the economy. They note that token-holders could be likened to shareholders who are entitled to derive profits or gains made by a company according to the number of tokens held (Joel & Mijes, 2020). Examples of tokenised blockchains are Bitcoin and Ethereum. Tokens are further classified as intrinsic, utility, security and asset-backed tokens (Callaghan Innovation et al., 2018).

2.4.1.7 Tokenless Blockchains

Tokenless blockchains are blockchains that have no basic unit for the transfer of value and are used for sharing data among participants on a network (Bashir, 2018). These blockchains do not require token or currency generation for their operation but possess other features of BCT such as security, immutability, and consensus agreement. Tokenless blockchains are used as a shared distributed ledger for storing data only. What differentiates them from full private blockchains is the use of tokens (Bashir, 2018). Since valuable data are stored on the tokenless blockchain, it could be a potential target of hackers who intend to steal personal information, trade secrets and so on.

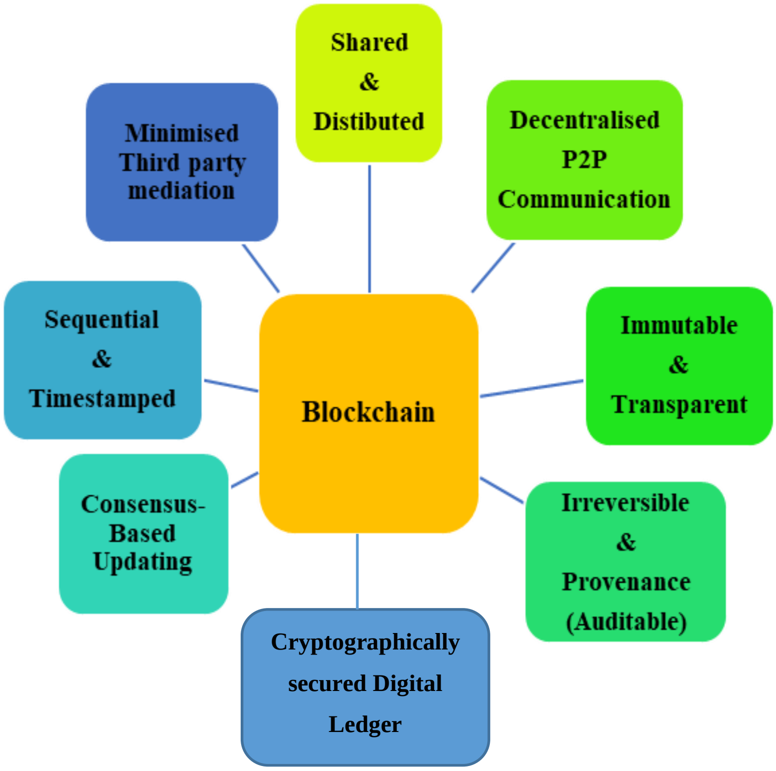
In practice, it may be difficult to adopt public or permissionless BCT because its unique features do not fit most commercial activities. It is unlikely that many businesses including government will allow open access to information. Similarly, there is no public blockchain because the Bitcoin blockchain is still being controlled by some coders or cryptographers. Consequently, the intermediaries still exist in the existing BCT platforms. One can argue that private blockchain could be the most wide type of BCT because there is the element of control in the private environment.

The next section discusses the unique characteristics of BCT.

2.5 Characteristics of BCT Architecture

Prior studies (Karajovic et al., 2019; Murray, 2018; Puthal et al., 2018) refer to BCT as shared, distributed, and decentralised ledgers using a P2P communication mechanism with a cryptographic signature for processing transactions in a transparent manner. Kiviat (2015) states that records on BCT are processed sequentially, timestamped, immutable, and auditable using a consensus-based verification protocol without third-party intermediation. The technology is transparent and difficult for hackers to penetrate because of the cryptographic systems and decentralised nature, and capable of verifying the genuineness of transactions, resolving potential accounting malpractices and fraudulent transactions (Patil, 2017; Peters & Panayi, 2016; Puthal et al., 2018). The various functions of BCT include platforms for smart contracts, smart property, generation of cryptocurrency, and verification of transactions (Bashir, 2017). The features of BCT architecture are diagrammatically represented in Figure 7.

Figure 7. *Features of BCT Architecture*



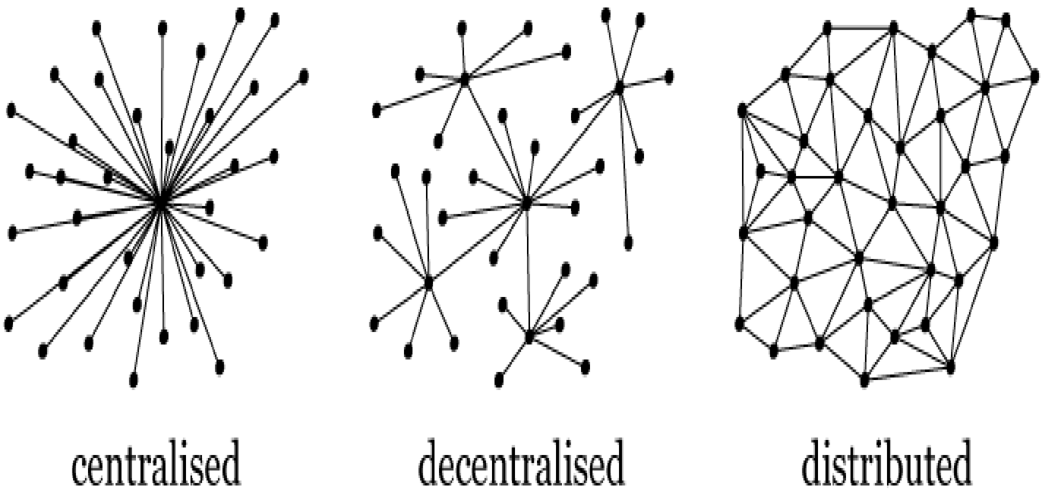
Note. Source: Adapted from Puthal et al. (2018, p. 8)

A brief explanation is further provided on the characteristic of BCT as follows:

Peer-to-Peer: P2P in blockchain indicates that all nodes or participants have unfettered communication access to each other without any intermediation such as financial institutions or controlling agencies.

Distributed ledger: Blockchain is a distributed ledger because a ledger is shared across the network among all nodes and unlike a centralised system, each participant holds a copy of the complete records (Bashir, 2018).). The distributed system can be decentralised or centralised In the distributed network of BCT architecture, every node within the network is responsible for the approval, maintenance, updating and validating of new transactions, and control is exercised jointly by all participants through a ***consensus-based updating*** (Lastovetska, 2019). An example of decentralised BCT is a public blockchain and a centralised one is a private blockchain (see Section 2.4.1). ***Figure 8*** shows examples of centralised, decentralised, and distributed ledgers.

Figure 8*. Centralised, Decentralised and Distributed Ledgers*



Note. Source: Anderson (2017)

Security: The resilience and security of the BCT networks are strengthened with the use of cryptography. A BCT ledger is *cryptographically secure* against tampering and misuse (Bashir, 2018). Transparency and immutable records are guaranteed because the authenticity of transactions can be ascertained independently by every user in blockchain " (Andoni et al., 2019). A user has two keys: a public key is a unique address for message encryption, and a private key is for reading an encrypted message and authorising transactions (Ferrag et al., 2019).

Append only: A block is appended only if the block is validated after distributed strict cryptographic rules and hash matching with a previous block (Ferrag et al., 2019). BCT is append-only because data can only be added to it in a time-ordered sequential manner. This means that once data is added to blockchain, it is impossible to change that data, thereby making an update of the recorded ledger and transactions history *immutable* (Galvez et al., 2018; Gao et al., 2018). However, a change can be effected if collusion against the BCT network successfully obtained 51% or more of the computation power, though this is a rare case scenario (Bashir, 2018). Such attempts to change transactions will involve a continuous calculation of PoW for the attached blocks and the entire blocks. Unless the majority of the nodes are malicious, such calculation is impracticable (Atlam et al., 2018)

Updateable via consensus: Transactions are updateable through consensus among all the participating nodes. There is no centralised or controlling authority for updating ledgers. Protocols and consensus algorithms for validating transactions are well-established in the BCT network (Bashir, 2018). Alternatively, the technology can be viewed as databases that allow multiple users to amend the ledger concurrently, and the outcome is based on agreement. In a centralised database where the ledger is managed by a single trusted party, which can increase the risk of theft or error (Bashir, 2018).

Provenance: Provenance in BCT makes it possible to track the origin of every transaction inside the blockchain ledger (Lastovetska, 2019).

It should be noted that the benefits derivable from BCT are based on the characteristics of the technology which include transparency, immutability, provenance and cryptographic security. Scholars have made general statements and drawn inferences based on the unique characteristics of blockchain, such as blockchain will change the landscape of corporate governance (Yermack, 2017), be used for identity management (Meier & Stormer, 2018), and it has the potential to transform businesses (McLean & Deane-Johns, 2016; Tapscott & Tapscott, 2017). Cai and Zhu (2016) note that the accuracy of the information stored on a BCT can be guaranteed. Patil (2017) is of the view that BCT as a shared ledger can be public to those with duly authorised access to it, for instance, bankers, lenders, tax authorities, government, courts, and auditors.

In the past, Bitcoin was reported to have been stolen by a hacker in 2011 (Maurer et al., 2013). The 2016 hacking into a Decentralised Autonomous Organisation (DAO) blockchain has called to question the transparency and immutability of BCT (Andoni et al., 2019). However, Andoni et al were quick to point out that these attacks were on peripheral applications attached to BCT such as e-wallets or smart contracts. The attack on DAO made Bradbury (2016) suggests that it is an impossible task to create a complex application with a zero bug, thus, BCT may not be an exception. Contrarily, Atlam et al. (2018) note that due to the robust security architecture in BCT, there is no single point of failure. However, organisations are advised to resist the idea of "jumping on the bandwagon" of blockchain's hype until they understand and identify what problems the technology can solve in the light of its limitations (Felin & Lakhani, 2018).

The limitations of BCT are often derived from its unique features. Having explained the characteristics of BCT, the next section examines the current limitations facing the adoption of BCT.

2.6 Limitations of Blockchain

Despite the many benefits of BCT which include decentralisation, transparency and trust, immutability, cryptographic security, and cost-saving, the technology has some inherent limitations. The previous section dealt with the characteristics of BCT and its associated benefits. It is important to examine some of the identified limitations which include privacy, confidentiality, scalability, security, regulation, scandals and public perceptions, and other technical issues (Bashir, 2017, 2018; Swan, 2015b; X. Xu et al., 2019).

2.6.1 Privacy and Confidentiality

Privacy of transactions and for users are of importance in finance, law, health, and other industries because organisations need to guarantee the confidentiality of clients' records. BCT does not guarantee the privacy and confidentiality of data due to its transparent nature, particularly in public blockchains (Biswas & Gupta, 2019), but uses the cryptographic feature to provide data integrity and availability (Bashir, 2018). Similarly, Ferrag et al. (2019) posit that the privacy protection procedures in BCT are inefficient because it is possible to link Bitcoin accounts to their owners. The private data such as customers' particulars stored on-chain (blockchain) are publicly accessible to all participants on the blockchain platform (X. Xu et al., 2019). Bashir (2018) also emphasized that by using traffic analyses, it is possible to identify a transaction's originator on blockchain by tracing back transactions to the source Internet Protocol (IP) addresses. Some of the identified techniques used to facilitate linking users back to the transactions are transaction graphs, address graphs and entity graphs (Bashir, 2018). Contrarily, Beerbaum (2018) insists that in BCT it is impossible to trace back public keys to a real-world identity.

Similarly, deanonymisation is a means to unravel the real identities of the original account owners which could help regulatory authorities investigate money laundering, theft and blackmail (Chen et al., 2020). Deanonymisation of Ethereum is a challenge because users of the platform do not need to reveal their identities. Similarly, for the Bitcoin platform, Chen et al. (2020) state that a combination of multiple sources of information such as name tag, source code and discussion board details can be used to deanonymise the identity of an account. The authors claim to have used graph-based deanonymisation to reveal the identities behind over 15,000 accounts belonging to WCC. It should be noted that the WCC is the root of EOA and other smart contract nodes associated with it (Chen et al., 2020). Turner and Irwin (2018) hold the view that Bitcoin users are not completely anonymous because they could be deanonymised through analysis of their public keys.

From Nakamoto's perspective, the main philosophy behind BCT innovation is the total elimination of an intermediary using an open and transparent platform for business transactions. Zhang et al. (2018) contend that the BCT's openness and transparency will make its integration into the health IT sector less likely due to the need for the protection of the client's privacy. The authors observe that despite data encryption, exposure of sensitive health data content is possible with flaws in encryption codes or software implementation (Zhang et al., 2018). Bashir (2018) considers a lack of privacy and confidentiality as among the factors that could inhibit the adoption of blockchain by financial institutions and some other industries. This could mean that the potential users of the technology must either trade off data privacy and confidentiality for transparency and integrity or vice-versa. However, some techniques have been proposed to address the privacy challenges in BCT which include Zero-Knowledge Proofs (ZKPs), homomorphic encryption, state channels, Indistinguishability Obfuscation (IO), ring signatures and use of hardware such as Intel SGX (Bashir, 2018, pp. 569-572). In the state channels, the main BCT only sees the final output since all transactions are performed off-chain, thus guaranteeing privacy and confidentiality. In encryption, information and data are encrypted to safeguard the privacy of users. Zcash cryptocurrency launched in 2016 is reported to have employed ZPKs to provide total privacy for users.

From the above analysis, it could be argued that, on one hand, there is tension between how to resolve the issue of privacy of data, and on the other hand, openness and transparency which is the original idea behind BCT innovation. Privacy of financial data and information is a fundamental factor that will impact the adoption of BCT. The extent to which this privacy-induced tension will impact the BCT disruption of some business models including accounting and auditing fields is worth further investigation.

2.6.2 Scalability

Scalability arises when BCT does not meet performance levels expected by the users (Bashir, 2017). Some studies note that presently scalability on blockchain is below the maximum throughput of conventional transaction processing systems offered by some top global credit-card payment platforms such as VISA, PayPal, and Master card (Andoni et al. 2019; Biswas & Gupta, 2019; Vukoli, 2016; Staples et al. 2017; Yli-Huumo et al. 2016). Throughput is the total number of transactions a system can process within a time window, and latency is the time required to respond to a single transaction (Staple et al. 2017, p.40). For instance, the estimated throughput on a BCT is seven transactions per second (tps) which may unlikely support any viable commercial operations, while VISA and Twitter have 2000 tps and 5000 tps respectively (Staples et al., 2017; Yli-Huumo et al., 2016). In the same vein, according to De Filipp and Wright (2018), the Bitcoin blockchain processes roughly 240,000 transactions per day which are far below the trillions of messages sent across the Internet or the 150 million daily transactions handled by credit card companies such as Visa.

A key challenge facing BCT lies in its scalability due to limited block size, duplication in data storage and slow processing rate (Biswas & Gupta, 2019). They further argue that the expansion of block size can enable more transactions to support a scalable blockchain implementation across industries (Biswas & Gupta, 2019). Conversely, there is no limit on block size in the Ethereum blockchain (Rouhani & Deters, 2017). Equally, among identified issues facing Ethereum are the huge consumption of resources, as prices per computational step outweigh that of centralised cloud providers, and restrictions imposed by miners on the total number of gas utilised in a block (Tikhomirov et al., 2018).

Similarly, storage optimisation and redesigning of BCT are ongoing efforts to enhance the scalability of the technology (Zheng et al., 2017). Reyna et al. (2018) suggest that the integration of BCT with IoT could be one of the ways to solve the scalability challenges of blockchain. Similarly, Andoni et al. (2019) note that sharding[6], sidechains and utilisation of payment channels are some of the proposed solutions to improve the scalability and processing speed of transactions.

2.6.3 Security

Fedorov et al. (2018) claim that quantum computers will put BCT security at risk because blockchain security depends on 'one-way' mathematical functions. They note that these codes are used for the generation of digital signatures and validation of transaction history in the blockchain ledger. In a conventional computer, it is difficult to break mathematical codes. Fedorov et al (2018) predict that within ten years of the adoption of blockchain, quantum computers will be able to break the one-way functions including BCT that are used to secure the Internet and financial transactions. Some of the explanations given to support this assertion include BCT's reliance on one-way codes. The 'one way' functions are easy to run on a conventional computer and tough to manipulate backwards. However, BCT could be at risk because the users' single line of defence is their digital signatures. Cracking the digital signatures may be possible using quantum computing which will make the BCT security architecture vulnerable to multiple threats.

According to a report by Eddy (2016), factoring, known as continued fractions, is the backbone of any cryptographic system. The difficulty associated with factoring large numbers makes cryptographic platforms complex and difficult to crack. He notes that advances in factoring which could be possible with quantum computing and its quantum cryptanalysis could render the complexity of any cryptographic system vulnerable and break every system that currently depends on encryption (Eddy, 2016). Similarly, Pawczuk et al. (2020) posit that advancements in quantum

[6] Sharding - A type of database partitioning that separates large databases into smaller, faster, more easily managed parts. These smaller parts are called data shards. The word shard means "a small part of a whole". https://www.techtarget.com/searchoracle/definition/sharding#:~:text=Sharding%20is%20a%20type%20of,small%0part%20of%20a%20whole.%22

computing could invariably overcome the BCT cryptography security apparatus. In the same vein, the current Bitcoin's Elliptic Curve Cryptography (ECC) standard and Elliptic Curve Digital Signature Algorithm (ECDSA) are susceptible to hacking (Al-Zubaidie et al., 2019; Swan, 2015b). ECDSA security features include integrity, authentication, and non-repudiation. The rapid development in IT security has been succinctly captured as follows:

> "Information security has faced such mass extinctions before. For example, during the Second World War, German military messages were encoded and decrypted using Enigma machines, initially giving the Axis powers an advantage until the Allies cracked the Enigma code. And in 1997, the Data Encryption Standard, an algorithm for encrypting electronic data that was then state of the art, was broken in a public contest to prove its lack of security. That gave rise to a second competition to develop a new protocol, resulting in today's Advanced Encryption Standard." (Fedorov et al., 2018, p. 466)

The security of assets on BCT depends on protecting the private key which is an individual digital identity (Efanov & Roschin, 2018). It is impossible to recover lost or stolen private keys in the BCT network, unlike a centralised system where the controlling authority can recreate a new digital identity for a lost or stolen account. Contrarily, the existing centralised banking systems are thought to have multi-layers of security protection for customers which include the use of plastic cards, security questions, identity checks and human cashiers. An increase in cyber-attacks on financial institutions has demonstrated that the protection of bank accounts using authentication security systems of a username and password is ineffective and unreliable (Al-Zubaidie et al., 2019; Alhothaily et al., 2017). Zouina and Outtai (2019) show that the use of a primary account number (PAN) for identification of the credit card and card verification value (CVV) to authenticate the owner by many existing payment platforms make the users vulnerable to cyberattack because a criminal can easily perpetrate fraud with access to PAN and CVV.

Having realised the inadequacy of PIN/password, a biometric authentication system was introduced as an additional security layer (Ali et al., 2019). Al-Zubaidie et al. (2019) note that ECDSA will be rendered useless where hackers have access to the private and ephemeral keys in the ECDSA or ECC because modification and message broadcast can be achieved with access to these keys. This analysis points to the fact that every system comes with its inherent shortcomings.

Despite these shortcomings, Al-Zubaidine et al. (2019) assert that the integration of ECDSA with encryption and authorisation will enhance security features such as confidentiality, authorisation, accountability, auditing, scalability, anonymity, and completeness. In addition, BCT security can be enhanced using quantum-safe encryption. Fedorov et al. (2018) suggest that the substitution of traditional digital signatures and encryption of all P2P communication in the BCT can be achieved with quantum cryptography. In the same manner, Eddy (2016) reports that researchers are already working on new cryptographic protocols that would challenge a quantum computer.

Ahmad et al. (2019) argue that in a distributed ledger it is difficult to ensure 100% compliance among the participating nodes and infiltration from adversaries can replicate arbitrary subsets to withhold transaction processes. This view is supported by Lin et al. (2018) who maintain that it is not feasible to design a solution that can address and resolve all security threats. There are still security challenges facing the adoption of BCT despite the use of cryptography on blockchains. Some of these security issues include malleability attacks, eclipse attacks, double spending and 51% attack by intruders (Bashir, 2018, Ferrang et al, 2019; Swan 2015). The BCT network is vulnerable to a 51% attack if intruder nodes collectively control more computational power (Yli-Huumo et al., 2016). A malleability attack occurs when an attacker hijacks, alters and rebroadcasts a transaction by deceiving the transaction originator that the original transaction was rejected (Decker & Wattenhofer, 2014; Yli-Huumo et al., 2016).

However, transaction malleability can be fixed with a Segregated Witness or SegWit soft fork upgrade of the Bitcoin protocol (Bashir, 2018, p. 147). SegWit addresses some limitations in the Bitcoin protocol such as security and throughput. Transaction malleability can be resolved by ensuring a separation of signature data from the transaction. SegWit also reduces transaction size which leads to cheaper transaction fees, decreases transaction signing and verification time thereby enhancing faster transactions, and enables script versioning which enhances scripting language without a need for a hard fork (Bashir, 2018).

2.6.4 Regulation

Regulation is considered the biggest hurdle that could derail the adoption of BCT particularly crypto-assets which are not recognised as legal tender (Bashir, 2017; Staples et al., 2017). Bashir (2017) asserts that financial institutions are yet to recognise technology as a platform for business transactions. It may be difficult for a regulatory authority to compel blockchain entities to comply with industry-specific security standards (Biswas & Gupta, 2019). On the contrary, some global financial institutions such as Barclays Bank, HSBC, and countries like the UK, US, Australia, China, and New Zealand have embraced some aspects of the technology. For instance, in New Zealand, salaries and wages can be paid in cryptocurrencies (NZ Inland Revenue Department, 2019). The UK has released a comprehensive blueprint on ways to harness DLT for the economic prosperity of the country (Walport, 2016). Similarly, New Zealand government agencies such as the Financial Markets Authority (FMA), Department of Internal Affairs (DIA) and Reserve Bank New Zealand (RBNZ) are working with BlockchainNZ on regulatory approaches to blockchain.

In April 2022, the Central African Republic was the first country in Africa to adopt Bitcoin as its official currency, and the second country in the world to do after El-Salvador[7]. In October 2021, Nigeria became the first country in Africa to announce central bank digital currency (CBDC) by launching eNaira using BCT. eNaira is a CBDC backed by Nigerian law and issued as a legal tender by the Central Bank of Nigeria (CBN).[8] In March 2021, New Zealand launched Stablecoin ($NZDs), a cryptocurrency backed by the New Zealand dollar and deployed on the Ethereum blockchain.[9] Similarly, in April 2020, China launched a digital RenMinBi (RMB) currency called Digital Currency Electronic Payment (DCEP), and in June 2020, a Blockchain-based Services Network (BSN) (Sung, 2020). It must be noted that DCEP is a Chinese national digital currency built on BCT and a cryptographic system. DCEP is reported to be pegged 1:1 to RMB and to avoid speculation, it will not be listed on cryptocurrency exchanges (Michael, 2020). The currency is fully backed by the Reserve Bank of the People's Republic of China, unlike other

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[7] https://africa.businessinsider.com/local/markets/central-african-republic-adopts-bitcoin-as-its-official-currency/cqhjbrh
[8] https://www.cbn.gov.ng/currency/enaira.asp
[9] https://www.globenewswire.com/news-release/2021/03/10/2190628/0/en/Techemynt-Launches-First-New-Zealand-Dollar-Stablecoin-NZDs.html

cryptocurrencies such as Bitcoins, Libra and Litecoins which are yet to have legal recognition. It could be argued that this demonstrates that with time more regulatory frameworks for BCT operations will unfold.

To encourage innovation and research development, it has been suggested that the regulation of BCT should only occur once the technology is widely adopted. Hanson et al. (2017) argue that guidance and control from regulators will create certainty and confidence in the blockchain marketplace, whereas neutral regulators will lead to ambiguities and uncertainties. Thus, blockchain technology may require a standard regulatory environment in support of its operation which could thereby facilitate its adoption.

2.6.5 Scandals and Public Perception

Cyberattacks are as old as the use of the Internet. In May 2000, the world was shocked by a devasting bug attack called 'ILOVEYOU' which crippled the activities of many users across the globe (USA, Europe and Asia) and cost an estimated $10 billion (Griffiths, 2020). Griffiths notes that the main weapon used by most cyber-hackers is social engineering irrespective of whether they are connected to nation-state actors, lone-wolf hackers, or criminal organisations. Similarly, the WannaCry ransomware relies on the use of both a strong key structure and encrypting algorithm, and the integration of hacking weapons leaked by the Shadow Brokers to cause harm (Hsiao & Kao, 2018). These ransomware attackers requested payment in Bitcoins or other cryptocurrencies before releasing victims' accounts and computers (Cointelegraph, 2020; Mohurle & Patil, 2017). For instance, the WannaCry and NotPetya ransomware viruses (allegedly state-sponsored by North Korea and Russia respectively) received ransom in cryptocurrency from their victims (Collier, 2019). The sum of US$300 in Bitcoin was demanded by the WannaCry virus hackers to decrypt each infected computer (Collier, 2017).

The dark side of blockchain lies in its ability to be used by criminals for illegal activities because the technology is not yet properly regulated, is decentralised and is censorship-resistant (Banerjee et al., 2018; Bashir, 2017; De Filippi & Wright, 2018). For instance, SilkRoad and DarkNet have been used for drug trafficking, terrorist operations, stolen credit cards and healthcare data and Bitcoin was used for payment purposes (Biswas & Gupta, 2019). Swan (2015) notes that the public perception of Bitcoin as an avenue for criminal activities such as scandals, scams and theft is another barrier to its adoption. For instance, it is still a mystery to the public whether millions of dollars stolen in March 2014 on Tokyo-based *MtGox* was internally or externally motivated fraud because the company claimed their blockchain platform was hacked using a transaction malleability bug. In the same year, it was reported that *Mintpal* was hacked and $2m worth of Bitcoin was stolen, and about $1.5 million Bitcoin in the cover of cryptocurrency exchange was alleged to be stolen and hidden in the personal wallet of the CEO and company's founder (The Guardian, 2017). Some of these scandals could be argued to leave a wrong perception in the public mind of blockchain, a technology with unique features such as transparency and cryptographic security.

2.6.6 Technical Challenges

Some of the technical challenges facing BCT include portability, interoperability, proliferation, and standardisation of blockchains.

Portability is the ease with which a system can be integrated with other systems, environments, and platforms without the need to change anything at the code level. The portability of BCT is still under various experimental considerations. However, Bashir (2018) notes that Hyperledger Fabric is touted to be portable at both infrastructure, libraries, Application Programming Interface (API) and code levels.

Interoperability or communication between and among different blockchains is another technical issue. It is necessary to have a unified protocol and standard that will serve as a platform and facilitate communication and exchange of information between numerous existing blockchain fabrics and ledgers (Bashir, 2018). For the BCT to achieve full adoption, collaboration and integration of efforts among stakeholders are important to create a common industry-standardised protocol (Alarcon & Ng, 2018; de Meijer, 2016). However, Castillo (2017) reports that Ripple, using its Interledger Protocol (ILP), conducted a single transaction across seven different ledgers in Germany which include traditional payment channels, public and private blockchains as well as a centralised ledger. This demonstration shows that interoperability is feasible in BCT.

The proliferation of blockchains has made standardisation, portability and interoperability seem difficult. Forking on BCT for whatever purpose is another challenge because “there is no easy way to merge or cross-transact on forked chains” (Swan, 2015, p.83). There have been different versions of the technology since the creation of the Bitcoin blockchain which has brought the technology into the limelight. The development of different versions of the technology can be said to grow exponentially. Some of these versions include Ethereum, Hyperledger, Ripple, Corda, and others. This has made the standardisation of the technology cumbersome on one hand, on the other hand, it has helped researchers to break new grounds in the use of blockchain.

Presently, BCT lacks standardisation which has made its integration into the existing infrastructure slow (Galvez et al., 2018). This lack of a common standard is attributed to the technology's relative immaturity and continuous development (Alarcon & Ng, 2018; Bashir, 2018; Carson et al., 2018). The lack of standardisation is evidenced by different descriptions of BCT and terminologies employed by different users. However, the ISO has a technical committee known as ISO/TC 307 which is responsible for standardising blockchain and DLT to enhance interoperability and data interchange between users, systems and applications (Bashir, 2018). Morris (2018) reports that the ISO proposed the release of the first standards not later than 2021 but without some important aspects such as a framework for security, privacy, identity, and interoperability. Additionally, collaborations among different players have led to the formation of different blockchain consortia such as R3, Hyperledger, Hashed health and Ethereum to ensure standardisation (Alarcon & Ng, 2018). BSN, though not a blockchain, recently launched in China is a platform to enhance the standardisation and interoperability of blockchain systems.

These are several factors that could inhibit the wide adoption of BCT by businesses. However, there are several ongoing research projects to tackle these challenges. Some of the proffered solutions by scholars include an increase in block size, block interval reduction, use of off-chain state networks, division of blockchain into layers, invertible bloom lookup tables, sharding, and state channels (Andoni et al., 2019; Bashir, 2017, 2018; Biswas & Gupta, 2019). Considering the properties and limitations of BCT, the technology does not fit all the use cases (X. Xu et al., 2019)

Staples et al. (2017) assert that public blockchain offers opportunities for disruptive innovation, disintermediation of trusted third-party companies and disruption of the business landscape, particularly where the trusted third parties are not trustworthy. Nodes' consensus is the basic principle of every blockchain data structure which means that no change can be effected on a BCT without the concurrence of other participants or nodes (Meier & Stormer, 2018). This principle according to Biswas and Gupta (2019) makes BCT risky to users because mistakes cannot easily be rolled back, and a loss of cryptographic keys by any user will lead to a total loss of investment. Equally, X. Xu et al. (2019) note that losing the key will lead to a permanent loss of control over smart contracts and an account.

Blockchains are available as open-source software which comes with inherent risks. As software, blockchain contains bugs like any other software (De Filippi & Wright, 2018). According to Zohar (2015), a bug in Bitcoin's core could result in inconsistencies between different versions of the code and could lead to Blockchain splitting. For instance, according to Zohar (2015), in March 2013 a bug in the code resulted in two versions of the protocol and an eventual fork in BCT. Bashir (2017) also notes a software bug was exploited in the DAO attack which resulted in losses of millions of dollars. There are no BCT architecture systems that fit all use cases and applications. However, the DAO hack was outside the Ethereum blockchain. Karajovic et al. (2019) note that it was a weakness in the DAO that was exploited by the attacker and not the Ethereum blockchain.

Siegel (2016) asserts that the Ethereum network does not contain any bugs, has been functioning as expected, and no one has ever hacked over $1 billion worth of ether on it. However, the theft of over NZ$20 million worth of cryptocurrencies in the New Zealand-based Cryptopia Exchange (Beynen, 2022) and the attack on Coinbase where hackers not only steal Ethereum classic coins but also rewrote the supposedly immutable blockchain ledger (Brandom, 2019), run contrary to Siegel's claim. Andoni et al. (2019) suggest exploring hybrid approaches that combine the features of public and private architectures as a way of bringing equilibrium and enhancing blockchain performances. The hybrid approach may be useful for a digital-driven economy since it is expected to bring balance and enhance blockchain performance.

On 12 June 2020, New Zealand signed a digital trade agreement with Chile and Singapore to achieve paperless trading, e-invoicing and payments, streamlined customs procedures for parcels, and promote online consumer protection (Stuff, 2020). The New Zealand Minister of Trade and Export Growth was reported to have said that besides the importance of having a robust digital economy, New Zealand entered into her first digital agreement as a response to COVID-19, to ensure the country remains prosperous and recovers quickly from the global pandemic. Consequently, the outbreak of COVID-19 and the need for a secure digital economy cannot be overemphasised. It may be argued that countries like New Zealand can leverage blockchain smart contracts for some government activities instead of reducing services, for example, Immigration New Zealand.

The BCT features of P2P, transparency, immutability, auditability and cryptographic security could have helped to keep vital government services operating during the COVID-19 induced lockdown. Conversely, the critics of BCT will also be wary of the technology's limitations, particularly the loss or theft of private keys, irreversibility of records and possible malfunction of the programming codes, all of which justify the need for government to tread with caution. This is particularly relevant in a post-COVID-19 world where the ability to digitally conduct business online will become a new normal way of doing things. Countries are gearing up to adopt platforms that accelerate the globalised digital economies of the future using new technologies such as BCT.

According to the WEF (2015) report, among the critical areas that BCT will need to address before its adoption include: (1) how to develop a roadmap to achieve market collaboration and standardized regulation, (2) how to structure a regulated tax framework, and (3) how to implement a cost-benefit analysis to determine the financial viability of distributed ledger technology. Consequently, alternative blockchain platforms are being developed to tackle some of the identified limitations in the technology.

2.7 Alternative Blockchains

According to Bashir (2017, 2018), the development of numerous BCT applications, protocols and platforms has increased due to the perceived success of Bitcoin and the ongoing public interest in the potential of BCT. Some of the applications or platforms are either new or complementary to the existing BCT, all in the name of facilitating the development and deployment of BCT solutions. Bashir notes that some of the new protocols add value to the technology by providing solutions to the identified limitations of the current blockchains, thus making it more user-friendly. The new BCT solutions include Kadena, Ripple, Stellar, Rootstock, Quorum, Tezos, Storj, Maidsfe, BigChainDB, and Multichain, while new platforms include BlockApps and Eris (Bashir, 2017, 2018).

As BCT evolves other approaches such as Hyperledger Fabric, Practical Byzantine Fault Tolerance (PBFT), Ripple and Tendermint are being developed to improve the consensus mechanism on blockchain (Wang et al., 2018; Zheng et al., 2018). However, Hyperledger and BSN are not blockchain protocols, but projects sponsored by Linux Foundation and the Chinese government respectively to advance BCT *(Bashir, 2017, 2018; Zhao & Pan, 2020)*. Hyperledger is a modular approach and a protocol designed to build a new BCT platform for industry-specific uses, which would be plug-and-play by the users (Bashir, 2017, 2018). Bashir further explains that the Hyperledger Fabric intends to enhance the existing blockchain's challenges and improve its auditability, interoperability, and portability (2017, 2018). Likewise, BSN is proposed to provide a platform for different users of the technology to interact and enhance connectivity.

Some of the emerging trends in BCT are the development of application-specific blockchains (ASBCs) for industries such as education, finance, and other real-world implementations. The enterprise-grade blockchains such as Bloq, Tylmez and Chain are tailor-made initiatives to address an enterprise problem. Private blockchains such as Hyperledger and Corda can be used in finance, medicine, and law. Princeton University is offering courses relating to BCT, and there is strong research interest in academia and the commercial sector (Bashir, 2017, 2018).

An effort to standardise blockchain is yielding fruit through the formation of consortia such as the Enterprise Ethereum Alliance with over 600 members and the Hyperledger Foundation with about 250 firms (Morkunas et al., 2019) and the BSN platform (Zhao & Pan, 2020). The Hyperledger project involves global financial market operators (CME, Deutsche Boerse, London Stock Exchange), prominent IT enterprises (IBM, CISCO, Intel), large financial institutions (ABN Amro, Australia and New Zealand Banking Group, BNP Paribas, BNY Mellon, Moscow Stock Exchange, Wells Fargo, SWIFT), and a host of others (Vovchenko et al., 2017). Blockchain is an important technology because it eliminates central administration and it can be easily integrated with other platforms such as iCloud, the Internet of Things (IoT), and local and wide area networks (Chakraborty et al., 2018). These emerging trends are geared towards realising the potential applications of BCT. Thus, this study is part of the emerging trend to examine the impacts the technology will have on the accounting and auditing profession.

It can be argued that BCT is not 100% foolproof and is still open to attacks, but research is ongoing on how to minimise the identified weaknesses, for instance, on a Bitcoin blockchain to prevent intrusion and hacking of the technology. Additionally, the application of BCT depends on the users, the technology can be employed for both legitimate and illegitimate purposes (Bashir, 2017). For instance, it is important to maintain the privacy and confidentiality of health records of all patients, but the anonymity feature of blockchain can also be used by the criminal element. Bitcoin's anonymity caused Kshetri and Voas (2017) to conclude that the creation of WannaCry ransomware was successful because hackers used cryptocurrencies as a form of payment. New Zealand could reap the benefits of the technology in its post-COVID-19 pandemic response to achieve a blockchain-based digital economy.

The next section examines the general applications of BCT and their use cases in some industries other than the accounting industry. This is important considering the interdisciplinary nature of both blockchain and the new world accounting and auditing professions. Irrespective of the scale of adoption or the aspects of blockchain that organisations wish to apply, the use of the technology will have monetary implications which will directly or indirectly affect accounting processes. Accounting permeates all facets of any business organisation's activities. Examining the general applications of BCT is relevant to the objectives of the study. Applications may serve as pointers to what auditors are expected to audit in a blockchain system and indicate the effectiveness of BCT in the prevention and detection of fraud.

2.8 General Blockchain Applications

According to the World Economic Forum (WEF) (2016), more than 24 countries, and over 90 corporations that have formed blockchain network consortia for their operations. Also, close to a hundred central banks have launched study groups to assess the technology's potential. With the huge investment in the technology and more than 2,500 patents filed, the WEF report asserts that about 80% of these banks could initiate BCT by 2017. Similarly, Zhang and Huang (2022) suggest that many central banks are embracing digital currencies. The Forum notes that global spending on blockchain solutions is forecast to be nearly $2.9 billion in 2019 (WEF, 2019). Thus, the number of research efforts in blockchain applications is growing exponentially.

Staples et al. (2017) note that globally, start-ups, enterprises and governments are examining the applications of blockchain in a different range of use cases and for a wide variety of requirements and regulatory demands. Some scholars (Appelbaum & Smith, 2018; De Filippi & Wright, 2018; Lemieux, 2017a; Peters & Panayi, 2016) acknowledge that the applications of blockchain technology are beyond the crypto-currencies which brought the technology into the limelight after the creation of Bitcoin by Nakamoto.

Adams et al. (2017) describe blockchain as a disruptive business innovation model. Tapscott and Tapscott (2016) believe that BCT is a technology that has more potential to revolutionise business activities in the next decade than AI, robotics, big data, social web, and the cloud. Some scholars suggest that blockchain can be adapted to cover a wide range of disciplines: government treasury management (Peters & Panayi, 2016), audit log management (Ahmad et al., 2019), supply chain management (Casado-Vara et al., 2018), real estate management (Veuger, 2018), and entrepreneurship and innovation (Chen, 2018). Others include clinical data sharing (Zhang et al., 2018), insurance, education, health record management, banking, weather forecasting and smart contracts as possible innovations (Dai & Vasarhelyi, 2017; Kokina et al., 2017; Li et al., 2017; Peters & Panayi, 2016).

Staples et al. (2017) point out that government services that can use BCT include registries and identity management, grants and social security, quota management, and taxation. Zhao et al. (2016) declare that the technology could revolutionise accounting, finance, management, and law and other fields that rely on the authentication of transactions. However, Swan (2015) considers the notion of BCT as an automated accounting ledger and the quantized-level tracking for record-keeping and administration as speculation and a futuristic notion. The general applications of BCT are briefly highlighted below.

2.8.1 Government

Governments want an effective and efficient means of delivering public services, reducing bureaucratic procedures, ensuring accountability, and generating more revenue with the least operational costs. Nordrum (2017) explains that some government agencies believe that they could leverage blockchain for re-engineering public services using the technology's immutability, transparency, and cryptographic features to ensure the protection of records from fraudsters and improve accountability and service delivery. Similarly, Peters and Panayi (2016) add that the application of BCT will enable efficient management of government cash management under a Treasury Single Account (TSA), elimination of idle funds, and reduction in the cost of borrowing with no need for a single point of administration. The technology can also be used as a public records repository for events, identities, assets, and documents such as a record of deeds, births, deaths, and marriages (Bashir, 2018; Swan, 2015). These possibilities have encouraged some governments in invest in and kickstart pilot blockchain programmes.

Like the launching of the Chinese DCEP, (ICAEW, 2020) reports that the US Congress debated in June 2020 whether to use Digital Dollars to alleviate the suffering of its unbanked citizens due to COVID-19. In the US, 14 million adults (6% of all households) have no primary bank accounts which means that cheque payments are of little or no use to this group of unbanked or underbanked citizens. Additionally, there is an infection risk associated with physical cheque clearing for citizens before they can access food and provisions. Similarly, Joel and Mijes (2020) opine that a BCT-driven decentralised payment system could help to curb the spread of coronavirus if organisations and other stakeholders accept cryptocurrencies for payment instead of cash. The Institute points out that the proposed Digital US$ are fiat currency that can operate like normal accounts held at the Federal Reserve by every US citizen. The Digital US$, will not only bypass traditional banks but will also be accessible from smartphones. The Institute was of the view that the roles of accountants will include advisory services on how to organise, claim, audit, access, and effect Digital Dollars transactions. However, Pirus (2020) reports that according to the FBI report, there was a 75% spike in daily cybercrimes in the USA since the start of the COVID-19 pandemic as hackers took the opportunity of the unprecedented increase in web activities. The dark web and anonymous digital assets helped the sharp rise in crypto exchange hacks and leaks because it is an easier avenue for money laundering (Kumar & Rosenbach, 2019).

Steinmetz (2018) reports that the UK was the first country to publish a comprehensive report on the likely implications of BCT for the government and economy in general. According to the article published in FinTech Future on 26 September 2019, the United Arab Emirates (UAE) has launched a digital bank to support small business owners (Connolly, 2019). New Zealand also recognises that tech is the third-biggest export revenue generation sector with over $16 billion annually and is not lagging behind in piloting blockchain programmes (Callaghan Innovation et al., 2018). The government and private sectors in New Zealand are actively involved in different BCT experiments.

Similarly, Dubai is building a single centralised BCT platform to coordinate all projects by government agencies, Illinois city in the USA is experimenting with different blockchain applications and platforms, and the US government is exploring how to use blockchain for procurement and contracts (Nordrum, 2017). Similarly, Butler (2022) reported that the state of Washington has passed a bill to create a BCT working group to explore the technology's various applications. Blockchain pilot projects for land registration management and property transaction are under consideration or being instituted in Brazil, Ghana, Georgia, India, Japan and Sweden (Lemieux, 2017a, 2017b). Estonia stores marriage certificates in a blockchain and Honduras intends to have all land register entries on a blockchain to prevent corruption and stop unlawful confiscations (Lufthansa Industry Solutions, n.d). In general, governments can use BCT applications for tax collection, identity management, record keeping, value registry, voting, health care and smart cities (Alketbi et al., 2018; Walport, 2016).

In April 2020, China launched a national blockchain platform called Blockchain-based Services Network (BSN) essentially to provide connectivity for Chinese global trade and commerce. The consortium of firms behind BSN includes China Mobile, State Information Centre, China Union Pay and Red Date Technologies (Sung, 2020). Similarly, Hangzhou province in China is experimenting with blockchain schemes to provide a unified digital identity for seamless recognition of consumers of government services. China intends to leverage BCT as the next generation IT facility to build smart cities and ensures cryptographically secured database connections with 5G for effective data management. However, BSN is a permissioned blockchain with the capacity to interoperate with major BCT platforms such as Ethereum, EOS, Hyperledger Fabric and the financial blockchain Shenzhen consortium (WeBank's FISCO BCOS) and Baidu's Xuperchain (Sung, 2020; Zhao & Pan, 2020). BSN is not a blockchain protocol, but a centralised platform for blockchain developers and users to plug in and code thereby reducing operational costs and facilitating interoperability of different Dapps (Zhao & Pan, 2020).

According to Notheisen et al. (2017), in Denmark, a BCT-based proof-of-concept prototype was designed for the Danish Motor Register (DMR) using the Ethereum framework in collaboration with the Danish Tax Authority. The authors note that car registration in Denmark is centralised and involves activities such as licensing, the payment of levies and taxes, repairs, modifications, inspections, and interactions with loan, leasing, or insurance firms as well as the transfer of ownership. The repository is the DMR database for all stakeholders which includes owners, government agencies and third parties associated with a vehicle's life-cycle. Ethereum blockchain is used to create automatic transaction-triggered smart contracts for the administration and management of DMR to reduce bureaucratic and costly procedures associated with the existing centralised system. However, Notheisen et al. (2017) acknowledge that the proposed prototype has not been tested for actual largescale applicability due to the lack of real-world blockchain-based systems other than for crypto-assets.

The trends in some of the piloted BCT experiments by various governments seem to favour permissioned or private blockchains. This is to ensure that government still retain control of both the users and activities of the blockchain network. However, Nordum (2018) argues that regardless of the various government efforts, it is difficult for anyone to claim that BCT can give meaningful outcomes for public agencies. Thus, it is unclear yet whether any government will adopt public or private BCT.

2.8.2 Supply Chain Management

Ahmad et al. (2019) designed an audit log model called "BlockAudit" leveraging BCT scalability and tamper-resistant features to enhance the security, transparency, and provenance of the existing audit log database. The authors note that the existing audit log relies on a centralised database system which is prone to physical access and vulnerability attacks. Ahmed et al. (2019) further claim that BlockAudit was tested using a real-world e-Government application and the model will resolve the vulnerabilities of the existing audit model. Similarly, a model of supply chain management using BCT was demonstrated to show an integration of members of a supply chain including the consumers and retailers, which is missing in the current linear supply chain model (Casado-Vara et al., 2018). The authors claim their model integrated blockchain, smart contract and a multi-agent system (MAS) which linked and verified all the members of the supply chain, including shipment, with an embedded reward/fine system for participants. This contrast with the present model where consumers have little or no information about the product's origin. However, the model used by Casado-Vara et al. (2018) to test agricultural products can be argued to have a straightforward supply chain system when compared with a manufacturing sector with a complex MAS.

In 2018, Maersk and IBM entered into a joint venture to create a real-time digital ledger for global shipping (Felin & Lakhani, 2018). The aim was to solve a lack of transparency in the shipping, cargo, and transport sectors. For instance, IBM and Maersk used a Proof of Concept (PoC) in September 2016 to track a container of flowers from Mombasa in Kenya to Rotterdam in the Netherlands (Kshetri, 2018). Similarly, Walmart was reported to have deployed BCT for tracking mangoes from Mexico to the United States, and a pork supply chain in China reduced its tracking time from six days to two seconds (Felin & Lakhani, 2018). Similarly, a Chinese online retailer JD.com is using blockchain to track beef supply from Australia to China to tackle the challenges of food contamination, product diversion and misrepresentation (Felin & Lakhani, 2018). Other companies currently using BCT for supply management are Fonterra, DHL, UPS, and FedEx.

The food supply chain can leverage the features of blockchains such as security, safety, transparency and efficiency. Galvez et al. (2018) postulate that with end-to-end traceability, BCT can enable consumers to identify the contents and components of foods using mobile phones and trace food items from retail store to farm thereby strengthening food security and authenticity. The authors further note that traceability can be useful in the production, processing, storage, distribution, retailing and administration of food chain management. Similarly, Aldag and Eker (2019) believe that BCT can prevent food fraud such as false labelling. However, food supply chain management is a complex long chain that depends on sensors or barcodes to scan food tracking data, and many players may or may not observe the correct procedures. Galvez et al. (2018) note that the linking of data collecting sensors with the BCT network cannot guarantee the accuracy of the inputted raw data despite the immutability of the data, and the technology cannot detect if the sensor has been tampered with.

Of the reviewed studies, none have been able to confirm if BCT can guarantee the delivery and quality of products in supply chain management. Therefore, it can be argued that BCT has not resolved the existing problems of safety and quality of the products. This invariably means that technology has not resolved some of the existing challenges currently presented. The application of BCT in some of these companies will require the input of accountants and subsequent validation by auditors. With the increased use of BCT by some companies, what is this adoption likely to mean for accountants and auditors?

2.8.3 Financial Services Industry

Financial services applications that can use BCT include digital currency, payments, reconciliation for correspondent banking, security clearing and settlement, and trade finance (Staples et al., 2017). Financial institutions are exploring the possibility of using BCT for post-trade settlement and cross border payment (Bashir, 2017; Nowiński & Kozma, 2017). Similarly, according to Rizzo, the ten major global stock exchanges experimenting with blockchain are the Australia Security Exchange (ASX), Chicago Board of Trade Company (CME Group), Dubai Multi Commodities Centre (DMCC), Deutsche Borse, Japan Exchange (JPX), Korean Securities Exchange (KRX), London Stock Exchange

(LSE), New York Stock Exchange (NYSE), Nasdaq and Toronto Stock Exchange (TMX) (Rizzo, 2016).

In 2014, the Bank of England highlighted the importance of BCT because most of the financial assets such as loans, bonds, stocks and derivatives are now kept in a digital or electronic form. Similarly, the European Securities and Markets Authority (ESMA) noted that investment funds and derivatives are held in virtual currency (Leonard, 2016). This means that investors can transact business without intermediaries like a Central Bank and other financial institutions. Despite the fact that trading in Bitcoin and other crypto-assets is illegal in China, the People's Bank of China (PBOC) has issued a national digital currency that could be used along with its official currency - Yuan - to stimulate its economy (Norman, 2017).

The Bank of Finland also published a report on the importance of Bitcoin driven by BCT as a medium of payment similar to other payment platforms such as Swift, Visa and PayPal (Huberman et al., 2017). Further, New Zealand legalised the payment of workers' salaries and wages with crypto-assets from 1 September 2019 (Inland Revenue Department, 2019). The ASX in Sydney embarked upon the use of BCT for the redesign clearing and settlement system in 2016. The Estonia Stock Exchange is conducting voting on a blockchain platform, and a US public Company (Overstock.com) accepted subscriptions for an equity rights issue with a private blockchain (Yermack, 2017).

Top global financial and technological institutions have experimented with DLT for wholesale banking activities such as issuing bonds and commercial papers, consortium loan financing and funds transfer (Lee, 2016). Lee (2016) reports that a blockchain start-up company, Tallystick, in partnership with Barclays Bank, used the BCT-invoicing application for invoice financing with a private company and its suppliers. With this process, the provenance of an invoice was established among the financier, buyer, and supplier via a private blockchain (Lee, 2016). Similarly, the Royal Bank of Scotland (RBS) has announced that it has built a Clearing and Settlement Mechanism (CSM) based on the Ethereum distributed ledger and smart contract platform. RBS claims that the test results are appropriate for a national level domestic payments system because it showed a throughput of 100 payments per second, with six simulated banks (Creer et al., 2016). According to Biswas and

Gupta (2019), there is a collaboration between Emirates NBD and ICICI Bank to use blockchain-based remittance and trade financing that is powered by the Finacle platform of Infosys Technologies.

Yermack (2017) highlights the benefits associated with issuing and trading corporate securities on BCT to include transparency of ownership, improvement in liquidity and a positive impact on institutional investors. Notwithstanding these highlighted benefits, some investors and firms will not adopt BCT for fear of having their financial data in the public arena (Bashir, 2017; Stratopoulos & Calderon, 2018). Yermack (2017) acknowledges this concern and notes that when investors realise that the benefits of using BCT for security trading outweigh the demerits, they will readily accept it.

The core function of financial institutions such as asset aggregation, market making, risk management and information clearing depends on efficient financial intermediation (Lin, 2015). He further notes that without traditional financial intermediaries such as commercial banks performing capital-aggregating roles, investment banks performing risk-managing roles, stock exchanges and broker-dealers performing informational and market-making intermediaries, it would be difficult for many individuals and firms to carry out key financial transactions. However, despite the fact that a feature of BCT is the elimination of intermediaries, Cai (2018) notes that technology cannot eliminate some of the traditional bank intermediaries' roles. She suggests that BCT could be used by financial institutions to reinvent banking processes and procedures. Gaggioli et al. (2019) share a similar view, arguing that financial firms will not entrust financial assets to BCT and relinquish control to anonymous participants, even if bank customers desire a decentralised network.

Bashir (2017) is of the view that it is possible to eliminate the financial institutions' intermediary role using appropriate smart contracts on BCT. In contrast, Hanson et al. (2017) note that the WEF rated BCT as a high-risk innovation with a low benefit. Similarly, Cai (2018) notes that the disintermediation of all activities in finance is not feasible because the traditional functions of banks are beyond building trust in transactions. Furthermore, she argues that BCT can reinvent and enhance bank operations by reducing some traditional layers of traditional intermediation (Cai, 2018). For instance, presently the interbank trade settlement involves so many parties: banks, central clearing houses, brokers and other firms whose job is to ensure that trade settlements between buyers and sellers are completed. The post-trade settlement takes between two to three days. With the use of BCT, all participants can immediately be on the same shared ledger thereby reducing the time, resources, and bureaucracy of trade settlement (Bashir, 2017).

Leonard (2016) suggests that regulators including the central banks can concurrently maintain their regulatory oversight while still ensuring the development of an advanced BCT-based financial economy. Though, from the present position of regulators, extending the regulatory framework to blockchain crypto-assets will defeat the disintermediation philosophy of BCT as propounded by Nakamoto (Yermack, 2017). Conversely, without a regulatory framework for BCT innovation, the technology may be left in the hands of criminals (Hanson et al., 2017).

From the analysis, it can be inferred that some apex banks and financial institutions are experimenting with the applications of BCT for financial services. However, as noted by Hanson et al (2017), BCT innovation could be used by some organisations to exploit people and make a super profit.

2.8.4 Insurance industry

In the insurance industry, the technology is capable of automating insurance processes, stopping fraudulent claims, ensuring prompt payment of a claim, facilitating transparency, and reducing the cost of processing claims (Bashir 2017). Counterfeiting fraud could also be eliminated where insurance certificates are stored on blockchain (A. W. Singer, 2019)[10]. Singer argues that to achieve fraud reduction in insurance, BCT needs to be combined with other technologies such as smart contracts and recent forensic approaches (A. W. Singer, 2019). For instance, with the integration of IoT and blockchain, a smart contract can be developed that can handle an insurance policy from the beginning to the end leading to transparency and ease of claim payment. Gaggioli et al. (2019) note that it is possible to use smart insurance contracts for the execution or non-execution of

Note: The use of initials before author’s name for in-text citation.

[10] In APA referencing, the initial(s) of author is added to Surname for in-text citation where two authors have the same Surname and the same year of publication.

specific clauses in an insurance policy. This includes a selection of policy and payment of premiums by users, calculation, and settlement of the claim without human intervention. Claim computations and payments are roles often performed by accountants in an insurance firm.

2.8.5 Aviation Industry

The aviation industry is currently experimenting with different BCT applications to improve service delivery, maintenance and logistics management. Mapperson (2019) notes that the giants in the aviation industry have embraced BCT to improve their services and reduce operational costs. For instance, Air New Zealand, Austrian Airlines, Brussels Airlines, Eurowings and Lufthansa are currently partners with Winding Tree, a Swiss-based BCT company. The reasons for this alignment with BCT lie in the technology's potential to streamline data sharing among information silos in airports and create a seamless and secure travel experience. The current methods of collecting and distributing information by airlines and airports are obsolete with many insecure isolated operating systems (Georgacopoulos, 2019).

Blockchain for Aviation (BC4A) was launched by Lufthansa Industry Solutions to compile potential applications of the technology, create industry-standards for its usage and to enhance flight maintenance transparency (Bellamy, 2017; Georgacopoulos, 2019). The BC4A initiative is expected to include software developers, aircraft manufacturers, logistics providers, lessors, civil aviation regulators, and maintenance repair and overhaul (OMR) service providers (Bellamy, 2017; Lufthansa Industry Solutions, n.d). Similarly, IBM is reported to be in partnership with the aviation industry to create a digital shared ledger by all stakeholders in aviation for recording flight events, operational states, and scheduled maintenance lists to track the entire aircraft lifecycle and performances of installed equipment (Bellamy, 2017). Some of these ongoing pilot programmes caused Mapperson (2019) to conclude that with the rate of BCT adoption, the technology will become a fundamental platform for all aspects of the aviation industry. It can be argued that it is too early to conclude how the stakeholders will eventually use BCT considering some of the limitations facing the technology.

2.8.6 Smart Contract

Like blockchain, there is no agreed standard definition of smart contracts (Bashir, 2018). This study briefly examines some of the attempts to describe smart contracts.

Siegel (2016) views smart contracts as standalone agreements that do not require interpretations of outside entities or jurisdictions. The code itself is the final arbiter of the agreement it represents. Atzei et al. (2017, p. 164) define smart contracts as "computer programs that can be correctly executed by a network of mutually distrusting nodes, without the need for external trusted authority". Smart contracts are self-executing programmes that are based on pre-determined and agreed conditions using appropriate encryption codes without human interference (FAO & ITU, 2019; Zhang et al., 2018). Bashir (2018, p. 262) describes smart contracts as "secure and unstoppable computer program representing an agreement that is automatically executable and enforceable".

Andoni et al. (2019) note that a combination of smart contracts with BCT can result in new innovative business solutions because of the technology's inbuilt transparency, security and tamper-proof features. BCT is often misconstrued as a complete technology solution, However, in reality, it is a technology component that supports larger business approaches and applications (Alexandre, 2019). In the same vein, some scholars note that the potential of BCT will be realisable when combined with other technologies such as IoT, mobile computing, AI, data analytics and machine learning (Alarcon & Ng, 2018). This is also the view of some scholars (Reyna et al., 2018; Walport, 2016) who note that for BCT or DLT technology to realise its potential, it must be combined with other applications, particularly smart contracts.

Smart contracts are regarded as viable for many use cases, including financial services, agriculture, aviation, energy, IT and communication where product traceability, service management, prevention of counterfeit and fraud as well as regulatory compliance are important (Walport, 2016). Swan (2015) opines that it is possible to have blockchain smart contracts that could reduce contractual disputes and facilitate smart literacy contracts. Blockchain smart literacy contracts are decentralised learning contracts that could open learning and educational courses to all individuals, especially in emerging markets (Swan, 2015). BCT will transform contract law and processing with the use of digital enforcement contracts, facilitate almost on-the-spot transaction settlement, and ease cheque clearing and settlement (Peters & Panayi, 2016). Apart from Ethereum, other BCT platforms that support smart contracts include Hyperledger Fabric, Stellar, Corda, Counterparty, Monax, Lisk and Axoni core (Bashir, 2018).

However, despite the benefits from the use of smart contracts, there are some challenges. For instance, it has been noted that smart contract codes are not error-free, as evidenced by the DAO Ethereum blockchain platform in 2016 which led to a loss of over US$ 150 million (Alketbi et al., 2018). The execution of smart contracts is prone to manipulation by participants or adversaries (Luu et al., 2016). In the same vein, Vessene (2016) shows that his review of Ethereum smart contract bugs per line of code reveals a minimum of 100 per 1000. The DAO incident caused Bashir (2018) to question the general notion that code is a law or smart contracts are flawless, and he affirms that users should be sceptical of some of these concepts since the implementation is still at the trial stage.

Vessene (2016) also lends credence to Bashir's view by stating that users need to be wary of contracts that are immutable and permanent but with significant error rates. The associated risks and benefits of smart contract applications are still theoretical because the technology is yet to be used for large commercial ventures (Walport, 2016). Another technical issue raised by Peters and Panayi (2016) is the feasibility of creating a legal and enforceable binding contract on a distributed and decentralised system in multi legal domains. Conversely, Marvin (2017) reports that the hack on Mt. Gox in 2014 and Bitfinex in 2016 was possible because these firms centralised a decentralised system. He further notes that the DAO hack happened outside the blockchain's fundamental security and encryption model, and stemmed from vulnerabilities in the smart contacts written above the blockchain network (Marvin, 2017).

Narayanan and Clark (2017) assert that it is misleading to assert that traditional registries are less secure compared to BCT. The systemic risk in BCT is not in any way less than centralised operations. The authors support their argument with BCT's endpoint security, the anonymity of public blockchain, irreversibility, and the instantaneous nature of transactions. Similarly, Khan and Salah (2018) note that limited randomness in private keys can be exploited to undermine BCT accounts. For instance, a loss of private keys, which could be likened to losing a mobile phone or having a computer bug, automatically means a total loss of access to the blockchain network and a complete loss of assets held in the blockchain (Lemieux, 2017b). Lemieux (2015) further observes that any application with access to the user's application folder can read a file containing private keys since the Bitcoin software which administers private keys uses a node's local storage or database to store them.

Smart contracts are fundamentally expected to be deterministic applications because they must ensure the production of the same output for a specific input (Bashir, 2018). Bashir (2018) notes that a deterministic characteristic guarantees that smart contracts always generate identical output for a specific input, thus producing executed programs that are reliable and accurate according to the prerequisite programmed in the high-level code. However, according to Androulaki et al. (2018), the responsibility to create deterministic applications on a BCT rests on the potentially untrusted programmer who, with malicious intent, can use only one non-deterministic contract to cripple an entire blockchain system.

Conversely, a lost password or token in a traditional centralised institution does not result in a total loss, the user can simply request another authentication code from the centralised regulator. Management and employees could engage in all manners of activities such as the destruction of books of account or even setting offices ablaze to cover up fraud. With blockchain, perhaps a deliberate loss of a token or private key or tinkering with smart contract codes could be a new way to perpetrate or cover fraudulent transactions. For example, the death of Gerald Cotton in 2018, the founder and the sole owner of the private keys to the Quadriga**,** a Vancouver-based crypto exchange has led to the permanent loss of users' funds worth about $124 million[11]. This arguably made the endpoint security in blockchains a possible nightmare for users. However, according to Bashir (2018), there are ongoing research projects to develop a standard framework that will address some of the issues of blockchain technology.

It is likely that where there are smart contracts, there will be smart auditing of their contents and execution procedures. The codes behind smart contracts are said to be penetrable or hackable by participants or adversaries. This imperfection could make

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[11] https://mailchi.mp/cointelegraph/btc-in-peril-quadriga-poNewZealandi-coinbase-punished-other news?e=fcb1d22428

users or stakeholders rely on the expertise of intermediaries as auditors for verification. It is important to explore whether BCT smart contracts will impact the relevance of auditors in a BCT environment, the likely impact BCT smart contracts have in the auditing field and how will an audit be executed in this decentralised network. The crux of this study is whether blockchain will enhance or disrupt the accounting and auditing fields.

An overview of BCT architecture shows that the technology is not new, but the launching of the Bitcoin blockchain is a novel idea. Being an emerging technology with a disruptive potential to upend many businesses, many of BCT's technical components are not well defined for non-technical persons' understanding. It is challenging to pin down apt descriptions of the technology and features. Perhaps this is because BCT is still evolving. Nonetheless, to understand its general implications on different business models, the study relies on the descriptions of BCT, its architecture and general applications in the existing literature. It is expected that as the technology matures there will be a clearer description and terminology of BCT and its associated components.

2.9 Summary

The chapter provided an overview of BCT and its general applications. An understanding of the basic terminologies, characteristics, architecture, protocols, and some applications of this technology is necessary to provide a background to the study. The prior literature has paid considerable attention to the need for the standardisation of the blockchain framework and terminologies.

The chapter showed that there is no agreed standard definition of blockchain, and many scholars have based descriptions of the technology on its potential features. The chapter further explained some key terminologies considered relevant to this study, as well as blockchain consensus protocols. It also explored the BCT architecture and how it works (without going into technical and engineering aspects) as well as blockchain applications. The existing literature revealed that apart from Bitcoin which runs on a public permissionless ledger, many of the ongoing projects lean towards private permissioned blockchains. It found also that some of the identified limitations of blockchain such as scalability, privacy, security, regulation, and other technical challenges are being addressed with ongoing research on alternative blockchains. Evidence from the literature showed that some governments have started providing regulatory frameworks for BCT operations within their jurisdictions in a piece meals fashion. The aftermath of the COVID-19 pandemic has caused countries to seek better means of conducting governance and business affairs in a digital era, and BCT, with its unique features, could be a platform to achieve this.

The chapter also reviewed the potential general applications of blockchain to government public services, supply chain management, financial services, insurance, and smart contracts. The potential applications of blockchain have caused some scholars to conclude that the impacts of the technology cut across different fields of human endeavours. It is yet unclear if blockchain technology is a standalone system that can work independently of other existing technologies or if it is a component that can add its unique features to other business applications. The way technology has been hyped gives the impression that it is a complete application package or the right solution for everything. However, it is evident that BCT is not a complete technology solution and can only function by integrating with other technology components such as smart contracts, AI machine learning and IoT. It is apparent that how blockchain will integrate into other technologies is still evolving, and that many of the envisaged applications will need to rely on smart contracts for their execution and operations.

The validation of transactions by miners using cryptographically hash algorithms appears to be the bedrock of the security mechanism of the Bitcoin blockchain. Miners are responsible for the validation of transactions in Bitcoin and other cryptocurrencies, and this makes double spending and other financial infractions by nodes somehow impossible. Double spending may be difficult in such monetary transactions because the amount held by all nodes is known, shared, and distributed. However, in real financial transactions, the participants cannot determine in advance the details of receipts and payments or transactions, and there are no miners to validate financial transactions. It could be argued that the Bitcoin blockchain configuration, particularly the validation of transactions by miners, is not practically feasible in financial transactions.

The potential to use BCT as a transacting technology is what makes many writers and scholars believe that the technology will disrupt the double-entry accounting system and eliminate the roles of auditors as intermediaries and fraudulent transactions. The proposed BCT-enable triple-entry accounting system assumes that the technology will facilitate immutable transactions that are cryptographically secured, auditable and transparent. Many companies are using BCT as transacting technology in their transactions, particularly in supply and logistics management, shipping, freight and forwarding and monetary transactions. Basically, what is missing is a complete BCT-driven financial accounting and reporting system. The technology has yet to be used as an ERP and among the factors that are found to be responsible are a lack of understanding of the practical applications of BCT, a lack of investment due to the Covid-19 outbreak, and resistance by people (see Section 8.4.2). Despite this, BCT has the potential to integrate with other technologies and can be used as an ERP, but the technology is still in different experimental stages. The usage of BCT is still limited, it may be difficult at this stage to predict whether it would be used for full financial accounting and reporting systems.

The next chapter explores the literature on the implications of BCT for the accounting and auditing profession, as well as the prevention and detection of fraud, which are the focus of this study. Accordingly, Chapter 3 reviews articles that are more specific to the accounting and auditing profession to better understand how BCT will enhance or disrupt (or both) the accounting industry.

Chapter 3

Literature Review - Implications of Blockchain Technology for the Accounting Industry

3.1 Introduction

This chapter provides a literature review of the effects of BCT on the accounting industry. Studies range from discussing the potential features of blockchain to the likely impacts the technology is expected to have on a particular field (Risius & Spohrer, 2017). However, questions have been raised about the lack of understanding of the practical applications of BCT (Beck & Müller-Bloch, 2017; Cai, 2018; Dai & Vasarhelyi, 2017; Risius & Spohrer, 2017), which problems BCT actually solve (Frederik, 2020), and the need to focus on how the technology will impact a specific field.

The chapter begins with an overview of the history of accounting ledger systems. The second section examines the implications of blockchain accounting activities with an emphasis on the proposed blockchain-enabled triple-entry accounting ledger, as well as the potential benefits and limitations of using BCT for accounting activities. This is followed by the implications of BCT for audit covering the areas that the technology may benefit and disrupt. The fourth section examines the current status of BCT diffusion among the Big 4 audit firms. The fifth section evaluates fraud prevention and detection system in a BCT environment focusing on financial fraud. The sixth section considers the technical skills required by accountants and auditors in a blockchain environment. The final section summarises the chapter.

3.2 Historical Overview of the Accounting Ledger Systems

This section briefly highlights the history of accounting ledger systems, i.e. single entry ledger, double-entry and the proposed triple-entry ledger system.

A ledger is “an account in a ledger that holds the records for all the transactions relating to that particular person (e.g. a debtor), thing (e.g. stock item), or activity (e.g. sales)” (Law, 2016). The ledger is where different accounts are kept (Smart et al., 2013). Ledgers are important because they are a fundamental conventional technology of market capitalism and ledger entries may be used to record any data structure such as identity, certification, contracts, and the titles of property and ownership (Davidson et al., 2018). The ledger is a classified grouping of transactions or entries and not a compilation of classified debits and credits (Littleton, 1926).

3.2.1 Single-Entry System

Before the double-entry accounting or bookkeeping system, there was a single-entry where written records were mainly of receipts and payments (Hooper, 2015), and transaction records were kept in a memorandum form. Brandon (2016) notes that single-entry bookkeeping is still in use by small businesses because it is less cumbersome to operate and requires little technical expertise, compared to double-entry bookkeeping. Brandon further states that cheque books are used to determine the flow of income and expenses which informs management about cash flow and current balances. Deficiencies in the use of the single-entry system include susceptibility to multiple errors and likely fraud, non-recognition of a firm's overall assets and liabilities, unacceptability for filing a tax return and difficulty in reconciling different book accounts with external records (Alboaie et al., 2018; Brandon, 2016; Mann, 1994).

As a result of these deficiencies, bookkeeping systems moved to a double-entry system. This method is superior to a single-entry method because it involves the systematic and orderly recording of all transactions and provides an arithmetical check on records using the trial balance (Hooper, 2015). The trial balance is used to check the arithmetical accuracy of the accounting ledger as total debits must equal total credits.

3.2.2 Double Entry Accounting or Bookkeeping System

Double-entry accounting or bookkeeping dates back many centuries, but Luca Pacioli is credited with documenting the modern double-entry bookkeeping system of debits and credits in 1494 (Cai, 2019; Henke, 1995; Hooper, 2015; Mann, 1994; Peragallo, 1956; Simoyama et al., 2017; Yamey, 1947). It has been the basis of recording, analysing and preparation of books of account and other financial information. Yamey (1947) claims that the origins of double-entry bookkeeping remain a mystery, a little like the understanding of double-entry for non-accountants. Contrarily, Sangster (2016) moots that Florence in Italy is the origin of the double-entry system innovation.

Double-entry accounting is referred to as the heart of modern financial reporting (Hooper, 2015) and its advent marked a significant improvement in financial record keeping, particularly in the prevention of accidental errors and identification of fraud (Alboaie et al., 2018; Carlin, 2019). Pazaitis et al. (2017, p. 107) note that double-entry bookkeeping recognised "the standardised quantification of the results of all business activities and the reduction of assets and equities to numerical abstractions". The double entry system could be likened to two sides of a coin where one side is referred to as debit and the other side is called credit. Barring any other accounting errors, the credit and debit sides must be equal, if the trial balance is unbalanced, this is an indication of errors in the accounting ledgers.

However, some scholars (Cai, 2019; Faccia & Mosteanu, 2019; Henke, 1995; Ibañez et al., 2020; Ijiri, 1986; Simoyama et al., 2017) have called into question the justification for the continued relevance of double-entry principles in accounting. Faccia and Mosteanu (2019) stress that the use of debit and credit to represent each side of an account is misleading and suggest that it is better to refer to them as the left section and right section. Cai (2019) posits that besides facilitating the establishment of accurate financial reports, stakeholders still worry about the trust, reliability and transparency of double-entry bookkeeping that is internally prepared by the management. Cai argues that this doubt necessitates the need for independent external auditors to ascertain the authenticity and integrity of the financial statements prepared by the management.

Equally, Henke (1995) believes that the double-entry accounting method has outlived its usefulness because it was designed for recording past transactions, but accountants are still improperly using such historical data for forecast and prediction. Henke acknowledges that there is no alternative method to the double-entry system yet, but he suggests that it is high time accountants developed a new system that relies on predictive data for forecasts (Henke, 1995). However, despite some scholars questioning the adequacy and rationale of Pacioli's double-entry system, the concept of debits and credits are what the accounting profession relies on for now as there is yet no acceptable alternative. Some scholars (Ijiri, 1986, 1988; McCarthy, 1982) have mooted the idea of a triple-entry accounting system to replace the double-entry accounting system.

3.2.3 Triple-Entry Accounting System

Triple-entry accounting is not a new phenomenon, it dates back to the 1980s when the late Professor Yuri Ijiri first mooted the idea of triple-entry bookkeeping in his paper titled “Triple-Entry Bookkeeping and Momentum Income” in 1982 (Gröblacher & Mizdraković, 2019; Ibañez et al., 2020; Ijiri, 1986). Similarly, McCarthy (1982) developed a Resource Event Agent (REA) accounting model as a generalised framework for accounting systems in a shared data environment. McCarthy (1982) advocates for the exclusion of elements of double-entry bookkeeping (credits, debits, and accounts) from the accounting framework because he perceives them as unimportant.

There has been much academic debate as to the appropriateness and workability of a triple-entry accounting system. Ibañez et al. (2020) believe that such a triple-entry framework is complex and does not add any new value to the present double-entry system. Similarly, Carlin (2019) notes that the implementation of Ijiri’s proposed system is not feasible in practice which could be why it has not been adopted for commercial use. Fraser (1993) concludes that the proposed triple-entry system has no beneficial value to decision-makers because the proposed extension has no purposeful contribution to the existing double-entry framework. Contrarily, some authors (Henke, 1995; McCarthy, 1982) are of the view that Ijiri’s triple-entry system will facilitate incorporating future transactions into financial statements and enhance the quality and reliability of accounting information, which will enable stakeholders to forecast future earnings based on both present and future transactions. Similarly, Melse (2008) believes that the triple-entry accounting framework is an innovation with the potential to enhance information analysis, disclosure and decision-making. There is no consensus as to the parameters for implementing the proposed triple-entry accounting system among accounting practitioners and academics.

3.3 Implications of BCT on Accounting Activities

This section examines how blockchain will enhance or disrupt accounting activities in the context of the proposed blockchain-enabled triple-entry accounting or bookkeeping system. It further explores the potential benefits of using BCT in accounting and the likely limitations of the technology.

Accounting covers many different activities. The areas of specialisation include management, financial, tax, audit and assurance services. BCT is envisaged to impact all these different areas in accounting (Deloitte, 2016a; Kiviat, 2015; Vishnevsky & Chekina, 2018; M. Xu et al., 2019). For this study, the word "accountants" is used to represent all accounting specialisations other than the audit specialisation. This is because only professionally qualified accountants can practice as auditors.

3.3.1 BCT-Enabled Triple Entry Accounting System

The term triple-entry account was coined by Ijiri in 1986, however, Wang and Kogan (2018) assert that the proposed blockchain-based triple-entry accounting system is different from Ijiri's trebit 1986 because BCT is expected to facilitate the automatic sharing of immutable ledgers. In 1982, Ijiri strongly suggested the need to modify the double-entry system and extend it to triple-entry bookkeeping. In 1986, he illustrated his concept using a worksheet, journal entries and three different financial statements: *Wealth Statement, Momentum Statement, and Force Statement* (Ijiri, 1986). He proposed "Trebit" in addition to the existing debit and credit. Ijiri's trebit proposed a new set of accounts to explain changes in income (Cai, 2019).

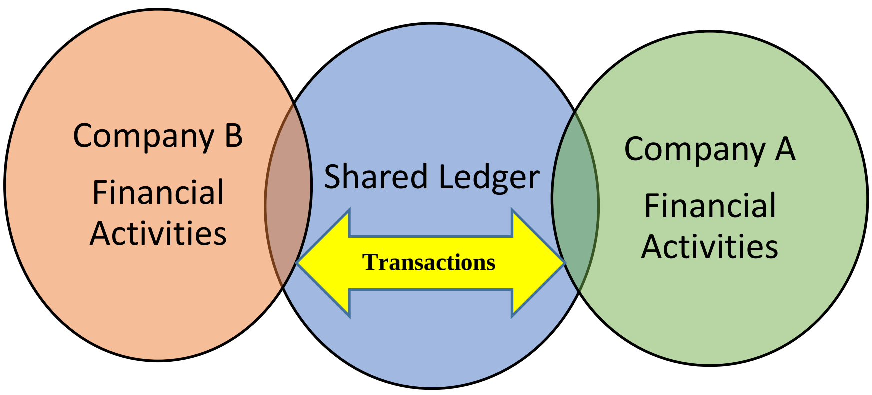
Kiviat (2015, p. 577) describes triple-entry accounting as "the idea that transactions on the blockchain are essentially accounting entries that are cryptographically sealed, preventing tampering and enabling near-real-time auditing". Some scholars (Faccia & Mosteanu, 2019; Patil, 2017; Peters & Panayi, 2016; Schmitz & Leoni, 2019) believe that blockchain could serve as a platform to achieve a triple-entry accounting system and transformation of the entire accounting ledger. Thus, attempts have been made by writers and some accounting professional institutes to describe the likely blockchain-enabled triple-entry accounting system.

However, before BCT, Grigg (2005) proposed a triple-entry accounting that combines financial cryptography with the existing double-entry system. Each financial transaction will require three entries: debit, credit, and a digitally signed receipt. Digital signatures denote an innovative means of creating reliable and trustworthy entries that can be easily integrated into accounting systems (Grigg, 2005), supporting authentication and non-repudiation of data origin (Bashir, 2018).

Grigg acknowledges that the proposed triple-entry bookkeeping software is built on the double-entry principles which result in the pairs of double entries linked by the central list of receipts, i.e., three entries for each transaction. Grigg (2005) concludes that triple-entry bookkeeping is not a revolution but an advance in accounting.

Blockchain triple-entry can alter the traditional double-entry system, apart from adding clarity and honesty to bookkeeping systems (Faccia & Mosteanu, 2019). Companies are expected to record their transactions directly into blockchain which will result in having a third copy in addition to the double-entry. Faccia and Mosteanu (2019) describe the third copy as the confirmation receipt. The receipt is described as a unique and cryptographically secured record that involves the digital signatures of the originator, the payer, and the accepting issuer with an inbuilt mechanism to prevent unauthorised transactions. Deloitte (2016a) notes rather than keeping multiple records, companies can keep their transactions directly in a joint ledger that is distributed, cryptographically secured, and difficult to falsify or alter by the users. The proposed blockchain-based triple-entry system is in **Figure *9***.

Figure 9. BCT-enabled Triple Entry Bookkeeping

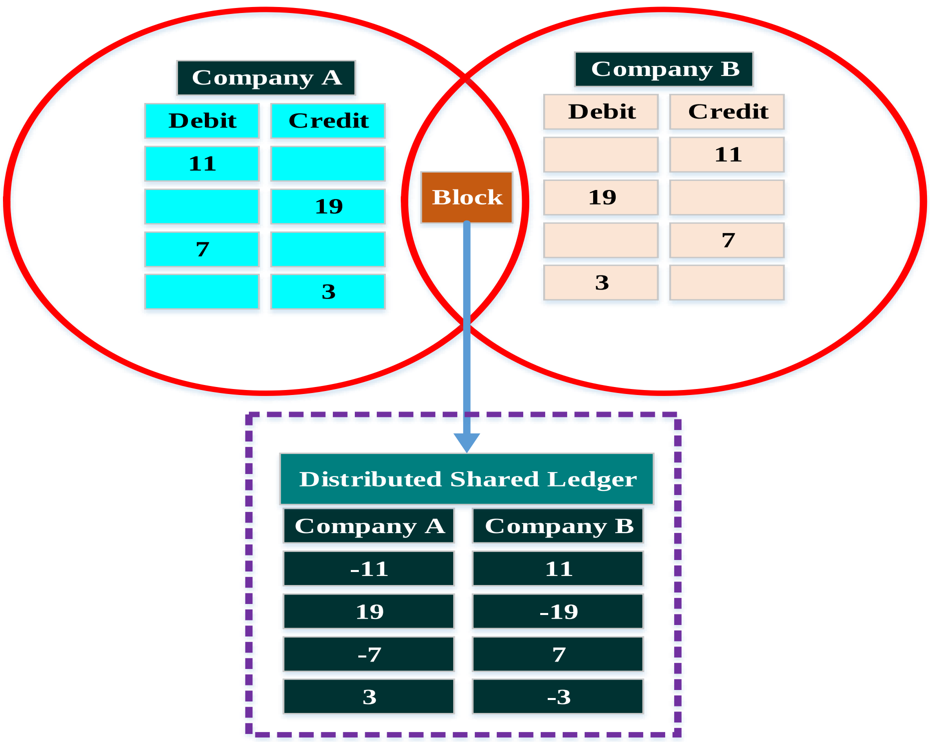


Note. Source: Adapted from Deloitte (2016a)

According to Patil (2017), blockchain will ensure new transaction data added to the shared ledger are authorised and users edit the ledger with the use of cryptography without any intermediation parties such as banks. Patil (2017) posits that transactions between two firms will result in the creation of private ledgers which will be automatically generated whenever the two firms transact business in addition to the usual double entries accounting system maintained by the respective companies.

The BCT shared ledger represents the third entry or the triple-entry (in addition to credit and debit) where transactions are immutable and automatically reconcile in real-time. It is possible to make the shared ledger public and accessible to authorised parties such as auditors, bankers, creditors, courts, and tax authorities (Patil, 2017). Patil's triple-entry concept is illustrated in **Figure 10**.

Figure 10. *Demonstration of BCT Triple-Entry Ledger*



Note. Source: Patil (2017)

The benefits of blockchain-enabled triple-entry are said to be beyond adding just a third entry to the conventional double-entry ledger system (Schmitz & Leoni, 2019). All parties to a transaction will have access to unalterable records (Simoyama et al., 2017) and a transparent shared ledger (Schmitz & Leoni, 2019). Wang and Kogan (2018) argue that triple-entry is an improvement to the customary double-entry system because blockchain supports the recording of accounting transactions as a third entry. Blockchain distribution, consensus mechanism and cryptographic security are adequate to protect recorded entries in a ledger from being tampered with since new transactions are added to the existing block to form a chain (Schmitz & Leoni, 2019). It is technically difficult for any participant to tinker with previous transactions in a blockchain. For any user or node to achieve this, its computational activities have to outnumber the entire linked chain. Karajovic et al. (2019) note that technology has the opportunity to create triple-entry accounting which can automatically confirm all transactions by the stakeholders, thereby enhancing the reliability of bookkeeping. Wang and Kogan (2018) state that in a blockchain triple-entry, trading parties do not need to post individual debits and credits since the technology's shared transaction records link the journal entries of trading parties. Schmitz and Leoni (2019) suggest that blockchain can eliminate the associated weaknesses of the double-entry bookkeeping. Besides facilitating a triple-entry accounting system, BCT is said to have other potential benefits for accounting activities.

The proponents of the triple-entry accounting system believe the third entry through the BCT ledger will revolutionise double-entry bookkeeping. This proposition has attracted much debate from academics, professional accounting bodies, and practitioners. This proposition has been theoretically demonstrated in different journals, but in practice, there seems to be no practical use for the BCT triple-entry accounting system. It is too early to predict if this novel idea will achieve what its proponents think it will because the commission of financial fraud is beyond keeping irreversible entries.

3.3.2 Potential Benefits of using Blockchain for Accounting Activities

In recent years, there has been increasing interest from academia, investors, and government in the potential range of applications BCT can be used for in accounting activities. Some scholars (Alarcon & Ng, 2018; Birt et al., 2019; Fortin & Pimentel, 2022; Karajovic et al., 2019; Schmitz & Leoni, 2019; Tapscott & Tapscott, 2017; Wang & Kogan, 2018) believe that blockchain is a disruptive technology with the potential to affect accounting. It is also viewed as an accounting technology (ICAEW, 2018; M. Singer, 2019a).

As explained in Chapter 2, blockchains are digital and distributed ledgers for recording and verifying transactions (Felin & Lakhani, 2018). The technology can impact the record-keeping processes from the initial transactions, processing, authorisation, and recording, to financial reporting including tax preparation (Bible et al., 2017). The technology can provide transparency, accountability and immutability of records (Weber, 2017). Blockchain can facilitate new partnerships, joint ventures and strategic alliances among firms for the creation of software development kits and applications programming interfaces (APIs) (Morkunas et al., 2019). Blockchain can change traditional methods of invoicing, contracting, record keeping, and processing of payments for trade and commerce because the technology is capable of recording and reconciling data simultaneously (CPA Canada & AICPA, 2017).

Baron (2017) lists the likely applications of blockchain in accounting to include automatic authentication processes, inventory processes and the development of smart contracts. A blockchain ledger can be developed to trigger transactions automatically (Kavita, 2018). It has been argued that blockchain has the potential to disrupt the entire accounting profession because accounting records are not alterable once committed under blockchain even by the owner of the business since all transactions and records are verifiable (Baron, 2017; Karajovic et al., 2019). Similarly, Deloitte (2016a) notes that the integrity of electronic files can easily be proved using blockchain by generating a hash string to represent the file's digital fingerprint which is immutably timestamped. Equally, EY (2018) states that BCT will provide digital trust and security for transactions.

Financial institutions’ accounts consist of various complex sets of ledgers ranging from account masters files for all customers inflows and outflows, cash-book and petty cash-book, journals, nominal ledger for the recording of expenses, bonds issuance and loan accounts (Peters & Panayi, 2016). These accounts make up the financial reporting system and accountants are responsible for maintaining these records. Yermack (2017) is of the view that firms can put all routine accounting information or ledgers on a blockchain that will be accessible to shareholders, debtors, creditors, and other stakeholders, and that these ledgers cannot be altered because they are time-stamped. Yermack further suggests that any interested parties can draw up an income statement and balance sheet without reliance on the periodic financial statements from the company and its auditors. Similarly, according to

Fortin and Pimentel (2022), BCT is a new way to measure and record financial transactions with the aid of cryptography and computer codes.

ICAEW (2018) is of the view that blockchain can provide a ‘universal entry bookkeeping’, where a single entry is shared identically and permanently with every participant. The Accounting Institute further notes that blockchain can enhance the effectiveness of the accounting process for transactions and assets, and operate as a global entry bookkeeping, thereby, empowering the accountancy profession to enlarge its scope to capture more activity and understand details of recorded transactions (ICAEW, 2018). Similarly, Deloitte (2016a) points out that the life cycle of each accounting event can be preserved on BCT with all supporting documents thereby making the entire organisation's processes across different departments, divisions and locations traceable. The technology could aggregate and reconcile different ledgers, eliminate failure and cost of intermediation, enhance transparency and independent audit of itself (ICAEW, 2018). The ICAEW emphasises further that blockchain will replace book-keeping and reconciliation work currently performed by accountants.

Peters and Panayi (2016) note that blockchain can be used for tax handling, and Dai and Vasarhelyi (2017) posit that tax filings can be automated with smart contracts. The COVID-19 pandemic brought to the fore the need for governments to find an efficient and effective digital platform to provide services and generate revenue, particularly from taxes. A blockchain platform will enable automatic tax reporting thereby creating collaboration between the tax authority and taxpayers and reducing the delay in filing and payment of taxes (Alarcon & Ng, 2018; Casino et al., 2019; Faccia & Mosteanu, 2019). The technology can reduce the possibility of fraudulent tax malpractices such as erroneous claims and tax refunds, and improve transparency in the payment of dividends (Hyvärinen et al., 2017). Blockchain is capable of ensuring that taxes are collected in real-time, where both tax authorities and companies are using BCT instead of the current retrospective tax system (Vishnevsky & Chekina, 2018). However, the use of blockchain governance to offer state services like taxation in a decentralised manner will likely depend on the diffusion of the technology and the overcoming of some of its inherent limitations.

With blockchain and smart contracts, ledgers and accounts can easily be automated in a blockchain structure (Peters & Panayi, 2016). This view is supported by ICAEW (2018) when it asserts that blockchain will not only lead to automation but will replace the bookkeeping and reconciliation process in accounting, and remove accountants from transactional-level accounting. A blockchain smart contract is an autonomous interactive piece of code for the decentralisation and delegation of services (Glaser, 2017). According to Gaggioli et al. (2019), transactions in a blockchain environment will need to trust of autonomous devices and non-human entities such as smart contracts. Contrarily, Brody (2020) suggests that for blockchains to operate efficiently at scale, they must be integrated into ERP systems. The automation of ledgers and accounts by Peter and Panayi (2016), and ICAEW appear confusing because these sets of accounts are currently automated in the existing ERP with the involvement of accountants. The issue of how will blockchain automate these ledgers and accounts without the input of accountants requires further exploration.

Yu et al. (2018) propose that blockchain will improve the quality of financial information through a reduction in disclosure errors and earning management by ensuring proper recognition, measurement, presentation, and disclosure in financial accounting. This can be achieved when organisations post all entries into the public blockchain and with the aid of smart contracts, the public blockchain can automatically produce accounting ledgers and financial statements (Yu et al., 2018). Similarly, Bradbury (2015) maintains that all transactions need to be recorded in blockchain for proper verification because validation of transactions is beyond the ordinary merging of accounting systems with a distributed blockchain ledger. Alarcon and Ng (2018) posit that BCT can potentially support error-free billing and payment processes by eliminating or minimising disputes associated with missing invoices because data is replicated, encrypted, and timestamped. Data replication on BCT ensures that the system is not shut down even if a part of a blockchain fails or is corrupted because one computer with a complete copy of the ledger can give access to others and thereby sustaining the entire system (De Filippi & Wright, 2018)

BCT smart contracts can disintermediate third parties and reduce the transaction costs of financial institutions (Morkuna et al 2019) including credit card companies such as Mastercard, PayPal, and Visa. Deloitte (2016a) asserts that the potential cost of operating BCT is minimal. Financial institutions and credit card firms have been accused of charging exorbitant fees as transaction processing fees. Hinchliffe (2020) reports that in June 2020 the UK's Supreme Court ruled that Multilateral Interchange Fees (MIFs) set by US card issuing giants Mastercard and Visa are anti-competitive. Mastercard and Visa may be forced to repay MIFs to UK merchants. Though this is still under litigation, the estimated pay-out for the UK merchants only is about £15.2 billion (€17 billion) and for other European merchants about €68 billion in damages from Visa and Mastercard (Hinchliffe, 2020). Perhaps, with BCT, such MIFs and other third-party imposed transaction processing costs will be reduced, if not eliminated.

Because of these likely applications, Birt et al. (2019) argue that with BCT, accountants and auditors are no longer required to undertake transaction processing, accounts reconciliation and control-type tasks. Similarly, Daluwathumullagamage and Sims (2020) assert that third-party services of professionals such as lawyers, brokers and bankers would not be needed in BCT-enabled corporate governance. To enjoy some of these perceived benefits, it should be recognised that blockchain has some inherent limitations, and some writers believe that BCT cannot disrupt accounting activities.

3.3.3 Limitations of using BCT for Accounting Activities

Despite the likely benefits associated with blockchain, some scholars (Coyne & McMickle, 2017; Tankersley, 2018) are still sceptical about whether blockchain has any tangible disruptive impact on the accounting profession since the technology has not been widely adopted for commercial activities. Some of the general limitations of blockchain that are considered a hindrance to its adoption were discussed in Chapter 2 (Section 2.6). These include privacy, confidentiality, scalability, security, regulation, scandals and public perceptions, and other technical issues. Nonetheless, privacy-related risk is not a new phenomenon in a digital system (La Torre et al., 2018) and the Internet was earlier viewed as a domain beyond government regulations (De Filippi & Wright, 2018). It could therefore be argued that some of these identified limitations are not peculiar to BCT only.

Privacy and confidentiality are important in the accounting record-keeping system. In a public blockchain system, it is difficult to maintain privacy due to the openness and distributed nature of the BCT system. Documents such as customers' data and other confidential records stored on blockchain are publicly accessible to all participants (X. Xu et al., 2019). Similarly, participants in BCT are not anonymous, but pseudonymous because each participant's identity is linked to a number and where a name can be linked to a participant's number every detail on BCT can be visible to everyone (Frederik, 2020). Privacy of datasets becomes a major issue where datasets are in the public domain (Banerjee et al., 2018). In a private permissioned blockchain, privacy and confidentiality of data are possible because procedures are regulated by a few authorised nodes which makes it similar to a centralised ERP system. Private permissioned blockchain is not consistent with the spirit of the Nakamoto blockchain system (Glaser, 2017). Due to its centralisation, a private permissioned blockchain can be hijacked by a few nodes thereby compromising its integrity (Coyne & McMickle, 2017).

Coyne and McMickle (2017) are of the view that blockchain is not totally suitable for accounting recordkeeping because accounting ledgers have existed to record economic activities for so many years. The digital currencies driven by blockchain exist within the technology itself, while economic dealings occur outside of accounting records. Blockchain's transaction verification and immutability features may not be useful in an accounting setting (Coyne & McMickle, 2017). Peters and Panayi (2016) caution organisations to exercise restraint in trusting blockchain with financial processes due to the technology's irreversibility structure. Halaburda (2018) shows that recording transactions on blockchain are time-consuming with huge storage and computational costs compared to a centralised ledger because of the consensus/reconciliation mechanisms and the storage of the ledger on many sites. There is no convincing evidence to show that the merits of adopting a distributed ledger offset the costs associated with its delays and duplicated storage (Halaburda, 2018). Peters and Panayi (2016) suggest the need to put in place mechanisms that will reduce human errors by developers and data hackers attempting to exploit loopholes in the financial codes. The adoption of BCT will not prevent accounting errors, asset misappropriation, and erroneous valuation of genuine transactions (Coyne & McMickle, 2017).

Where every stakeholder of a firm using blockchain prepares an individual financial statement as suggested by Yermack (2017), the outcomes will be a multiplicity of financial statements. Yermack acknowledges that such a practice will compromise the firm's privacy. Yu et al. (2018) insist that merely looking into the financial statements or transactions by shareholders is not sufficient to grasp the true picture of an organisation's financial position, cash flow situation and operating performance. Reports from some organisations currently experimenting with blockchain show that the firms record information pertaining to accounts payables and receivables on blockchain as they are not ready to store all their financial activities on blockchain (Schmitz & Leoni, 2019). This suggests that these firms still rely on ERP software, and internal and external auditors to validate the authenticity of transactions (Schmitz & Leoni, 2019).

In the preparation of accounting records, there are established conventional accounting standards that need to be followed. ICAEW (2018) posits that the integration of blockchain into the financial system requires the formulation of regulations and standards which will be a major challenge for the accounting industry. Faccia and Mosteanu (2019) are of the view that it is possible to have accounting standards and regulations built into blockchain smart contracts which will ensure complete automation of all accounting entries. However, these scholars (Faccia & Mosteanu, 2019; Yu et al., 2018) did not take into consideration that smart contracts run on programming codes themselves have inherent weaknesses and are subject to human error and manipulation. Other scholars (Gaggioli et al., 2019) are concerned about whether financial institutions will be willing to entrust their financial assets to a blockchain-decentralised system and surrender their control to anonymous users. Similarly, the regulation of blockchain becomes complex and difficult when users cut across international boundaries (Yu et al., 2018). Williams (2019) states that it is currently impossible for all BCT network users to agree on one unified standard which could be viewed as anti-innovation development.

Balanc3 is a software designed and developed to use blockchain and smart contracts architecture for processing accounting ledger as a triple-entry system (Peters & Panayi, 2016). The platform is capable of constructing, storing, managing and signing documents digitally to guarantee the integrity and security of accounting records (Peters & Panayi, 2016). Balanc3 can manage payable and receivable accounts in real-time and integrate with other accounting software systems such as

Sage Intaact, Xero and QuickBooks. These features were celebrated by BCT enthusiasts. However, Zheng (2019) reports that Balanc3 launched in 2014 is shutting down. Like Balanc3, the Factom blockchain is a decentralised publication protocol for building record systems that are immutable and independently verifiable. It enables secure storage of digital proofs for data provenance and integrity solutions without disclosing private data or requiring trusted intermediaries[12]. Some scholars (Atlam et al., 2018; Karajovic et al., 2019; Risius & Spohrer, 2017) note the future challenge that could confront all these efforts by individuals and consortia is how to synergise and integrate blockchain into an acceptable platform

Similarly, the data to be processed by accountants are very large (Yu et al., 2018) due to the huge increase in transactions undertaken by an enterprise. Auditing data quality supports the comprehension/understanding of the importance of big data for decision-making (La Torre et al., 2018). It is necessary to examine how blockchain is expected to support such large accounting data if the technology is adopted in light of some limitations of blockchain which include scalability, storage, throughput and slow processing problems. Contrarily, Wang and Kogan (2018) believe that with the increase in IT capabilities, accounting and auditing applications will not be affected by BCT's limitations such as scalability and high computational cost. Other technical issues highlighted in Chapter 2, Section 2.6 that could impact the accounting industry are the loss of private keys by users and the possibility of a 51% attack by rogue miners. The issue is what will happen to various ledgers and accounting records where private keys are lost by the holders and such a loss is known to be irreversible. Yermack (2017) posits that the BCT's decentralisation of authority can be exploited by rogue participants. Tikhomirov et al. (2018) note that miners can use secure sources of randomness, block numbers and the average time between blocks to approximate the current time to modify the timestamp and manipulate other environmental variables where profitable to do so. Researchers have provided different descriptions of the proposed BCT-driven triple-entry. There is a need to find out from practitioners their perception and workability of such innovation in practice.

[12] https://www.factom.com/factom-blockchain/

Glaser (2017) claims that despite assertions about BCT, many writers have no full grasp of how the technology works nor they can give an apt description of the basic or innovative characteristics associated with it, which creates a gap. Glaser suggests that this gap arises because of the complexity behind the interplay of blockchains and difficulty in understanding the resulting properties coupled with inadequate knowledge of information systems (IS). This rationale aligns with the position of Halaburda (2018) that there is a lack of understanding about the technology driving the blockchain system because there is no agreement as to what benefits accrue from it or what it cannot do. Most of the technology anticipated uses such as smart contracts, encryption and distributed ledger are distinct concepts and are not inherent in a BCT system (Halaburda, 2018).

It is not certain if BCT can gain a competitive advantage over the current platforms in standardised market environments despite the technology's potential cost savings from eliminating third parties from operations (Andoni et al., 2019). Mulligan et al. (2018) assert that blockchain is over-hyped because the proponents of the technology believe it can provide a solution to virtually everything. Some of these arguments and counter-arguments regarding the potential applications of blockchain by different writers demonstrate the Dunning-Kruger effect, i.e., the inability of people to recognise their ignorance in a specific domain or the false belief that they do have adequate knowledge about specific tasks and certain issues (Dunning, 2011).

Some scholars (Cai, 2021; Ibañez, 2021, May 27) made commendable attempts at demonstrating what the proposed BCT-enabled triple-entry accounting would look like in practice. But, this remains a theoretical conjecture which has no practical use case or adoption. Also, the key rhetoric by these authors is BCT will facilitate triple-entry bookkeeping by adding a third copy of the transaction or confirmation receipt. Contrarily, Risius and Spohrer (2017) posit that it is still unclear how best to harness the features and the design of BCT to meet the specific needs of any industry. Glaser (2017) notes that researchers need to first ascertain the types of transactions with their possible accrued benefits from BCT affordances and design how to measure such improvement in concrete terms because only a few studies provide convincing use cases on the likely impact of blockchain. Alboaie et al. (2018) postulate that BCT is no one-size-fits-all technology because the human element can affect the reliability and authenticity of data in any human-driven system. The irreversibility, inflexibility and restrictive nature of blockchain transactions can make it impracticable to create a blockchain smart contract that can forecast all operational contingencies or unintentional errors (Pereira et al., 2019). The next section reviews the implications of blockchain on audit.

3.4 Implications of Blockchain on Audit

This section covers a brief description of audit, some existing blockchain audit application models, and the potential benefits and disruption of BCT to the auditing profession.

3.4.1 What is Auditing?

The definition of audit or auditing is no longer defined in the Auditing Standards Glossary (Gay et al., 2018), however, there are provisions for auditors' objectives. According to ISA 200 (revised 2009), the overall objectives of the audit are:

> To obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, thereby enabling the auditor to express an opinion on whether the financial statements are prepared, in all material respects, in accordance with an applicable financial reporting framework; and to report on the financial statements, and communicate as required by the ISAs, in accordance with the auditor's findings (Para 5, p.73).

ISO 19011:2018 defines an audit as a "systematic, independent and documented process for obtaining audit evidence (records, statements of fact or other information which are relevant and verifiable) and evaluating it objectively to determine the extent to which the audit criteria [a set of policies, procedures or requirements] are fulfilled" (ASQ, 2020). A financial statement audit is a "systematic process of objectively obtaining and evaluating evidence regarding assertions about economic actions and events to ascertain the degree of correspondence between those assertions and established criteria; communicating the results to interested users" (Johnstone et al., 2016, p. 3).

An audit can be internal or external. The former is directly responsible for the management as part of the internal control mechanism to achieve the overall organisation objective. Internal audit staff are employees of an organisation. The external audit is often backed by law, it is a statutory requirement for public companies to subject their financial activities to audit. For instance, SOX Section 404(b) mandates companies to have external auditors. The aim is to ensure that the firm's reported information always reflects the economics of its transactions and the true picture of assets and liabilities, besides enhancing the confidence that stakeholders can place in the management-prepared financial statements (Johnstone et al., 2016).

Janvrin and Watson (2017) note that in the 1990s the traditional auditing scope was extended to include assurance services that focus on evaluating the viability of information and systems in different organisations. This trust (assurance) service has standard programs designed to appraise the design and effectiveness of controls appropriate to the security, availability, processing integrity, confidentiality or privacy of the information processed by the systems at an entity, a division, or an operating unit of an entity (Association of International Certified Professional Accountants (AICPA), 2020).

Management is responsible for creating a firm's financial statement, and designing and maintaining an effective internal control system over financial reporting, while the goal of external auditors is to provide opinions on the reliability of the financial statement and the effectiveness of the internal control system (Johnstone et al., 2016). The traditional function of audit has changed due to the evolving technological conditions in which auditors operate. This traditional function of audit has been expanded as a result of the ever-increasing change in technological innovation used in the business operating environment (La Torre et al., 2019). Hence, a company's managers are at liberty to conduct their business using different tools and innovations to achieve their objectives, but auditors are required to ascertain and report on the genuineness and reliability of the applied procedures. To achieve the audit's objective, La Torre et al. (2019) assert that auditors can use both the accounting system and information from external sources as audit evidence. It is therefore important to briefly examine some theoretical BCT audit application models from the existing studies.

3.4.2 Blockchain Audit Application Models

Very few empirical studies exist on the impact of blockchain research concerning accounting and auditing, but researchers developed theoretical models: Cao et al. (2018); Yu et al. (2019); and Wang and Kogan (2018).

Cao et al. (2018) examined auditing and blockchain with emphasis on auditor competition, audit quality, client misstatements, and regulatory policy in a unified framework with federated blockchain using Zero-Knowledge Proofs (ZKPs). ZKPs are used to authenticate the validity of an assertion and provide privacy protection for the assertion (Bashir, 2018). ZPKs properties include completeness, soundness, and zero-knowledge property. Bashir (2018) notes that blockchain experts are exploring ZPKs protocol because of its privacy properties to meet the requirements of industries such as finance, health and law, where privacy is a priority. Cao et al. (2018) argue that a federated blockchain using ZKPs has the potential to aid collaborative auditing and ensure the efficiency and reliability of the auditing process for fraud detection. The client's transaction information cannot be revealed beyond confirmation of requested information using ZKPs and encryption. A hybrid of public and private blockchains is referred to as federated blockchains (Casino et al., 2019). However, this model is designed for a permissioned blockchain.

Similarly, Yu et al. (2019) proposed a decentralised auditing framework based on BCT in which a third-party auditor (TPA) is eliminated from the auditing scheme. Using a PBFT consensus algorithm, they designed a Data Auditing Blockchain (DAB) to collect auditing proofs instead of bitcoin transactions. Yu et al. (2019) further claim to establish a blockchain-based auditing scheme with the potential to improve the reliability and stability of auditing schemes without a TPA. Besides decentralisation, the scheme is expected to ensure public auditability, preservation of privacy, batch auditing and traceability of auditing history.

Correspondingly, Wang and Kogan (2018) designed a framework for applying blockchain to accounting and auditing through the application of a Blockchain-based Transaction Processing system (Bb-TPS). The proposed model could be used for real-time accounting, continuous monitoring and permission management, as well as integrating with the existing ERP, thereby enhancing the integrity of information, reducing transmission cost, accelerating transaction settlement, and preventing fraudulent transactions (Wang & Kogan, 2018). However, Bb-TPS is still a prototype that requires practical validation.

Simoyama et al. (2017) propose a framework that combines triple-entry ledgers and a private permissioned variant of blockchain. Simoyama et al acknowledge that their proposal is an anti-corruption and non-technical framework that aims at checkmating corruption by enhancing transparency, and effective audit and risk awareness in Brazil or any other corruption-ridden country. The framework by Simoyama et al. (2017) is based on the permissioned blockchain system which could still be another avenue to create a corrupt system since the permissioned platform is controlled by a few nodes. However, prior studies by Cao et al. (2018); Yu et al. (2019); and Wang and Kogan (2018) are mainly quantitative studies, besides being theoretical models that require practical validations. This study is a qualitative study that will empirically explore the impact that blockchain will have on the accounting and auditing profession.

3.4.3 Potential Benefits of BCT on Audit Functions

Auditors often have to sieve through a large volume of data, place trust in management and other third parties and used to rely significantly on samples before providing a professional opinion on the financial statements to shareholders (Alarcon & Ng, 2018). These processes are sometimes fraught with anomalies which impair the judgement of auditors and subsequently affect decision-making (Rîndaşu, 2019; Rückeshäuser, 2017). Accounting and auditing professions are often confronted with Big Data kept by clients in disjointed manner which requires professional analysis (PwC, 2015). However, Deloitte (2016a) posits that using blockchain can help the auditor in the verification of large important data automatically behind the financial statements and focus on critical areas such as complex transactions and internal control mechanisms. EY (2018) supports this position by stating that BCT will enable real-time auditing and replace audit sampling by making it easier to examine every single transaction and investigate fraud.

ISA 700 (revised 2015) states that auditors should obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error.[13] The 2020 Association of Certified

[13] https://www.ifac.org/system/files/publications/files/ISA-700-Revised_8.pdf

Fraud Examiners (ACFE) reports that external auditors were only able to detect four per cent of fraud despite detection being a very important concept in fraud investigation (ACFE, 2020). Notwithstanding, it is not the auditor's main responsibility to detect fraud, but ISA 700 (revised) mandates auditors to check for material misstatements that could affect their opinions. In June 2020, the Wirecard accounting scandal dubbed "German Enron" where EY as auditors failed to detect huge financial misstatement in the company accounts which eventually led to the collapse of the German financial services firm (IndianExpress, 2020; Wright, 2020). Lemmon (2020) reports that the idea that it is not the responsibility of the auditor to detect fraud could ultimately lead to the audit profession becoming irrelevant soon because auditors have access to a firm's financial records and statements.

The reliance by the public on external audit work has been a subject of debate due to the failure of some multinational enterprises (MNEs) such as Adelphia, Enron, WorldCom, AIG, Lehman Brothers, HIH Insurance, Bond, Satyam, Fuji Xerox New Zealand and Australia in which auditors were unable to spot material misstatements. The demise of these MNEs owing to the manipulation of companies' financial records at the expense of investors, government and stakeholders remains among the darkest moments in corporate history (Bradbury, 2015). These accounting scandals have demonstrated that the external auditors were found culpable as they were not independent and failed to spot major misstatements in the financial statements (Yu, et al. 2018). For instance, in 2005, Deloitte & Touché was fined $50 million concerning its failed audit of Adelphia Communications, KPMG paid litigation charges in 2010 of $44.7 million and $24 million in respect of two US mortgage firms, New Century Financial Corporation and Countrywide respectively. In September 2020, the UK's Financial Reporting Council fined Deloitte and two of its former partners £15 million ($19.4 million) for professional misconduct in their audits of the software company, Autonomy before its acquisition by Hewlett-Packard (Cohn, 2020).

The failure of some MNEs and the criminal indictment of Arthur Andersen in 2002 reduced the number of big auditing firms from five to four (Cunningham, 2006). Ever since then governments, regulators, investors and the public have been exploring mechanisms to strengthen regulations to enhance the transparency of financial reporting and hold audit firms more accountable for their misdemeanours

(Kahan, 2006). The public outcry gave birth to regulations such as the U.S Sarbanes-Oxley Act of 2002, the China State-owned Assets Supervision and Administration Commission of the State Council (SASAC) (Chi et al., 2013; Cunningham, 2006; Pan & Seow, 2016) and the New Zealand Audit Regulation Act 2011 as well as new standards and corporate governance codes by different countries and professional bodies. Despite these efforts, the expectation gap regarding audit functions persists. The public expects auditors to detect financial fraud from any entity they have reported upon, but the audit firms' main function is to express opinion on the true and fair view of the financial statements prepared by the management. Can technology help to bridge the expectation gap in audit? Innovations like blockchain with features such as distributed shared ledger, P2P, immutability and transparency have made writers believe that this technology can disintermediate audit or benefit it.

Managers of companies have engaged in earnings management to distort financial reports for personal gain, however, with blockchain immutable and time-stamped transactions it will be difficult for such managers to manipulate sales or expenses (Yermack, 2017). Yermack further asserts that in real-time accounting, suspicious asset transfers and other transactions among related parties will not be possible in a blockchain accounting environment, because it will be easier for stakeholders to spot them (Yermack, 2017). Furthermore, Alarcon and Ng (2018) postulate that blockchain will help auditors to verify voluminous transaction data, automate, and authenticate transactions and concentrate effort on technical audit areas that require human judgement and complex problem-solving.

Simoyama et al. (2017) argue that audit work will benefit from blockchain's immutability of records, distributed database system, audit trail and cryptography. Crosley and Anderson (2018) believe that the future audit is not about auditing transactions but, rather auditing the blockchain itself, assessing and verification of people, processes and systems. Alboaie et al. (2018) point out that the audit of the future blockchain-based informatics system will require the collaboration of auditors and programmers to arrive at a workable audit solution for real-world problems. Swan (2015) suggests that a smart contract auditor, which entails an independent verification of whether blockchain-based artificial intelligence (AI) smart contracts are working as instructed, could be a likely future occupation.

Similarly, Birt et al. (2019) note that drones are being used to carry out an audit in remote places considered inaccessible, costly or dangerous to humans.

3.4.4 BCT Disruption of Audit

According to Cunningham (2006), the Big 4 auditing firms assume they are too big to fail or nothing can disrupt their dominance considering the likely impact their demise could have on the global economy. Cunningham (2006) asserts that the way the government allowed KPMG to go scot-free in 2005 despite the firm's admittance of its involvement in illegal tax shelter schemes affirms the belief that they are considered too big to fail. However, some scholars (Cao et al., 2018; Tapscott & Tapscott, 2017; Wang & Kogan, 2018; Yermack, 2017; Yu et al., 2019) believe that blockchain will at least disrupt audits if the technology does not completely eliminate audit work.

Blockchain could disrupt the auditing business by ensuring audit pricing is a function of work rather than the size of clients, discouraging misstatement of records by clients, enhancing the efficiency of audit sampling, reduction in supervision costs by the regulators, and making financial records difficult for auditors or hackers to tinker with (Cao et al., 2018). In the same vein, BCT would enable traceability of all auditing history and verification of all data by the data owner or user at any time (Yu et al., 2019). Cai (2019) believes that apart from being expensive and tedious, current accounting and auditing practices are still inadequate to prevent fraud.

BCT will abolish intermediaries and middle managers in businesses such as accounting, commercial banks and entertainment to consolidate assets and business operations (Tapscott & Tapscott, 2017). It can be an infrastructure for a decentralised economy in many domains (Vial, 2019). With blockchain, reliance on the expertise of auditors and the integrity of managers will be unnecessary since the technology can provide consumers with financial statement information with real-time accounting (Yermack, 2017). Similarly, Yu et al. (2018) suggest that blockchain can make the accounting process transparent and enhance the quality of the external audit report. Yermack further asserts that the users of financial statements can trust the absoluteness of blockchain data and use their accounting judgement for depreciation or revaluation at no cost to the users, thereby eliminating the need for auditors (2017). Similarly, Glaser (2017) argues that an audit is not required in a private permissioned system where there is no trust issue for validation and database updating because a private permissioned blockchain is nothing but an intra or inter-group technology upgrade.

In contrast, Tan and Low (2019) believe that blockchain cannot disrupt the auditing industry because the technology is still evolving. This view sits well with Galvez et al. (2018) who posit that in the administration of BCT, auditors can ascertain whether rules and regulations are complied with and verify if updated data are tainted by participants; and Yu et al. (2018) who note that an auditor will be a node in a blockchain. Similarly, the recording of entries on blockchain cannot provide suitable audit evidence for all transactions because unauthorised entries and false related-party transactions can still be executed on a blockchain (Bible et al., 2017). However, countries like the UK, Australia, China, and New Zealand have provided one or two regulatory frameworks for BCT activities. In February 2020, Australia announced a five-year National Blockchain Roadmap development which covers regulatory mechanisms, direct foreign investment and collaborations (Kalsi, 2020). Similarly, the South African Central Bank using BCT, under the experiment named Project Khoka 2, in conjunction with the Johannesburg Stock Exchange and other four leading commercial banks has successfully issued, cleared and settled debentures (Naidoo, 2022).

Boomer (2016) notes regulation is an obstacle blocking the diffusion of blockchain because regulation usually lags behind technological innovations. However, Cao et al (2018) assert that auditors and clients may be unwilling to adopt blockchain because of the market intricacies despite the associated benefits of using the technology. Cao et al. (2018) suggest that regulators are expected to coordinate and enforce the adoption of blockchain for auditing purposes to reduce financial misstatements and audit costs.

Considering the technical processes and preparation involved in the interpretation of the financial statement, users of financial statements will still require the expertise of accountants for meaningful interpretation of financial statements (Coyne & McMickle, 2017), and auditors will still be relevant (Schmitz & Leoni, 2019). This view is supported by M. Singer (2019a), who suggests that the reconciliation of accounting entries will not be completely automated on blockchain because the assessment of the accuracy of complex accounting transactions requires the professional expertise and experience of auditors. Conventionally, users of financial statements often depend on auditors to provide assurance on any company information (La Torre et al., 2019). Coyne and McMickle (2017) further argue that auditors can independently verify copies of distributed ledgers without using a blockchain. Similarly, where all participants share mutual trust and interact freely, blockchain technology will be of no use, and a centralised software platform will be the most cost-effective solution (Wessling et al., 2018).

Boillet (2017) believes that no technology has absolute error-free security and the BCT system too has inherent weaknesses. Therefore, one of the auditor's tasks will be to ensure that transactions are protected with an adequate and up-to-date security and encryption mechanism. Boillet notes that an auditor can achieve this via cyber and software auditing trusting that real-time systems will flag and interrogate abnormalities and unusual transactions as they unfold. An auditor is expected to assess the risk associated with the integrity of IT solutions, applications and controls (Boillet, 2017). It is important to ascertain and evaluate the accuracy of blockchain-based records (Perkinson & Miller, 2016). This brings to the fore how auditors will assess the risk associated with blockchain without a basic understanding of the basic logic behind BCT, sound IT knowledge and skills. The germane concern will be whether auditors as independent evaluators need to understand the programming language of blockchain. To address some of these claims, more practical applications and substantial empirical studies will be required.

Thus, it appears that there is insufficient evidence as to the general impact of blockchain technology on the audit profession. One of the sub-objectives (See **Table *1***) of this study is to examine what auditors are expected to audit in a blockchain system in light of divergent views among scholars as to the roles of auditors.

3.5 Current Status of BCT in Audit and Assurances Firms

The section briefly highlights the current status of the technology to understand the position of auditing and assurance firms towards the diffusion or adoption of

BCT. Different blockchain pilot programmes by the Big 4 accounting firms have been reported, the germane question is whether the “Big 4” audit firms are adopting BCT. The global audit market is dominated by the “Big 4” audit and assurance firms: Deloitte, Klynveld Peat Marwick Goerdeler (KPMG), PricewaterhouseCoopers (PwC) and Ernst & Young (EY).

Auditing of crypto-assets could be undertaken without relying on the participation of the “Big 4” accounting firms (O'Neal, 2019b). This point is supported by the progress made by IBM in the blockchain solution. Anujit (2019) reports that with the approval of the US Patent and Trademark Office (USPTO), IBM has patented two solutions to audit BCT networks that can certify the data integrity in any organisation's BCT-based system. Despite the immutability of entries on blockchain, the company’s stakeholders still require assurances that records on blockchain remain immutable and reliable. IBM’s patented audit solution will assist independent auditors to ascertain that the businesses have the right controls in their BCT-based system (Anujit, 2019).

Hood (2017) notes that accounting firms are proactive and innovative with blockchain instead of relying on outsiders to create new services and tools that could likely reshape accounting. All these efforts are still at the experimentation stage and not much has been put into full commercial use (Coyne & McMickle, 2017). Equally, scholars (Cong et al., 2018) have observed that the increasing migration of large accounting firms towards advisory services is a likely pointer to mitigate the effects of disruptive technologies like blockchain. Zohar (2015) sees the dominance of small groups or cartels as a big risk to the fundamental core of blockchain which is decentralisation. Manski (2017) shares a similar view when posits that BCT is a double-edged sword that can be used either to improve the sustainability of the global economy or to exacerbate inequality. Wang et al. (2018) acknowledge that in China blockchain attracts huge investment from capitalist ventures. Huberman et al. (2017) assert that “Bitcoin is a monopoly run by a protocol” but it is not regulated like other monopolies. It is evident that scholars are divided on whether the exploration of blockchain by governments, leading accounting firms and financial institutions is for protectionism or opportunism purposes. The extent of involvement and investment in BCT by the leading audit and assurance firms domiciled in New Zealand is unknown. This study examines the extent of adoption of BCT in the accounting industry.

Despite different schools of thought, huge investments have been made by governments, international organisations, financial institutions, audit and assurance firms to explore the potential of blockchain (Boomer, 2017; Wang & Kogan, 2018). Over $3 billion has been invested annually by accounting firms in BCT (Sadu, 2018). The efforts of the "Big 4" accounting firms in unravelling how the wide adoption of BCT could impact the accounting profession are ongoing. Besides audit, the accounting firms offer a variety of professional services such as tax, consulting, enterprise and financial advisory as well as other assurance-related services. The status of BCT in the top leading accounting and auditing firms is highlighted below.

3.5.1 Deloitte

Karajovic et al. (2019) report that Deloitte developed a Rubix platform to simplify and speed up the auditing process of blockchain transactions. Deloitte is using its blockchain laboratory to enhance supply chain management. Additionally, Deloitte has been reported to have been in partnership with government institutions which include the City of Rotterdam, in launching a blockchain pilot project for recording lease agreements in real estate. It also provided consultancy services to the People's Bank of China for the issuance of a national digital currency (Das, 2021). O'Neal (2019a) reports that the Bank of Ireland in collaboration with Deloitte launched a joint proof-of-concept blockchain trial and Deloitte's blockchain solution is used to verify employee credentials in some commercial banks in Ireland. Das (2021) reports that Deloitte has completed an audit of a permissioned blockchain system operated by an MNE. The audit of the blockchain protocols and applications was carried out in accordance with the professional auditing and assurance standards. Despite this laudable claim, Deloitte has not provided detailed information about the MNE involved and what business activities or operations were audited. This may be because of the commercial sensitivity of BCT.

3.5.2 Klynveld Peat Marwick Goerdeler (KPMG)

Similarly, KPMG created digital ledger services to help clients to realise some potential benefits of blockchain such as cost reduction, faster and more secure transactions, and automation of back-office operations (KPMG, 2017). KPMG partnered with IBM's Watson on cognitive computing or AI and with Microsoft on making Blockchain as a Service (Baas) (Hood, 2017, 2018; Karajovic et al., 2019) and developing a blockchain-powered solution for telecom settlements in conjunction with three software companies: Microsoft, R3 and Tomia. The firm has further partnered with the U.S. Food and Drug Administration to integrate BCT into the pharmaceutical supply chain, as well as the United Arab Emirates in the launching of a blockchain-enabled Know Your Customer (KYC) application (O'Neal, 2019a).

3.5.3 Ernst and Young (EY)

EY in partnership with Accenture is experimenting with editable blockchains (Hood, 2017; Karajovic et al., 2019). The Blockchain Analyzer crypto-related software is developed by EY as a multi-purpose solution that can be used for audit, tax, and transaction monitoring in a BCT environment. Additionally, the firm has also designed a Crypto-Asset Accounting and Tax (CAAT) software tool that enables its U.S. customers in filing tax returns regarding crypto-assets (O'Neal, 2019a). In Asia, EY is credited with launching a blockchain platform – Tattoo – which helps customers to determine the quality, provenance and genuineness of imported wines from Europe (O'Neal, 2019a). Using ZKP technology, EY's solution assists clients to undertake secure and private transactions on Ethereum public blockchain network.

3.5.4 PricewaterhouseCoopers (PwC)

PwC is proactive in exploring blockchain and cryptocurrencies by commencing receipt of Bitcoin as a mode of payment in 2017 and developing blockchain as digital assets for global client services (Hood, 2017; Karajovic et al., 2019; O'Neal, 2019a). Besides its partnership with Northern Trust, an asset management company, to facilitate BCT real-time audit and transparent transactions (Partz, 2018a), PwC is providing advisory services on the issuance of a US dollar-backed cryptocurrency in collaboration with *Cred*, a decentralised lending platform (Partz, 2018b). PwC also released a cryptocurrency auditing software solution that is said to be capable of auditing companies in cryptocurrency businesses (O'Neal, 2019b). The firm claims to have undertaken an audit of *Tezos*, a large scale blockchain cryptocurrency company (O'Neal, 2019a).

However, the auditing profession is driven by standards that hinder the profession from embracing any new technology unless it is approved by the standard-setting board (Issa et al., 2016). The current scope of the audit is “regulation-driven” (La Torre et al., 2019). Perkinson and Miller (2016) note that it is difficult to envisage how blockchain will navigate the intricacies of accounting standards and financial reporting. The adjustment of the current auditing standards to accommodate any disruptive innovation may be difficult for the auditing profession because the standards are formulated to suit the traditional auditing processes (Issa et al., 2016). Efforts are ongoing by accounting standards-setter institutions, IASB and IFRS, to provide guidance on the accounting transactions involving cryptocurrencies (Leopold & Vollmann, 2019). Faccia and Mosteanu (2019) believe that BCT triple-entry system can accommodate the programming of accounting standards and regulations with the aid of smart contracts. Hence, it is important to examine what auditors are expected to audit in a blockchain environment. The oncoming wave of adoption further underlines the need for an empirical study to ascertain how BCT is being diffused in the accounting and audit profession.

The Big 4 have expanded the scope of their trading to include assurance and consulting services. As innovators and to remain relevant, they have invested heavily in emerging innovations such as BCT, AI, and IoT to meet the needs and aspirations of their clients and enhance their operations. These accounting and assurance firms are continuing to make innovative efforts to exploit different BCT applications to meet the ERP needs of their clients and for accounting and auditing purposes. The leading global accounting and assurance firms have shown their innovativeness by partnering with some leading IT technology companies and among the recent breakthroughs are the offering of BaaS, and software for auditing cryptocurrencies. It could be argued that BCT will likely be another tool that accounting firms could use to provide consulting and IT services to their clients. Consequently, the technology may not disrupt the auditing profession as was envisaged by some pro-BCT innovations.

3.6 Fraud Prevention and Detection in a Blockchain Environment

This section provides a background on the challenges of detecting financial anomalies and financial losses as a result of fraud. It examines BCT prevention and detection mechanisms, the effects of the GIGO conundrum and how the technology has been said to be exploited for cybercriminal activities.

3.6.1 Background on Financial Fraud

In the digital age, financial fraud has increased with consequences for the global economy (Lewis, 2018). In 2019, the financial cost of global fraud and error was estimated to be over USD 5 trillion or £3.89 trillion (Gee & Button, 2019). Fraud offences are a growing concern for businesses and governments globally (Freitas, 2020). Some studies have traced this phenomenon increase in financial fraud to the advent of technological innovations such as computers and the internet (Tapp & Burg, 2001; Wei et al., 2013). Similarly, the use of other technological innovations has added to the rise in the commission of fraud in every business (Lewis, 2018). The use of the internet has made it easier for cybercriminals to defraud individuals, companies, and government (Ali et al., 2019; Huang et al., 2018). Besides the new challenges and opportunities, emerging technologies are changing the landscape of politics, global markets and human interactions (Gee & Button, 2019). Similarly, new technologies and innovations such as AI, Bitcoins, and IoT have been identified to enhance the efficiency and effectiveness of people and companies including cybercriminals (Gee & Button, 2019; Lewis, 2018). Tackling an imminent cyberattack is a critical challenge for governments and companies that rely on information and communication technology (ICT) for their operations (Huang et al., 2018).

Prior studies have examined factors responsible for the increase in fraud and near failure of the existing system to detect anomalies. Fraud detection is a major challenge confronting so many businesses. Wei et al. (2013) assert that the features of most online bank frauds were due to an imbalanced large data set, weak forensic evidence, and uniqueness of fraud behaviour and patterns. Real-time detection and weak predictive accuracy are among the challenges of the existing fraud detection system (FDS) due to the creation of an improper complex detection model (Abdallah et al., 2016). As most of these technologies are poorly protected, cybercriminals capitalise on the loopholes or cracks in any platform to defraud users and destabilise their operations (Huang et al., 2018; Lewis, 2018). Perpetration of online fraud by cyber-criminals remains high because there is little or no synergy of effort among financial firms, regulators and people due to concern about data privacy (Ali et al., 2019; Meng et al., 2018).

Ahmed et al. (2016) note that an anomaly detection is a tool that is considered useful in identifying irregularities not only for financial fraud detection but also in other fields such as computer network intrusion and human behavioural analysis. Prevention and detection of fraud have been identified as the appropriate protection tool against fraud since the fraud prevention system (FPS) alone is not adequate (Abdallah et al., 2016). Prevention of fraud and discovering anomalies in financial transactions are considered important to companies due to pressure and scrutiny from government agencies and shareholders (Khan, 2006, as cited in Digabriele, 2008, p. 331). Kokina et al. (2017) suggest that fraud prevention and waste reduction are critical research future areas in BCT that need to be explored. As a FinTech, blockchain could enjoy users' patronage if the technology prevents and detects financial fraud. Thus, can the blockchain support real-time detection and solve the weak predictive accuracy of the existing FDS?

3.6.2 Prevention and Detection Mechanism in BCT

Blockchain has been said to have inbuilt features that can prevent and detect fraud due to its distribution, P2P, cryptography security and immutable nature. As earlier explained in Chapter 2 2.5, these features caused some scholars to conclude that the technology is not prone to fraud or anomalies.

Scholars (Meier & Stormer, 2018; Rechtman, 2017; Tapscott & Tapscott, 2017; Wang & Kogan, 2018) believe that blockchain could help prevent and detect fraudulent transactions. Kshetri (2017) claims that there is no single point of failure or vulnerability in blockchain. Similarly, Taleb (2019) believes that fraud has a zero percentage of occurrence in a blockchain. Banerjee et al (2018) assert that blockchain can facilitate self-resuscitation of records from a hacking intrusion, trace its history and force the firmware to roll back to its prior position using a *forking* protocol. No detection mechanism is 100% impenetrable but compromised systems should have an inbuilt self-healing mechanism like blockchain (Banerjee et al., 2018).

Ali et al. (2019) believe the use of blockchain's cryptographic system could help to achieve privacy-preserving collaboration among the stakeholders. Similarly, blockchain can allay fears about privacy with transparency and cryptographic security mechanism. (CAANZ, 2017). However, one of the challenges identified with the adoption of blockchain is the privacy of information due to the distributed and transparent nature of the technology (Banerjee et al., 2018). Conversely, Coyne and Mcmickle (2017) suggest that confidentiality may not pose any significant threats to the adoption of blockchains for accounting because transactions can be verified and preserved without exposing private data to a third party. The digital signatures on blockchain can reduce the risk of fraud or theft (Deloitte, 2016b)

Blockchain can be used in government functions to improve the provision of services, transparency, the security of monetary systems, and the prevention of criminal activity (Steinmetz, 2018). The verification procedure and consensus instrument can prevent technology from failure and fraud without the need for a central regulator (Pereira et al., 2019). Falsification of transactions or double-spending is difficult in a blockchain-distributed ledger because ledgers are replicated on all network nodes and validation is done through consensus, this readily leads to automatic identification and correction of any false transactions (Pereira et al., 2019). For instance, the outbreak of COVID-19 has raised global consciousness of the need to strengthen digital trade, and some writers assert that blockchain technology will be a transparent and cryptographically secure solution. In contrast, Coyne and McMickle (2017) posit that the adoption of a blockchain is not a substitute for instituted controls by accountants to check accounting errors, earnings management and fraud. However, total elimination of financial infractions is not feasible on a blockchain, but the technology improves the recognition of fraud in real-time accounting (Wang & Kogan, 2018).

3.6.3 BCT and Garbage in Garbage out (GIGO)

From the above analysis, so many writers believe that BCT can prevent and detect fraud. However, it is important to note that the computer does not think, but merely follows instructions given to it. Kothari (2004, p. 373) posits that "if poor data or faulty programs are introduced into the computer, the data analysis would not be worthwhile". This proposition assumes that information is as good as its source(s). It means bad inputs will generate bad outputs (Seland, 2018; A. W. Singer, 2019).

Ferris (2018) notes that the likelihood of blockchain reducing the misappropriation of assets is high, but the technology is said to be ineffective against collusion, corruption, and financial statements fraud. This position is supported by (Bible et al., 2017) when they assert that transactions posted in blockchain can still be unauthorised, illegal, fraudulent, between related parties or wrongly classified in the financial statements. Equally, BCT cannot protect against fraud based on feeding "garbage" information into it because it is possible for authorised personnel to make an unauthorised change undetected (Ferris, 2018). Treiblmaier and Beck (2019) moot that BCT alone cannot authenticate the genuineness of the recorded information. Ahmed et al. (2016) note that the absence of effective general-purpose anomaly detection techniques is due to the advancement in computing and the proliferation of data repositories, an anomaly detection tool in one field may be unsuitable for other fields. There is no consensus among scholars as to whether blockchain parameters can effectively tackle the challenges of GIGO. Thus, this study intends to find out if the GIGO concept applies to BCT or not, and whether the technology anomaly detection techniques can prevent and detect all fraudulent transactions.

3.6.4 Use of BCT for Fraudulent Activities

Despite some of the highlighted BCT mechanisms for fraud prevention and detection, the technology is said not to be 100% flawless and has been used by cybercriminals for different fraudulent activities including Ponzi schemes. Kshetri and Voas (2017) assert the diffusion of cryptocurrencies is partly responsible for the increase in the incidence of ransomware because extortionists can be anonymous on BCT unlike existing payment system with more traceability. However, online fraudulent activities are not limited to the use of BCT, cybercriminals can use any innovative IT platform for nefarious activities which have undesirable consequences.

Fraud can be perpetrated on the BCT if the input data is tampered with, and the technology does not authenticate transactions in the real world because the recording of items on the BCT does not translate to actual physical exchange (Schmitz & Leoni, 2019). The technology cannot detect deceit (Bradbury, 2015) and cannot serve as an alternative to the current accounting ledger system (Coyne & McMickle, 2017). Yeoh (2017) notes that blockchain cannot prevent fraud executed by collusion among participants. Similarly, Kokina et al. (2017) assert that blockchain cannot prevent the theft of property when used for payment purposes. Pereira et al. (2019) posit that blockchain is much more expensive at both the verification and storage stages. Simoyama et al. (2017) note that transactions are not the main sources of corruption, but things that go along with payments such as negotiations, agreements and deliveries which can easily lead to the misappropriation of funds.

Due to reliance on communications, most P2P protocols are vulnerable to attacks such as Sybil, Man in the Middle and Denial of Service (Reyna et al., 2018). M. Xu et al. (2019) claim that notwithstanding the encryption and anonymity of transactions in blockchain, it is still possible for data to be hacked into it. Hackers are often motivated by financial gain (Gee & Button, 2019). The anonymity provided by blockchain is to the advantage of cybercriminals. Security issues affecting Ethereum include an unfamiliar execution environment, sub-optimal high-level language, anonymous financially motivated attackers, and limited ability to patch contracts (Tikhomirov et al., 2018) as well as deanonymisation which was highlighted in Chapter 2 (Section 2.6.1). Insecurity in smart contracts is attributable to the difficulty of detecting anomalies between their intended and actual behaviour (Atzei et al., 2017). For instance, the hacking of *MtGox*, and *Mintpal* in 2014 earlier discussed in Chapter 2 (Section 2.6.5) are classical examples of fraud in blockchain. Similarly, in smart contracts, the creation of an abnormal contract could be a result of Denial of Service (DoS) attacks for resource wastage, token theft and business logic of smart contracts (Chen et al., 2020). However, the BCT database is less vulnerable to hacking because hackers need to manipulate the entire technology-distributed architectural system to achieve this unlikely task (Friedlmaier et al., 2018).

Bitcoin and blockchain smart contracts are new digital technologies for Ponzi schemes to explore. Vasek and Moore (2015) classify Ponzi schemes on Bitcoin into four categories: high-yield investment programs (HYIP), mining investment scams, scam wallet services and scam exchanges. HYIP is a fraudulent scheme that allows investors to gain money from the investment made by new entrants. According to a survey of Bitcoin scams conducted by Vasek and Moore (2015) between 2011 to 2014 about $11 million worth of Bitcoin has contributed to the scams and only $4 million has been returned to the victims. Bartoletti et al. (2020) describe the Ponzi scheme on Ethereum as “Smart” Ponzi schemes. Online fraudsters leverage smart contracts features of anonymity, transparency, security, immutability, and unstoppable program to lure both unsuspecting and greedy investors.

Bartoletti et al. (2020) divide the security vulnerabilities of the implementation of Ponzi schemes into those harming investors and those harming the scheme itself. Those harming investors are a result of bugs in the blockchain code which are unintentional but enable the owner of the scheme to profit at the expense of investors, while those harming the scheme expose the scheme to DoS attacks or blackmailing. In both Bitcoin and Ethereum blockchains, it is difficult to identify the scammers and quantify the amount of gain accrued to them due to the multiplicity of addresses or accounts (Bartoletti et al., 2020; Vasek & Moore, 2015). Fraud prevention and detection will be a new challenge for forensic accountants and auditors in a blockchain environment.

Fraud raises significant concern for accountants and auditors because of the trust that the public place in the accounting profession. The possibility of fraud in any financial environment is high. This led Yu et al. (2018) to point out that misrepresentation of records is possible in both manual and automated accounting systems as is the falsification of transactions to suit the personal interest of management or major shareholders. The occurrence of errors is possible in all spheres of human endeavours which include end-user programming (Phalgune et al., 2005). Similarly, Rückeshäuser (2017) observes that industrial and academic advocates of blockchain-based accounting have not taken proper cognisance of the involvement of the top management in accounting fraud particularly their ability to override existing control systems. It could be said that where top management can override internal control of which blockchain will be a part, fraud can still be perpetrated within the technology. For instance, the executive management of Autonomy hid major losses on computer hardware sales and re-classified them as marketing expenses thereby misstating the firm’s financial performance (Cohn, 2020). Equally, it is important to know what will auditors likely do in such a situation. Pereira et al. (2019) note that there is a high chance of misconduct and fraudulent activities since blockchain does not rely on the trustworthiness of the users. Similarly, in a BCT environment where a loss of a private key will result in a total loss of transactions or assets associated with that key.

It is evident from this analysis that there is no consensus among the researchers as to what blockchain can do concerning the prevention and detection of fraud and if the technology can overcome the GIGO conundrum. As noted by Huang et al. (2018), without a thorough understanding of the cybercrime ecosystem, it will be difficult to effectively tackle cyberattacks. Halaburda (2018) asserts that outside Bitcoin or crypto-assets, there is no technology yet that offers "permissionless distributed ledgers that cryptographically assure immutability without a need for trusted third parties" (p. 29).

In summary, several studies which have examined the theoretical applications of blockchain have referred to the technology as a database (Tankersley, 2018); a database engine in an accounting system (Tan & Low, 2019); a decentralised autonomous corporation (Swan, 2015a); as augmented audit (Smith, 2018a) and an institutional technology and a new method of organising economic activity (Davidson et al., 2018). Furthermore, previous studies by Wang and Kogan (2018) designed a framework for applying blockchain to accounting and auditing through the application of a Bb-TPS. Similarly, Cao et al. (2018) used a unified framework to analyse the effects of blockchains for financial reporting and auditing, Yermack (2017) explored corporate governance and blockchain, and Gupta et al. (2018) examined Hyperledger fabric using blockchain. Cai and Zhu (2016) analysed the application of blockchain to rating fraud for online businesses, Karajovic et al. (2019) examined the broad implications of blockchain in the accounting industry, and Hyvärinen et al. (2017) evaluated whether blockchain could solve tax fraud.

This study seeks to understand the effectiveness of blockchains in the prevention and detection of fraud. The next section discusses the requisite skills needed by accountants and auditors in the blockchain domain.

3.7 Technical Skills required by Accountants and Auditors in a BCT Environment

This section examines the relevance of whether accountants and auditors require any special skillsets in a BCT environment. In a rapidly changing business world, research suggests that the accounting industry requires professionals who are not only technically sound in AIS but could also handle complex IT requirements in accounting services and operations (Pan & Seow, 2016; PwC, 2015). Technological advances are possibly going to have an impact on different aspects of accounting and auditing functions (Lord, 2004; Tanaka & Sithole, 2015). The issue is whether an advanced technology like blockchain will require accountants and auditors to understand programming languages or algorithms and advanced IT skills to operate effectively in a BCT environment.

Oesterreich et al. (2019) describe IT skills as "skills in human-computer-interaction, digital competence and understanding that involve the ability to communicate with computers and machines, detailed IT-know-how and use of IT applications (e.g., ERP, MS office and other computer programs)". Implementation of new technologies across many professions and industries is compelling many professionals to upgrade or acquire new skill sets to fit into a digital environment as accelerated technological advances are obsoleting many skills (Berger & Frey, 2016). Moll and Yigitbasioglu (2019) argue that little or no attention has been given to how new technologies will impact the functions of accountants, or the new skills and competencies required of accountants to remain relevant and navigate the digital domain. Some scholars have suggested the inclusion of BCT courses for accounting and business students (Stern & Reinstein, 2021), and the integration of technology and data analytics skills into the accounting curriculum (Andiola et al., 2020).

However, the importance of IT skills has been at the forefront of the research conducted in the accounting industry by academics (Botes, 2005; Duff et al., 2019; Huang & Vasarhelyi, 2019), practitioners (Deloitte, 2017; PwC, 2015) and professional institutes (Association to Advance Collegiate Schools of Business, 2020; CAANZ, 2020a; ICAEW, 2018). The transformation impact of technologies compelled the Pathways Commission (2012), set up by the American Accounting Association (AAA) and the American Institute of Certified Public Accountants (AICPA) to study the future structure of higher education for the accounting profession, to recommend integration of accounting programs with emerging accounting and business IT throughout their academic curricula.

CAANZ (2020b) emphasises that the combination of innovative technologies, intense competition and globalisation are major factors that will challenge and disrupt the accounting profession because automation is facilitating new providers to gradually take over the core accounting activities. Auditors may be required to provide financial valuation and regulatory guidance concerning the relevancy of blockchain to clients as well as the diffusion of such innovation. The likely issue will be how will accountants or auditors function without basic knowledge and understanding of blockchain. Dai and Vasarhelyi (2017) note that the technicality involved in the audit of smart contracts is complex and it will require auditors to possess the requisite skills and understanding of the technology. No wonder Brazina and Ugras (2018) insist that auditors must be conversant with the technologies adopted by their clients and comprehend the kinds of internal controls to checkmate any significant misrepresentation. Dai and Vasarhelyi (2017) suggest the need for future research to examine what knowledge and training should accountants and auditors acquire to function in the blockchain-based AIS and what training will enable them to understand, design and audit smart contracts?

Brazina and Ugras (2018) suggest that one way to gain credibility in an automated accounting environment is to pursue a recognised technology credential such as the AICPA's certified information technology professional (CITP) or Certified Information Systems Auditor (CISA) qualifications. These qualifications can help to hone skillsets in emerging innovations, IT system audit, business solutions and security. As discussed in Chapter 1 (Section 1.2), the opinions of scholars (Appelbaum & Smith, 2018; Bible et al., 2017; Pimentel et al., 2021; Stratopoulos & Calderon, 2018) were divided as to whether accountants and auditors need to understand the basic programming behind the blockchain technology or not. The relevance of learning programming codes to professional accountants remains a debatable topic. However, the understanding of the core accounting functions should not be neglected for the understanding of programming codes. Proficiency in different AIS software will be sufficient for accountants to operate in a different IT environments including BCT. Thus, this study seeks to explore whether accountants and auditors require higher technical skillsets in a BCT environment.

The benefits of using blockchain include a reduction in accounting-related expenses due to the automation of accounting transactions, enhancing the transparency of transactions among stakeholders, elimination of fraud, and reduction in false information and misrepresentation (Alboaie et al., 2018; Faccia & Mosteanu, 2019; Gröblacher & Mizdraković, 2019; Schmitz & Leoni, 2019; Yu et al., 2018). Faccia and Mosteanu (2019) claim that accounting standards and regulations can be programmed using smart contracts in blockchain triple-entry account systems and automation of tax filings. It is unclear if blockchain would be better than a traditional ERP system in tracking accounting transactions (Coyne & McMickle, 2017). It is evident from some of the reviewed literature that blockchain could be an opportunistic platform for changing the existing business model or a protectionism tool in the hands of capitalists. It could be argued that accountants will still be relevant irrespective of the software adopted. Consequently, this thesis intends to examine how will blockchain disrupt or enhance the accounting and auditing profession, prevent, and detect fraudulent transactions.

3.8 Summary

This literature review highlighted the implications of blockchain as it affects accounting, auditing, and the prevention and detection of fraud. Some scholars have challenged the relevance of double-entry bookkeeping in a digital age and proposed triple-entry accounting as a way forward. The chapter further juxtaposed the workings of existing ERP with blockchain smart contracts solutions. The advent of blockchain is believed to be a technology that can be leveraged to accomplish the realisation of triple-entry accounting. The BCT-enabled triple-entry system is still in various experimental stages and is not yet fully adopted for financial reporting and accounting purposes. It may be difficult to ascertain its relevancy and potential to disrupt the existing double-entry accounting system. Despite this advocacy for a new way of bookkeeping, this study revealed that the double-entry system remains the fulcrum of the accounting system.

The chapter discussed the responsibilities of management and auditor vis-a-vis their involvement with the financial statements and changes brought about by technology to the traditional functions of the auditor. It also explored and provided insights into the issues surrounding BCT concerning whether the technology can eliminate audits or not. It further examined the benefits and limitations of blockchain smart contracts. The unique features of BCT led some writers to assert the possible elimination of auditors in a BCT environment. Some further suggested that the technology will not eliminate the auditor, but that the auditor will be a node in a BCT system. These pro- and counter-arguments may likely continue until BCT is adopted as one of the mainstream technologies. Audit roles may not go away because they are statutorily required by law, and many investors may not rely on unaudited statements irrespective of the technology underlying such financial records.

The chapter reviewed how the prevention and detection of fraud in blockchain could affect the adoption of the technology as well as the likely effect of GIGO. To better understand the potential of blockchain and its inbuilt fraud prevention and detection mechanisms, it was important to explore the wide-ranging blockchain literature. Thus, the insecurity of smart contracts, Ponzi schemes and cyberattacks were briefly discussed. It was evident that no prevention or detection of fraud mechanism is 100% resistant to corruption, and blockchain is not an exception. BCT's inbuilt fraud prevention and detection mechanisms associated with the operations of cryptocurrencies have led some writers to believe that the technology could help in eliminating fraudulent financial transactions. The technology is said to have no single point of failure. However, despite these claims, the security vulnerability of BCT was exploited in some cryptocurrency platforms which has led to a massive loss in investment. It could be argued that, as is common in other technological innovations, the human interface is the weakest link in BCT operations.

In this context, the chapter highlighted the importance of empirically examining whether blockchain can enhance or disrupt the accounting and auditing profession by engaging blockchain start-up firms, professional accountants, and members of academia. The thesis argues the need for an empirical study to ascertain whether blockchain can prevent and detect fraud if BCT ledgers require no audit verification and validation and how accounting practices will change in a BCT-based environment. Additionally, the chapter examines the likely skillsets required of accountants and auditors in a blockchain AIS. Blockchain is an important concept warranting further study for both theoretical and practical reasons, in both the accounting industry and for its general applicability. The Big 4 accounting firms are innovators in the adoption of BCT since they are at the forefront of piloting different BCT experimentation programmes. The next chapter discusses the Technological, Organisational and Environmental (TOE) framework and which is the theoretical framework underpinning this thesis.

Chapter 4

Theoretical Framework – Technological, Organisational and Environmental Framework

4.1 Introduction

This chapter discusses the theoretical framework adopted in this study to explain the perceptions of the participants about factors that can potentially enable or inhibit the disruption and adoption of the accounting and auditing profession by BCT. In an era of rapid technological advancement, it is inadequate to have a prescriptive or narrow framework to understand the disruptive effect of any technological innovation and the multi-dimensional factors affecting the adoption of emerging technologies. The study expanded the Technological, Organisational and Environmental (TOE) framework with consequences of innovation context to empirically explain BCT adoption and disruption of the accounting and auditing profession. It explores incentives and barriers to BCT disruption of the accounting and auditing profession, as well as the unintended consequences of adopting the technology as a FinTech. The study further attempts to ascertain whether there are organisations that have adopted BCT for financial reporting and accounting systems.

The first part of this chapter provides an overview of the adoption theories of innovation. The second section explores the TOE framework, and the three contexts underpinning this theory, and highlight studies that have used it as a theoretical framework. The next section explores the choice of the TOE as a theoretical lens. The last section provides a summary of the chapter.

4.2 Overview of Innovation Management Theories

Innovation is described as a significant source of disruption for organisations, and organisations are expected to manage innovation wisely (Dodgson et al., 2014). Innovation adoption is a process followed by an organisation to adjust to its environment for operational sustainability and effectiveness (Damanpour & Gopalakrishnan, 1998). Gupta et al. (2007) define innovation as the creation or appearance of a new idea. Disruptive innovation or technology is described as change that makes previous products, services and/or processes ineffective (Millar et al., 2018, p. 254). To differentiate disruptive innovation from disruptive technology, Millar et al. (2018) describe the former as organisational change or introduction of a product, service, or process that disrupts the operations of current stakeholders in the industry and the latter as a technology with the potential to produce disruptive innovation.

The complex processes associated with the adoption of emerging technologies and innovations have made innovators, practitioners, academics, and technology users interested in understanding, managing, and predicting their adoption or diffusion (Lyytinen & Damsgaard, 2001). Similarly, Kilkki et al. (2018) posit that the volatile and challenging effect of ever-changing technological development is one of the significant problems of the digital era. BCT has been described as a disruptive innovation that can upend many business models, including the accounting and auditing profession. However, Yu and Hang (2010) argue that disruptive innovation is not synonymous with the upending of existing or traditional businesses. This study regards BCT as a disruptive technology because the technology has the potential to create disruptive innovation.

Dodgson et al. (2014, p. 10) succinctly put it, “there is no unified theory of innovation management, just as there is no unified theory of innovation”. Most studies conducted on the adoption of innovations apply different theories of innovation adoption to understand the factors underpinning the acceptance or rejection of innovation. Several models for understanding and predicting the adoption of innovation by researchers exist, and some of these models are deeply rooted in psychology, sociology, communication, and information systems (Taherdoost, 2018; Venkatesh et al., 2003). Researchers can use any of these models either as a single theory or as combined theories to explain the factors behind diffusion or non-diffusion of innovation and information systems (IS).

Some of the widely used innovations of adoption theories include the Theory of Reasoned Action, Technology Acceptance Model, Theory of Planned Behaviour, Theory of Interpersonal Behaviour, Unified Theory of Acceptance and Use of Technology (UTHAUT), Diffusion of Innovation (DOI), Electronic Data Interchange (EDI) adoption model, Disruptive Innovation Theory (DIT), TOE framework, and Social Cognitive Theory (Baker, 2012; Kuan & Chau, 2001; Lou

& Li, 2017; Milosavljevic et al., 2019; Reinhardt & Gurtner, 2018; Rogers, 1962; Rogers, 1995; Straub, 2009; Taherdoost, 2018).

The theory of Reasoned Action (TRA) is initially designed for sociology and psychology studies to study and predict human behaviour but was later modified to study the individual acceptance of technology (Taherdoost, 2018; Venkatesh et al., 2003). The model relies on three constructs of human behaviours attitude, social norms and intention which are expected to be rational, systematic, and volitional. Technology Acceptance Model (TAM) Theory is used in the context of IS for the prediction of IT acceptance and its usefulness. The core constructs of the theory used to explain the rationale for adopting innovation are perceived usefulness, perceived ease of use and subjective norm (Taherdoost, 2018; Venkatesh et al., 2003). However, the limitations of TAM include, that it cannot be applied to all new cases of new technology adoption (Lou & Li, 2017), and cannot ascertain the level of user acceptance after the implementation of IT systems (Davis, 1993). The Theory of Planned Behaviour (TPB) is said to be an extension of TRA. Ajzen (1991) explains that TPB postulates that behaviour depends on beliefs or salient information relevant to the behaviour. Taherdoost (2018) notes that the three constructs influencing behavioural intention are attitude towards behaviour, subjective norm, and perceived behavioural control. The Theory of Interpersonal Behaviour is an offshoot of TRA. Some scholars (Taylor & Todd, 1995) combined features of TAM and TPB to predict the acceptance of technology by users. The use of TAM and TPB theories is considered unsuitable for this study because of the identified limitations inherent in these theories for this thesis. BCT is an evolving technology, and it is yet to be adopted for financial accounting and reporting applications, thus, TAM theory cannot be applied to this thesis.

Rogers' DOI is a widely employed theoretical model to study the adoption of technology in ERP and EDI, IS and IoT (Chen & Ni, 2019; Hsu & Yeh, 2017; Ilin et al., 2017; Oliveira et al., 2014; Surry & Farquhar, 1997). Some scholars claim that DOI is the most suitable theory in use for exploring factors influencing the adoption of an innovation or new technology (Al-Jabri & Sohail, 2012; Hameed et al., 2012; Ilin et al., 2017; Straub, 2009). DOI has been used beyond its initial domains of anthropology and sociology to study diffusion in other fields such as education, public health and medicine, communication, marketing and management, economics, and others (Rogers, 2003). However, Perdana et al. (2020) note that DOI is unable to provide sufficient information on the extent of an organisation's IT adoption and implementation. One of the objectives of this study is to understand the extent of BCT adoption and implementation for financial accounting and reporting purposes. The use of DOI for this thesis was deemed not suitable given that the level of BCT diffusion was still evolving.

Similarly, Clayton Christensen in his 1997 book, “The Innovator’s Dilemma” propounded disruptive innovation theory (DIT). Christensen brought to the limelight the use of the terms disruptive technology and disruptive innovation, and his book generated discussions about the nature of disruption (Kilkki et al., 2018). Among identified features of disruptive innovation is changing the value proposition compared to the existing technology, and the small entrant firms are at advantage in a disruptive market because the market leaders see no reason for the innovation (Christensen, 2000; Christensen et al., 2006). DIT could have been a useful theory to explore BCT disruption of the accounting industry, but this study did not find any organisations that have adopted BCT for financial accounting and reporting systems. Consequently, it may be difficult to measure BCT's success with some of the proposed yardsticks for measuring disruptive innovation by Christensen. It is for these reasons that this study rejected the use of DIT as a theoretical lens.

Straub (2009) believes that complex factors surrounding the adoption of technology make it difficult for a single theory to explain why people or organisations adopt innovation or new technology. Ajzen (1991) notes that it is difficult to explain all human behaviours because many factors influence behaviour. BCT requires an interdisciplinary approach to achieve wider theoretical and empirical perspectives. Similarly, Hameed et al. (2012) point out that since there is no single theory of innovation adoption that is one-size-fits-all, researchers have been employing different theories and theoretical models to elucidate the adopter’s attitude and innovation adoption behaviour in IT adoption. However, the TOE framework presents a flexible framework to understand the process of technological innovation (Baker, 2012), and Modiba and Kekwaletswe (2020) note that the three constructs of TOE influence how organisations interpret, pursue, and accept emerging technologies. The TOE framework is said to be compatible with Roger’s DOI and its generic nature has made it useful for studying different types of IS innovations (Choi et al., 2020; Zhu et al., 2003; Zhu et al., 2006). Previous studies have integrated the EDI adoption model with the TOE framework to examine innovation adoption (Kuan & Chau, 2001).

The TOE framework is the most relevant to the aim of this study, given the importance, this framework places on technological, organisational, and environmental contexts influencing the adoption of emerging technological innovations such as BCT.

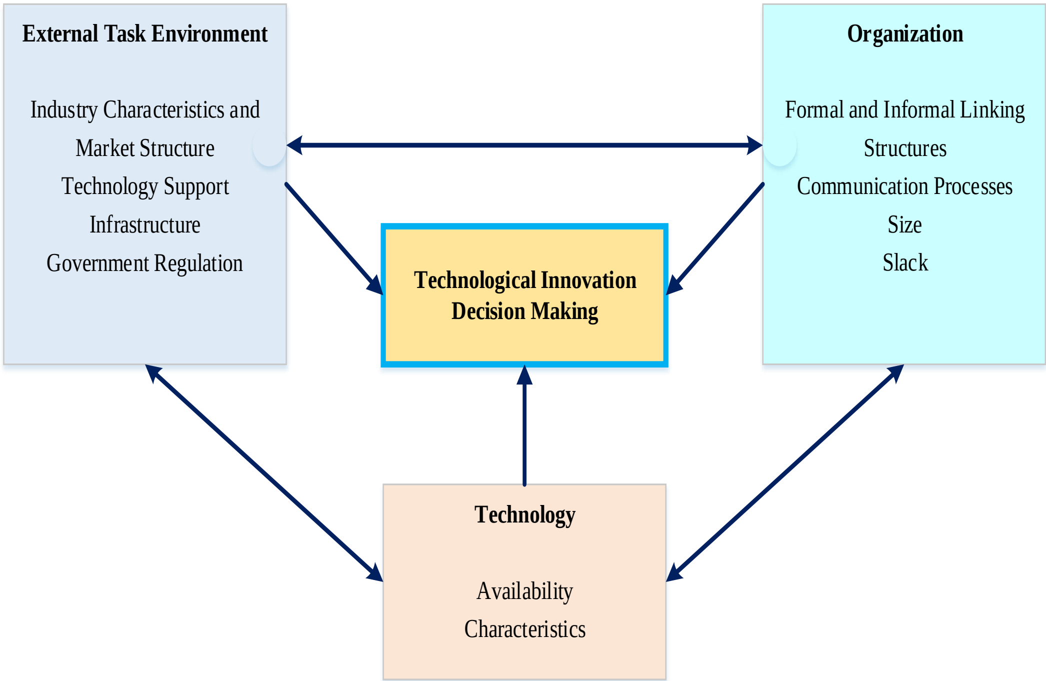
4.3 Technological, Organisational and Environmental Contexts Framework

The process by which an organisation adopts and implements technological innovation is influenced by three contexts: technological, organisational, and environmental (DePietro et al., 1990). The three contexts were developed from the users' perspective of what influenced their decision to adopt or reject an innovation.

The organisational context is the most significant factor in the adoption of IT innovation in the organisation (Clohessy & Acton, 2019). It encompasses internal related issues which include the firm's structure, size, management structure, resources, and communication (Kouhizadeh et al., 2021; Oliveira et al., 2014). An organisation's structures and processes could limit or enhance the adoption and implementation of new technology (Tornatzky & Fleischer, 1990). The technological context includes useful technologies that are available internally and externally to a firm. A firm's decision to adopt a new technology depends not only on the technological context of the industry in which an organisation operates but also on how well the new technology matches the existing firm's infrastructure (Tornatzky & Fleischer, 1990). The external environmental context which includes competition and infrastructure support can influence the adoption of any innovation (Museli & Navimipour, 2018; Tornatzky & Fleischer, 1990). As the external environment influences the adoption of innovation by organisations, an organisation can also shape the adoption of innovation in a particular industry (DePietro et al., 1990). The consequences of innovation adoption were derived from the Roger's DOI theory. Rogers (2003) emphasised the importance of the exploration of consequences innovation adoption by innovation researchers.

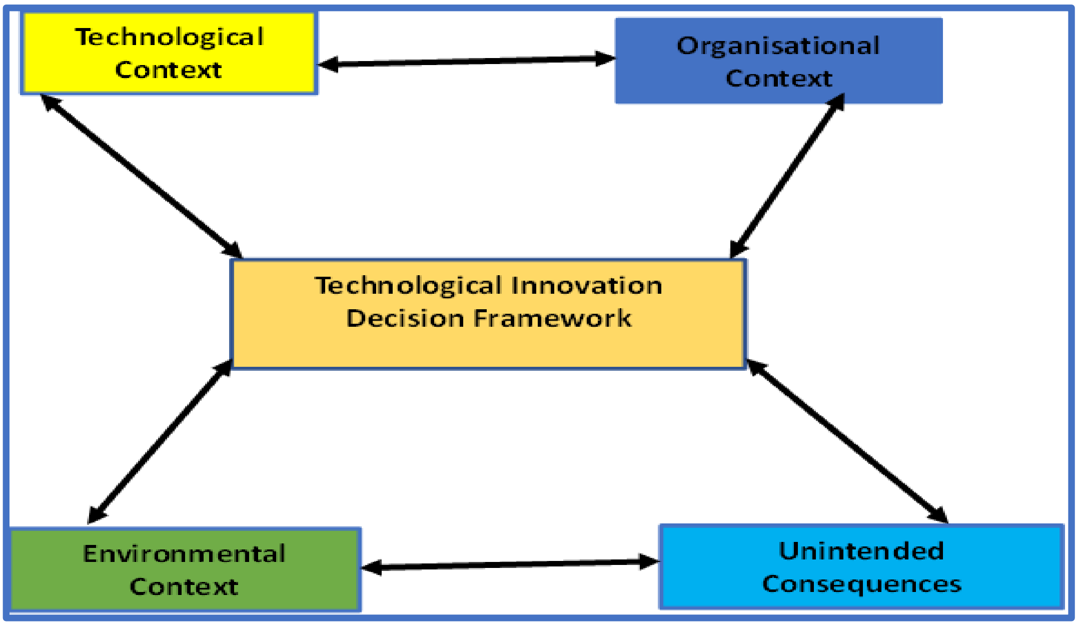
Consequently, the study expanded the TOE framework with the inclusion of Roger's DOI consequences of adopting BCT to the users. Figure 11 depicts the context for the TOE theoretical framework, and Figure 12 shows the expanded TOE framework.

Figure 11. *Technological, Organisational and Environmental Contexts*



Note. Source: DePietro et al. (1990, p. 153)

Figure 12. Expanded TOE Framework



Note. Source: Author

4.3.1 Empirical Literature on the TOE Framework for Innovation Adoption

The TOE framework has been widely used as a single theoretical framework or in combination with other innovation adoption theories for studying the adoption of different IT innovations in different fields such as e-business, cloud computing, ERP, EDI, e-commerce, and knowledge management systems (Arpaci et al., 2012; Awa et al., 2017; Borgman et al., 2013; Soares-Aguiar & Palma-dos-Reis, 2008; Zhu et al., 2006). The TOE framework has been applied in many fields of study: the EDI adoption model in small firms (Kuan & Chau, 2001); analysing of e-business assimilation with the conceptualisation of three new constructs: initiation, adoption, and routinisation (Zhu et al., 2006); factors affecting adoption characteristics of cloud computing adoption characteristics (Low et al., 2011); investigating XBRL adoption for both internal and inter-organisational purposes (Henderson et al., 2012); understanding digital transformation in South African financial service providers (Modiba & Kekwaletswe, 2020); and evaluating the factors that influence blockchain adoption in the freight logistics industry (Orji et al., 2020). Similarly, Choi et al. (2020) applied TOE to understand factors that contribute to the resistance of organisations to BCT in supply chain networks; and (Schmitt et al., 2019) used the TOE structure to study key determinants of Smart Contracts and IoT.

Both qualitative and quantitative methods have been used to establish the TOE in different industries. The qualitative approach can be a systematic review of literature, social media, interviews, large-scale surveys, and qualitative single or multi-case studies. Researchers and scholars have used one or a combination of these methods. For instance, to explore the low adoption of BCT in 20 Irish firms, Clohessy and Acton (2019) adopted interviews with a multi-case study approach; Saheb and Mamaghani (2021) used a mixed-method qualitative analysis in the exploration of the obstacles and values of BCT adoption in the banking industry. Rosli et al. (2013) adopted a quantitative method to examine the extent of the adoption of audit technology among 38 Malaysian audit firms and the factors that influence them. Similarly, Akter et al. (2021) relied on semi-structured interviews to examine factors affecting the decision to deploy BCT in the accounting industry. Using a qualitative exploratory study, Seshadrinathan and Chandra (2021), explore factors influencing the adoption of BCT in accounting applications.

In previous studies, some scholars combined TOE with other innovation theories. Henderson et al. (2012); Wang et al. (2010); Zhu et al. (2006) combined DOI theory and the TOE framework to analyse the adoption of IT innovation; Katebi et al. (2022) integrated both TAM and TOE to investigate factors affecting the adoption of precast concrete in building projects; Chatterjee et al. (2021) applied an integrated TAM-TOE model to understand AI adoption. Furthermore, Lu et al. (2021); Toufaily et al. (2021) combined DOI and TOE framework models to understand BCT adoption. The TOE framework and the Institutional Theory were combined to explore the adoption of an e-procurement system (Soares-Aguiar & Palma-dos-Reis, 2008), and e-commerce (Gibbs & Kraemer, 2004). These examples highlight the wide acceptance of the TOE framework theory in the exploration of innovation management. **Table *2*** highlights some TOE-Based Innovation Adoption Studies.

Borgman et al. (2013) investigate organisations' factors influencing cloud computing adoption and governance using the TOE framework. The authors considered factors that promote and prevent cloud computing adoption, and the influence of IT governance processes and structures on decision and implementation processes. This study brought to the fore the importance of IT governance's effects on the adoption of cloud computing. However, the study acknowledged that a narrow sample size of 20 firms is insufficient for the generalisation of the result. Borgman et al (2013) suggested the need to undertake qualitative research across geographical zones to explore this phenomenon.

Al Hadwer et al. (2021) explore organisational factors impacting cloud-based technology adoption. The study analysed and classified technical and non-technical factors influencing organisational attitudes concerning the adoption of cloud computing. This study is a systematic review of the existing literature with a seven-year time frame of studies that have applied TOE to explore the adoption of the TOE. The study extracts and classifies factors considered as critical to the adoption of cloud computing adoption by organisations in the last seven years. The time frame covered by this study is narrow. Also, it could be argued that in addition to the narrow time frame, studies by Al Hadwer et al (2021) could not have examined and extracted all organisation's influential factors affecting cloud computing adoption using the TOE framework.

Table 2. *Examples of TOE-Based Innovation Adoption Studies*

Studies	Field of Application/ Innovation	Summary of Findings		
		Technological Context	Organisational Context	Environmental Context
Toufaily et al. (2021)	BCT	Technological immaturity, Security, Data privacy, cost, scalability and performance, Interoperability, complexity	Governance and leadership readiness, business model alignment, Organisational readiness	Regulatory uncertainty, Network effects and inter-organisational connectedness, Ecosystem readiness
Kouhizadeh et al. (2021)	BCT – Supply chain System	Security, access to technology, negative perception, Immutability, and Immaturity	Financial constraints, Lack of management commitment and support, Lack of knowledge and expertise,	Lack of governmental policies, Market competition and uncertainty, Lack of external stakeholders' involvement
Akter et al. (2021)	BCT - Accounting	Perceived benefit (trust &automation), cost, complexity,	Insufficient employee knowledge, Top management support, Organisation innovativeness	Lack of use cases, External pressure, Trading partner readiness, Government support, COVID-19 pandemic
Lu et al. (2021)	BCT	Relative advantage (technology trust and information security), Complexity	Top management support, Organisational readiness, corporate social responsibility	Competitive pressure, Government support
Choi et al. (2020)	BCT	Complexity, Maturity, Compatibility, Scalability, security and privacy, cost of implementation	Technological awareness, Technical knowledge and expertise, Perceived risk of vendor lock-in, collaboration, Perceived effort in collaboration	Perceived constraints of Government support, Regulations, infrastructure
Modiba and Kekwaletswe (2020)	Digital transformation	Digitisation, Banking platforms, Data privacy and security, System Integration	Business activities, Role of leadership, Regulations, Infrastructure development, Financial impact, Development and training of employees	Competition within the industry, Politics, Governance, Operational culture, Compliance,
Moradi and Nia (2020)	Audit analytics software	IT Complexity, Technological competence	Management Support, Size, Regulations,	Professional help, Standards
Schmitt et al. (2019)	IoT and Smart Contract	Performance expectancy, Maturity, Compatibility,	Firm size, Attitude towards change, Organisational slack, Perceived technical capability, and Security concerns.	Regulatory policy, Competitive pressure, Legal uncertainty, Consumer perception, External data
Clohessy and Acton (2019)	BCT	Perceived benefits, Complexity, Compatibility, Data security, Maturity Relative advantage Disintermediation	Top management support, Organisational readiness and size, business model readiness	Regulation, Market dynamics, Industry pressure, Government support, use cases
Palacios-Marqués et al. (2015)	Web knowledge exchange	Technology integration, IT experts	Commitment-based HR practices,	Competition
Bradford et al. (2014)	Centralized end-to-end identity and access management (CIAM)	Rogue systems, Non-availability of a centralised repository of IDs, Weak data governance, Non-standard processes across the organisation, Lack of agreement on security rules	Lack of agreement on the classification of users, Lack of strong executive leadership, Lack of committed resources, and Security are viewed as IT problems, not business problems	Vendor changes, Government regulation, and Cloud Computing
Aboelmaged (2014)	e-maintenance technology	Infrastructure and Competence	Maintenance priority, Size and ownership type	Competitive Pressure
Rosli et al. (2013)	Audit technology	Cost-benefit, Compatibility, and Complexity)	Top management commitment, Human resource IT competency, and Organisation readiness	Client's AIS complexity, Competitive pressure, Professional accounting bodies support, and Vendor services

Note. Source: Summarised by Author

Relying on the interpretivist philosophy and a case study strategy, (Modiba & Kekwaletswe, 2020) adopted the TOE framework to explain factors propelling or inhibiting digital transformation in South African financial services (SAFC). In addition to being a qualitative study, the authors designed a conceptual framework for the exploration and explanation of digital transformation in SAFC. This framework, however, would require further studies to ascertain its usefulness. This is because digital transformation is not only at its infancy stage in SA but in entire African states. Schmitt et al. (2019) explored the process of adoption and implementation of the integration of IoT with Smart contracts as technological innovation. It is a qualitative content analysis that used the structure of the TOE framework. The findings extended three elements of the TOE to include opportunities and challenges of IoT integration with Smart contracts. However, the study relied on four experts' opinions for the analysis of the opportunities and issues that could confront organisations when smart contracts are integrated with IoT. The potential limitation of this study is its small sample size.

Similarly, Toufaily et al. (2021) adopted the TOE framework to evaluate the challenges and implications of adopting BCT in the private and public sectors in the United Arab Emirates (UAE). The authors relied on TOE to differentiate between the challenges and expected value of BCT adoption. The study conducted 46 semi-structured interviews with different stakeholders in the private and public sectors in the UAE. This study examined the perspective of entrepreneurs regarding the challenges and implications of the adoption of BCT. The study's participants were limited to entrepreneurs within the UAE and this could be a limitation since all the participants were from the same geographical location.

Clohessy and Acton (2019) adopted a multiple-case study approach with the TOE framework as a theoretical lens to investigate organisational factors influencing the adoption of BCT. Using the qualitative content analysis method vis-a-vis the TOE framework, the study predicted some factors that influence the decision of some organisations to adopt BCT or not. The potential limitation of this study is similar to that of Toulifaily et al (2021) because this study's sample size is geographically limited to 20 companies in Ireland and the study did not include participants from the country's government institutions.

The theoretical innovation lens used in the study by Kouhizadeh et al. (2021) is the TOE framework with Force Field theories to provide an explanation of the barriers to BCT adoption for sustainable supply management. This is quantitative research that used the Decision-Making Trial and Evaluation Laboratory embedded with force field theory to analyse and differentiate various barriers against the adoption of BCT for a sustainable supply chain system. This study explores only the barriers against the adoption of BCT in supply chain management with 47 practitioners and academics. The study did not mention the geographical spread of these participants.

Another study that has employed the TOE framework to highlight constraints and key determinants of an organisation’s resistance to BCT adoption is Choi et al. (2020). The study used Structural Equation Modelling and an online questionnaire (83 respondents) to highlight factors that deter firms from adopting BCT for supply network operations. This study sample size is fairly reasonable. However, the potential downside of using an online questionnaire survey is that it is difficult for researchers to assess the level of understanding of the respondents concerning the topic which could lead to uninformed responses thereby affecting the quality and reliability of collected data.

Other studies that have examined a diverse set of factors that affect the adoption of BCT in different domains beyond cryptocurrency applications include: barriers to the adoption of BCT in green supply chain management (Bag et al., 2021); a decision-aid model for evaluating challenges to blockchain adoption in supply chains (Karuppiah et al., 2021); barriers to the adoption of BCT in business supply chains (Mathivathanan et al., 2021); and BCT adoption barriers in the Indian agricultural supply chain (Yadav et al., 2020). However, most of these studies have applied the TOE framework to understand BCT adoption in supply chain management.

Notwithstanding, there are limited studies that have adopted the TOE framework to explore the factors influencing BCT adoption in the accounting industry. Akter et al. (2021) attempted to explore the drivers of BCT adoption in the accounting industry. This is a conference paper that obtained qualitative data from 11 participants to explore the drivers of BCT adoption in the accounting industry. Relying on an interpretive qualitative research approach and the TOE framework, the study identified some key factors influencing BCT adoption in the accounting industry. The key factors identified are broadly classified as enablers and inhibitors of technology adoption. The enablers include perceived benefits, firms' level of innovativeness, top management support, external pressure, and government support, while technological complexity, insufficient employee knowledge, trading partners' readiness, and lack of use cases as inhibitors. The study further denoted the impact of COVID-19 and perceived cost as a mixed influencer. The 11 participants were from Australia and the USA. The number of interviewed participants is too small to make a significant conclusion on the potential drivers of BCT adoption in the accounting industry. The study also failed to examine if there are organisations that are currently using BCT for accounting and reporting purposes.

Similarly, Seshadrinathan and Chandra (2021), using the TOE framework, explore factors influencing the adoption of BCT in accounting applications. This is a qualitative exploratory study with a sample of 12 organisations experimenting with BCT adoption for accounting applications. The geographical locations of these organisations are unknown, but the study claimed that the interviewed firms have a global presence. Like Akter et al. (2021), this study identified trust, regulatory environment, competition, industry, uncertainty, relative advantage, technological readiness and top management supports as factors that could influence the adoption of BCT for accounting applications. The sample size of 12 respondents is inadequate for the exploration of factors influencing the adoption of BCT for accounting applications.

Though using a different theoretical framework, Milosavljevic et al. (2019) is another study that attempted to explore drivers of BCT use in accounting. This study adopted the Unified Theory of Acceptance and Use of Technology (UTHAUT) instead of the TOE framework, and the respondents are mainly accountants. The study found that the potential adoption of BCT for accounting purposes depends on performance expectancy and social influence. The potential flaw in this study is that it focuses on a group of respondents who were mainly accountants, which possibly narrows the depth of collected data and engagement with the practitioners and experts from other relevant fields.

As mentioned, most of the existing literature that highlights factors inhibiting the adoption of BCT is primarily in the area of logistic management, but an attempt was made by a few studies (Akter et al., 2021; Milosavljevic et al., 2019; Secinaro et al., 2021) on the drivers of BCT adoption for accounting purposes. The study by (Akter et al., 2021) relied on small sample size, and the interviewed participants excluded blockchain start-ups and academics. Similarly, Milosavljevic et al. (2019) explore the drivers of BCT for accounting purposes and adopted UTHAUT as a theoretical lens but with accountants as the only respondents.

Drawing from the existing literature, there is empirical support for the use of the TOE framework across different fields concerning innovation adoption, particularly in understanding factors influencing the adoption from technological, organisational, and environmental perspectives. The contribution of this study is that it looks beyond the present rhetoric of factors influencing BCT adoption by engaging with practitioners from blockchain start-ups, IT and financial experts, accounting regulatory bodies, senior editors, organisational leaders, auditors and accountants from both the Big 4 firms and non-Big 4 firms, supply chain experts as well as academics from 13 countries. Furthermore, the common denominator of all the interviewed participants is that they have basic knowledge of BCT. The study attempted to examine the unintended consequences of adopting BCT as a FinTech, thus expanding the TOE framework.

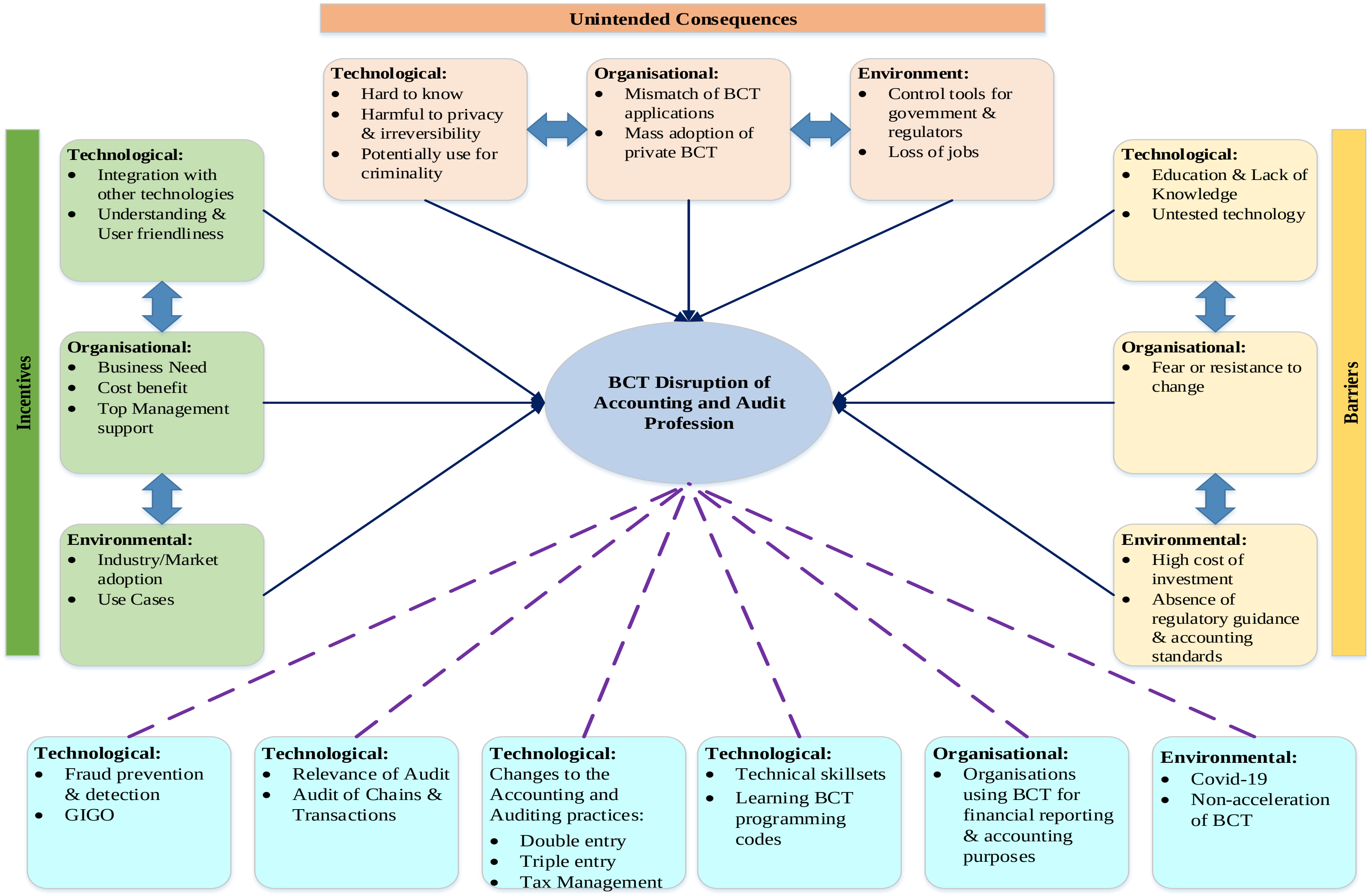
4.4 The TOE Framework in the Context of this Study

BCT has been optimistically expected to bring a quantum disruption to the accounting and auditing profession. Some studies suggested BCT will disintermediate the role of auditors, bring an end to double-entry accounting and enable triple-entry accounting (Cai, 2018; Lombardi et al., 2021; Yermack, 2017). The focus of this study is to understand factors influencing BCT adoption and disruption of the accounting and auditing profession. In line with the study's objectives and theoretical assumption, ***Figure 13*** summarises the conceptual framework for the study. At the heart of this framework is the technological, organisational, and environmental factors that encapsulate incentives and barriers to BCT adoption, the novel addition of unintended consequences and the impact of COVID-19 on its adoption as a FinTech. The framework also encompasses BCT security mechanisms for fraud prevention and detection and the effect of GIGO on the effectiveness of BCT fraud architecture. It incorporates the likely changes that BCT could bring to the double-entry accounting system, triple-entry and tax management, technical skillsets and understanding of BCT programming language by the accounting professionals as well as the relevance of auditors in a BCT environment.

The organisation of the themes and findings of this study are classified under the technological, organisational and external environment context (see **Figure *13***). The study's themes and findings were analysed using the TOE framework. The study's findings were categorised under relevant context. For instance, the three TOE contexts have incentives, barriers, and unintended consequences. The findings under technological context include changes to the double-entry accounting system, BCT triple-entry accounting system, fraud prevention and detection mechanisms, the relevance of audit, audit of chain or transactions, changes to accounting practices, required technical skillset for professional accountants and understanding of programming codes. These are directly and indirectly related to the technology's characteristics (see **Figure 11**). Under technological innovation decision-making, these factors are influenced by the BCT innovation itself rather than the environment and organisation. Similarly, organisations that have adopted BCT for financial accounting and reporting were analysed under the organisational context, while the impact of Covid19 relates to the external environment context.

Modiba and Kekwaletswe (2020) assert that TOE is a popular paradigm used to explore technological innovations in qualitative research. Interviewing experts is strongly recommended as a means to obtain information on the progress and adoption of BCT development (Toufaily et al., 2021). Aside from this study is qualitative research, it used semi-structured interviews that allowed participants from various disciplines and backgrounds an opportunity to give their professional and technical perspectives on the adoption of BCT and its potential disruption of the accounting and audit field. This has added depth and enriched the existing literature on the factors influencing the adoption of BCT and the implications of technology for the accounting and auditing profession, effectiveness of BCT security mechanism for fraud prevention and detection, and the technical skillset required by accountants and auditors. Thus, the use of interviews is considered appropriate for this study as it elicited first-hand information from the interviewees on the extent of BCT disruption and adoption.

Figure 13. *Conceptual Framework of BCT Disruption and Adoption*



Note. Source: Author

Rogers (2003) acknowledged that diffusion researchers have paid little attention to the consequences of innovation adoption because they assume that the adoption of innovation comes with inherent benefits. He suggested that such pro-innovation bias could be resolved by predicting the likely consequences of the diffusion of innovation. Furthermore, Rogers suggested that researchers should consider unintended consequences, which could be desirable or undesirable, in the diffusion of innovation adoption. Although Roger's DOI could be used instead of the TOE framework, this study is more focused on an adaptable framework that explains the combination of complex factors that influence the adoption of BCT and the disruption of accounting and auditing. From the available literature, to the best of the researcher's knowledge, none of the existing studies has considered the unintended consequences of BCT innovation using the TOE framework. Similarly, the comprehensive TOE approach could facilitate the testing of theory generalisability, model expansion and construction of new suitable contexts by researchers (Al Hadwer et al., 2021). Thus, this study attempts to expand the TOE construct to understand possible unintended consequences of the adoption of BCT.

Toufaily et al. (2021) note that "technological innovations are constructed socially (p. 2)" and the TOE theory provides a theoretical framework to socially construct technological innovations. The philosophical assumption underpinning this study is the social constructivist-interpretivism paradigm. This philosophical assumption is used by the researcher to understand and construct the perceptions of participants concerning BCT disruptive innovation. The researcher uses this philosophical assumption to understand and construct the perceptions of the study participants regarding disruptive innovation from BCT in the field of accounting and auditing.

Additionally, Gupta et al. (2007) assert that the environment and the actors (firms, individuals) have a significant impact on the choice of innovations and several researchers treat each factor as if they are mutually exclusive. Researchers should combine the impact of actors and the environment in determining factors influencing innovations because both are not mutually exclusive (Gupta et al., 2007). The application of the TOE framework enables this study to analyse and combine the actors and environmental factors to understand the BCT innovation phenomenon. Additionally, this study further eliminates the adoption of cryptocurrencies from its analysis by focusing on BCT adoption for financial reporting and accounting purposes. This practice is similar to what Stratopoulos et al. (2020) used in their study by eliminating the technology application in Bitcoins and other cryptocurrencies and concentrating on the BCT applications in the real sector.

Glaser (2017) notes that considering the number of advertised prototypes and tests conducted in many different industries, blockchain can be said to have reached the development phase and adoption has started. The recent Deloitte 2020 global blockchain survey (Pawczuk et al., 2020) lends credence to Glaser's view. According to the Deloitte report, several companies consider blockchain as integral to their organisational innovation and are implementing the technology as part of their business procedures. The survey involved 1,488 senior executives and practitioners with a broad understanding of blockchain, digital assets, and DLT in 14 nations (Brazil, Canada, China, Germany, Hong Kong, Ireland, Israel, Mexico, Singapore, South Africa, Switzerland, the United Arab Emirates, the UK, and the US) and was conducted between 6 February to 3 March 2020. The result indicates that about 88% of the respondents believe that the blockchain is scalable and will eventually achieve mainstream adoption. However, the Deloitte report acknowledges that the effect of COVID-19 was not a factor in the results because the survey was conducted in the early stage of the pandemic. In contrast, a survey of 350 Chinese companies in 10 industries showed that the outbreak of COVID-19 has not deterred the desire to invest in industrial BCT because 70% of the respondents affirmed their willingness to sustain capital investment in BCT projects (Erazo, 2020b; Hanqing, 2020). However, Australia and New Zealand are not included in the Deloitte 2020 global blockchain survey. Besides having participants from New Zealand, Australia and 11 other countries, this study includes the effect of COVID-19 on the adoption of BCT disruptive innovation.

Within the field of management, the TOE framework has been used to explore innovation adoption in many fields. However, none of the existing studies on BCT disruptive innovation has examined the unanticipated consequences of adopting the technology. Thus, in addition to the use of TOE contexts to ascertain BCT adoption for financial reporting and accounting systems, the unintended consequences of adopting BCT as a FinTech solution were examined.

To summarise, using the TOE framework as the theoretical lens, this study examines the adoption and disruption of BCT in the accounting and auditing profession. The importance of examining the adoption of BCT in the accounting industry has made some scholars assert that "any research investigating accountants' perceptions about the adoption of BCT, including perceived challenges, would be highly valuable" (Moll & Yigitbasioglu, 2019, p. 13). Similarly, Schmitz and Leoni (2019) suggest the need to assess the adoption stage of BCT within the accounting and auditing profession to determine how the accounting industry is adapting to emerging innovation. Such empirical study can demonstrate how the accounting and auditing profession is adapting to blockchain innovation (Schmitz & Leoni, 2019).

Adoption of innovation is likely to have a direct or indirect impact on service-based industries such as accounting, auditing and assurance firms. The CPA and AICPA (2017) assert that BCT is impacting professional auditors whose clients are using the technology to record transactions. For instance, the migration of clients from the current accounting ledger like ERP to blockchain Hyperledger or triple accounting ledger will certainly affect audit procedures for auditing firms. Equally, the adoption of innovation could affect the financial activities of a company starting from the basic record keeping, maintenance of financial records, reconciliation and reporting procedures. Relying on the existing theoretical framework, the study's conceptual framework confirms and expands the TOE framework to understand BCT innovation adoption and advance knowledge of the likely disruptive impact on the accounting and auditing field. The use of TOE contributes to the overall objective of this study and helps to answer research questions.

4.5 Summary

This chapter explains the theoretical framework adopted for this study. The TOE theoretical framework espoused by Tornatzky and Fleischer (1990) was adopted. This thesis applies technological, organisational, and environmental contexts to guide analysis and findings. The TOE framework is adopted in this study because it supports the study's qualitative methodological approach and the social-constructivist-interpretivism philosophical assumptions. The framework lends credence to the use of the interview to explore factors influencing the adoption and disruption of BCT innovation. Additionally, many scholars have extensively used the TOE framework to understand a wide range of technological innovations and support both qualitative and quantitative data analysis.

The extent of the adoption of BCT and its disruptive impact has been viewed from different perspectives by different scholars. However, this study engaged a diverse group of experts from BCT start-up firms, accounting regulatory bodies, academics, financial experts, accountants and auditors using the semi-structured interview to understand the adoption of BCT and its implications for accountants and auditors. The adoption of BCT by organisations is expected to have a direct or indirect impact on the functions of accountants and the roles of auditors. It is evident that no theory ticks all the boxes of innovation research requirements due to the complexity surrounding innovation adoption. Nonetheless, the conceptual framework developed in this chapter is used to explore BCT disruption of the accounting and auditing profession and factors participants considered as incentives, barriers, and unintended consequences of adopting BCT.

The next chapter presents the research methodology and methods used to conduct the study.

Chapter 5
Research Methodology and Method

5.1 Introduction

This chapter discusses the study's research methodology and method adopted to answer the research questions and achieve the research objectives. This study explores (with a sample of academics and practitioners) their perceptions of (1) what BCT has disrupted or enhanced in the accounting and auditing profession; (2) how BCT has changed the accounting practices; (3) how relevant are auditors and what auditors need to audit in a BCT environment; (4) how effective is the effectiveness of BCT for fraud prevention and detection;(5) what technical skillsets do accountants and auditors need; (6) what incentives and barriers affect the adoption of the technology as well as the unintended consequences; and (7) how COVID-19 has accelerated the adoption of BCT. The researcher believed that a better understanding of the BCT phenomenon from the perspectives of accounting professionals, blockchain start-ups, regulators, policymakers, organisational leaders, and academics would provide better insights into BCT and its effectiveness in fraud prevention and detection as well as its impacts on the skillsets required of accounting professionals. In seeking to understand this phenomenon, the study addressed 11 research questions (see Chapter 1, Section 1.3).

The first section deals with the rationale for adopting qualitative methodology and social-constructivist-interpretivism which is the philosophical assumption underpinning the study. A discussion of the research methods follows and includes data collection and research sampling, a description of the participants, access to data, the interview processes, and data analysis. Ethical considerations and criteria for evaluating the study's quality, including the reflexivity of the study are explained. The final section highlights the limitations and delimitations of the study. The chapter concludes with a summary.

5.2 Research Methodology

The thesis adopts a qualitative methodology. This section provides the rationale for this adoption by highlighting the methodology's strengths and weaknesses. It further justifies the choice of social constructivism-interpretivism as the research philosophical assumption underpinning this study.

The methodological choice available to the researcher includes quantitative, qualitative, and mixed methods design (Bloomberg & Volpe, 2019; Kothari, 2004; Niglas, 2010; Saunders et al., 2016). The underlying factor for researchers should be the choice of appropriate methodology to achieve the research purpose (Bloomberg & Volpe, 2019; Tashakkori & Teddlie, 2016). In this study, a qualitative methodology was adopted with elements of intersectionality to understand what BCT is disrupting or enhancing in the accounting and auditing profession. This approach broadened the evidence base of the disruption or enhancement BCT could bring to the accounting and auditing fields.

5.2.1 Qualitative Research Method

Qualitative research focuses on real-world phenomena, examine the complexity surrounding such phenomena, and recognises that research issues are multi-dimensional in nature (Bloomberg & Volpe, 2019; Leedy & Ormrod, 2015). Qualitative research is often associated with an interpretivist philosophy because researchers must assimilate different subjective and socially constructed meanings of the research's participants to explore the phenomenon being studied (Bloomberg & Volpe, 2019; Goldkuhl, 2012; Saunders et al., 2016). Bloomberg and Volpe (2008) note that to convey an open and developing trend, research questions in the qualitative study often commence with *"how"* or *"in what ways"* and *"what"* and open-ended questions will aid exploration and discovery. It is equally important to ensure research questions are non-directional by avoiding the use of leading questions with yes or no answers (Peterson, 2019). In intersectionality-informed qualitative research, Hankivsky (2014) lists the key tenets to include:

> "First, human lives cannot be explained by taking into account single categories, such as gender, race, and socio-economic status. People's lives are multi-dimensional and complex. Second, when analyzing social problems, the importance of any category or structure cannot be predetermined; the categories and their importance must be discovered in the process of investigation. Third, scholars, researchers, policymakers, and activists must consider their own social position, role and power when taking an intersectional approach. This "reflexivity," should be in place before setting priorities and directions in research, policy work and activism. Fourth, intersectionality is explicitly oriented towards transformation, building coalitions among different groups, and working towards social justice. Fifth,

> multi-level analyses that link individual experiences to broader structures and systems are crucial for revealing how power relations are shaped and experienced."

This study considered the complexity and dynamism of participants' experience and industry before grouping them. The grouping of participants into categories was not predetermined, it was done after each interview. A qualitative and intersectionality methodology supports reflexivity and the need for a discussion of the position of the research actors: the participants and the researcher, and the power dichotomy (Hunting, 2014). The reflexivity of the study was discussed (see Section 5.5.5) to establish the values of the researcher and the participants.

Bloomberg and Volpe (2019) state that qualitative research often arises from a perceived issue, scholarly debate, or a phenomenon that requires further investigation or understanding, the problem statement is fundamental to shed light on the known and the unknown. The ongoing scholarly debate is that BCT is said to have the potential to change many business operations. Some scholars believe that BCT will disrupt the accounting industry, reduce, or eliminate the roles of auditors and that the technology has an inbuilt mechanism to prevent and detect fraud. Similarly, Levitt et al. (2017) note that researchers can enhance the meaningfulness and understanding of their studies by forming questions that challenge existing propositions. This study's research questions were formulated to augment or challenge the current perceptions of BCT concerning its potential impact on the accounting industry. For instance, what are auditors expected to audit in a BCT?; how relevant are auditors in a BCT environment?; what types of fraud or anomalies can occur in a BCT environment?; and do accountants and auditors need to understand BCT programming language to use the technology?

Saunders et al. (2016) note that in research design, there are three approaches to theory development: induction, deduction, and abduction. The qualitative study follows an inductive approach because research is about idea generation (Bloomberg & Volpe, 2019). The inductive approach involves the collection of data to explore a phenomenon, the identification of themes and patterns, the creation of a conceptual framework, and theory generation and building (Saunders et al., 2016). In inductive inference, known premises are used to produce unverified conclusions. Even though qualitative research follows the inductive approach, Yin (2016) notes that the deductive approach can be applied because it can assist in enhancing the significance of a study.

Similarly, Saunders et al. (2016, p. 145) note that the inductive approach is most suitable where a study begins with the collection of data to explore a phenomenon to create or generate theory as a conceptual framework. Similarly, Schwartz-Shea and Yanow (2012, p. 27) explain that qualitative research follows an inductive logic inquiry. This aligns with the view of Creswell (2013) that a researcher should inductively develop or generate a theory or pattern of meaning instead of beginning with a theory as in post-positivism. Thus, this study used an inductive approach because data was collected through semi-structured interviews to explore the BCT phenomenon and its implications for the accounting and auditing industry. However, data analysis was both inductive and deductive. The initial categorisation of the research conceptual framework is deductively obtained from the reviewed literature while coding of the transcripts was inductively done.

When conducting research, the qualitative methodology has a number of strengths. In general, in qualitative studies, researchers begin with open minds to explore the complexity of the phenomena being studied (Leedy & Ormrod, 2015). Qualitative research can extend the knowledge base and even add new value to scholarship in a field (Peterson, 2019). A qualitative researcher develops a conceptual framework and theoretical contribution using different data collection techniques and analytical procedures to understand participants' thoughts and relationships (Saunders et al., 2016). It involves divergent views or realities (Garvey & Jones, 2021). Yin (2016) notes that "the allure of qualitative research is that it enables you to conduct in-depth studies about a broad array of topics" which may be unlikely with other research methods (p.6). In contrast, Kara (2017) notes that in qualitative data analysis, there is limited room for creativity in the evaluation of quantitative data, while there is more scope for the interpretation and sense-making of qualitative data.

This study interviewed participants to explore: the complexity of BCT, understand their experiences, identify any intended and unintended consequences of adopting BCT, and investigate what BCT will disrupt or enhance if adopted for financial accounting purposes. To emphasise the importance of the qualitative line of inquiry, (Patton, 2015, p. 10) argues that:

> "Qualitative inquiry is especially valuable for identifying unintended consequences and side effects. If all a program evaluator looks at is whether the intended outcomes are attained, especially using standard performance indicators such as reading tests, employment statistics, and health outcome data, then other, unintended effects will be missed. To find unanticipated effects, you have to go to the fields where things are happening, observe what is really going on, interview program participants about what they're experiencing, and find out through open inquiry, both intended and unintended."

The feature of qualitative research is the value it places on data collection, integration and presentation from a variety of sources of evidence (Yin, 2016). He notes further that the complexity of the research setting and the diversity of participants are factors that attract the use of interviews and possible triangulation among a variety of sources. Triangulation is a combination of multiple methods, measures, methodologies, or theories to cross-reference findings to achieve research synergy. Triangulation can reduce bias in sources of data, methods, and investigation (Collis & Hussey, 2009; Peterson, 2019) and can add depth and richness to the research. Triangulating should be seen as a frame of mind instead of as a methodological choice because it keeps the researcher focused on seeking corroborating or conflicting ideas or data (Yin, 2016).

However, Fielding and Fielding (1986) state that triangulation or the multiple-strategy approach is not a panacea for internal and external validity. The authors explain that there is no method that is free from biases and triangulation with such a method could lead to a false sense of assurance. Fielding and Fielding (1986), therefore, emphasised that respondent validation is an alternative approach. This study achieved triangulation through the diversity of participants from different disciplines and geographical locations. The researcher ensured respondent validation by sending the interview transcripts to some respondents for review.

Leedy and Ormrod (2013) note there is a similarity in the research processes adopted in both qualitative and quantitative approaches because both methods involve the identification of a research issue, literature review, data collection and analysis (Leedy & Ormrod, 2013). It has been argued by some scholars that all research methods have their inherent merits and demerits, (Bryman et al., 2008; Saunders et al., 2016).

Despite the various strengths of qualitative research methods, many weaknesses have also been identified. One of the main weaknesses is the research quality criteria. Bryman et al. (2008) note that the quality criteria for the quantitative study are properly defined and widely agreed upon, unlike qualitative research. Quantitative studies follow structured guidelines with a method of measuring concepts, variables, and hypotheses that are defined at the start of the study and remain unchanged throughout.

The conventional cannons of inquiry, reliability and validity guide the quality of research in natural sciences and quantitative study (Saunders et al., 2016). Other quantitative terms such as sampling, correlation, rigour, significance, and comparison are assumed to be a universal language and unique to a research paradigm (Jones et al., 2013; Morrow, 2005). Some scholars consider that these terms are inappropriate for qualitative studies (Bloomberg & Volpe, 2008, 2019; Jones et al., 2013; Peterson, 2019) which has necessitated the need to provide alternative terminologies for interpretivism-based studies.

Jones et al. (2013) stress that the language adopted by a researcher is important because it reflects a paradigm and worldview. The alternative terms used in qualitative research are Credibility (Internal Validity), Transferability (External Validity or Generalizability), Dependability (Reliability), and Confirmability (Objectivity) (Bloomberg & Volpe, 2008; Morrow, 2005). However, Morrow (2005) points out that these corresponding terms should not be misconstrued as an absolute way of achieving similar aims or yardsticks equivalent to measuring rigour in a quantitative study. Thus, the researcher used these terms in evaluating the quality and trustworthiness of the study.

Nevertheless, the strengths of using a qualitative methodology far outweigh the weaknesses (Patton, 2015). There has been a rise in qualitative research over the last 25–30 years (Bryman et al., 2008) and it is now a mainstream form of research in many different academics and professional fields (Yin, 2016). Qualitative research focuses on real-world phenomena, examines the complexity surrounding such phenomena, and recognises that research issues are multi-dimensional in nature (Leedy & Ormrod, 2013). The choice of data collection methods should be contingent on the purpose of the research and its overall goal and not on whether the research uses a qualitative or quantitative approach (Bell & Waters, 2014).

Qualitative study is often associated with an interpretivist philosophy since researchers must assimilate different subjective and socially constructed meanings expressed by the research participants on the phenomenon under consideration (Saunders et al., 2016). In qualitative studies, researchers begin with open minds to explore the complexity of the phenomena being studied (Leedy & Ormrod, 2015; Schwartz-Shea & Yanow, 2012), and there is wide latitude for creativity in qualitative data analysis (Kara, 2017). Maxwell (2013) notes that the main strength of qualitative research is its ability to process and connect the world in terms of people, situations and events, and the inductive approach emphasises descriptions of specific situations or people rather than numbers.

Using qualitative methodology, this study critically examines and provides explanations about how blockchain will enhance or disrupt the accounting and auditing profession from the perspectives of practitioners across various disciplines. The practical goals of qualitative research are the generation of meaningful and experientially credible results and theories for participants and others, improving existing practices and programmes, and intellectual participatory engagements with the participants (Maxwell, 2013). Qualitative research can extend the knowledge base and even add new value to scholarship in a field (Peterson, 2019) beyond quantitative hypothesising and variable testing. A qualitative researcher develops a conceptual framework and theoretical contribution using different data collection techniques and analytical procedures to understand participants' thoughts and relationships (Saunders et al., 2016). Similarly, in the analysis of 36 articles on BCT conducted by Lombardi et al. (2021), it was reported that 90% of these articles were qualitative studies. Secinaro et al. (2021) also acknowledge that qualitative research is the most used method among authors in exploring BCT in the accounting and auditing fields. Studies by Lombardi et al. (2021); Secinaro et al. (2021) lend credence to the relevance of qualitative methodology for this thesis. Thus, the study adopts a qualitative methodology as it provides a richly descriptive, exploratory, and explanatory study of the BCT disruption and adoption in the accounting and auditing fields from the perspective of practitioners and academics.

Researchers' engagement with practitioners is said to be important in determining the disruption and diffusion of BCT in the accounting industry (Lombardi et al., 2021; Schmitz & Leoni, 2019). The researcher contends that quantitative methods were inadequate to facilitate such engagement with practitioners and academics or to produce the rich and in-depth data necessary to address the study's aims. Similarly, the qualitative approach is said to be better than a quantitative approach where available literature is limited (Leedy & Ormrod, 2015). The choice of qualitative methodology for this study is also due to the limited literature on BCT and its practical implications for the accounting industry. In the researcher's view, this study follows some of the fundamental assumptions of a qualitative study which include: understanding the processes by which events and actions take place, developing contextual understanding, facilitating interactivity between researcher and participants, adopting an interpretive stance, and maintaining design flexibility (Bloomberg & Volpe, 2019, p. 217).

5.2.2 Social Constructivist-Interpretivist Paradigm

The fundamental philosophical position of qualitative research is that it is constructivist in nature since within a specific context and time frame researchers attempt to understand and interpret intricacies surrounding the social and cultural world (Bloomberg & Volpe, 2019). Creswell (2013) notes that the combination of social constructivism and interpretivism is another worldview or paradigm.

Social constructivists are of the view that reality is socially, culturally, and historically constructed (Bloomberg & Volpe, 2008, 2019; Lincoln et al., 2011). "Reality is constructed through social interactions in which social actors create partially social meanings and realities" (Saunders et al., 2016, p. 130). Similarly, Levitt et al. (2017, pp. 6-7) explain that "constructivist-interpretive researchers seek to use dialogical exchanges with participants to uncover meanings that are held by sets of people or systems while exemplifying their process of analysis to illustrate and make transparent their interpretive processes." In the interpretive paradigm, epistemologically, the main focus of researchers is to make sense of the world around us, and to create new, better explanations and interpretations of social words and contexts (Saunders et al., 2016). In interpretive research designs, researchers did not have mindsets to test predefined concepts and definitions but were mostly concerned with understanding how those concepts and roles are applied in the field (Schwartz-Shea & Yanow, 2012). Thus, researchers focused on context-specific meanings that aid understanding of the phenomenon being studied instead of generalised meaning abstracted from a particular context (Schwartz-Shea & Yanow, 2012). Researchers heavily rely on the participants' perceptions of the phenomenon under investigation which are often subjective but extracted through social engagement and interaction (Creswell, 2013; Ponelis, 2015).

The thesis fits well into the social constructive-interpretivism paradigm because it relied on the participants' views to explore and construct whether BCT is disrupting or enhancing the accounting and auditing fields. Saunders et al. (2016) state that interpretivism is clearly subjectivist because of its focus on complex and multiple understanding of different interpretations which is in line with the position of Burrell and Morgan (2019). Nonetheless, the subjective nature of interpretivism provides a wide range of understanding of a phenomenon from various perspectives, which would otherwise be lost by strictly adhering to a quantitative-driven positivist-objectivist viewpoint. This study's adoption of this approach is further buttressed by the view of Schwartz-Shea and Yanow (2012):

> "… a constructivist-interpretivist methodology that rests on a belief in the existence of (potentially) multiple, intersubjectively constructed "truths" about social, cultural, and other human events; and on the belief that these understandings can only be accessed, or co-generated, through interactions between researcher and researched as they seek to interpret those events and make those interpretations legible to each other." (p.4)

Interpretivists acknowledge that their values and beliefs are significant in the interpretations of collected data (Saunder et al 2016). However, Schwartz-Shea and Yanow (2012, p. 112) argue that "the question about researchers intentionally choosing evidence that supports their argument while ignoring evidence that undermines it evinces an anxiety that is not unique to an interpretive researcher: researchers working in other methodologies are also capable of 'cooking the books' (and there are plenty of examples of that from laboratory research; …)." Thus, interpretive researchers have open minds to accommodate multiple perspectives beyond the partial prejudices of some participants' narratives, and reflexivity and ethical considerations assist in mitigating this issue (Schwartz-Shea & Yanow, 2012). An axiological implication of this is that this research focuses more on significance than rigour (Ponelis, 2015) and is value-bound and explicitly subjective (Saunders et al., 2016). It also accommodates both inductive and deductive research approaches (Modiba & Kekwaletswe, 2020).

This researcher shares the views of some prior studies (Centobelli et al., 2021; Keller, 2013; Schmidt et al., 2020) that suggest that the accounting and auditing industry is conservative in embracing technology that could change current accounting practices and possibly brings transparency to financial transactions and stem the tides of corporate failure. Auditors are not solely responsible for corporate failures. However, some recent findings (IndianExpress, 2020; Lemmon, 2020) revealed that auditor's negligence or collusion with management has led to the collapse of some multi-national companies (for instance, the 2020 Wirecard fraud in Germany, and the 2018 collapse of Carillion in the UK). Consequently, regulators must encourage the adoption of any technology including BCT, if it can enhance transparency, prevent and detect fraud (which may ultimately stem the tide of corporate failures) and revolutionise auditing and assurance practices. Additionally, irrespective of the adoption of any technology, the overriding factor is the human element that often interferes with the benefits derived from such innovation.

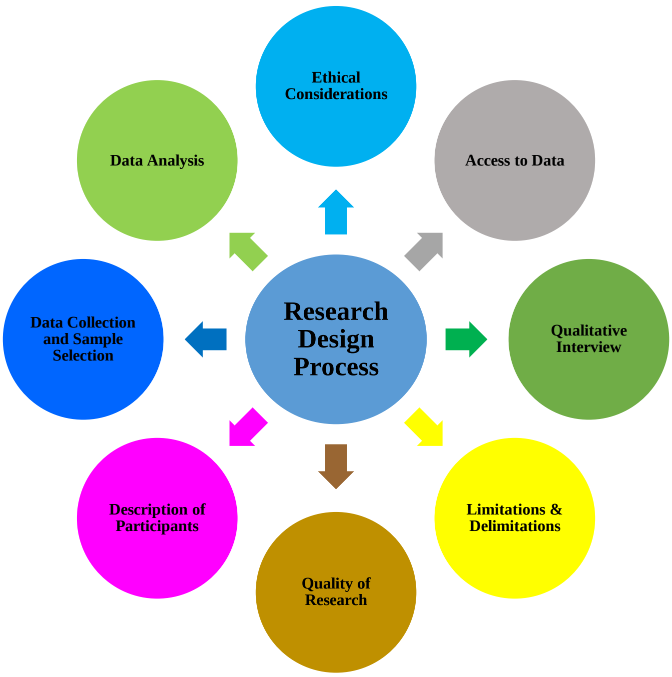
Despite these assumptions, this study relied on the views of several participants from blockchain start-ups, accountants, auditors, accounting regulators, academics, and other financial experts. It is from this engagement that the researcher constructed the participants' worldviews about whether blockchain disrupts or enhances the accounting and auditing fields.

This research attempted to understand BCT from a context-specific perspective of the study participants. A flexible design is important in interpretive research because the researcher starts with insights from prior knowledge, and attempts to expand and elaborate on the initial research questions but has no control over the responses of the participants (Schwartz-Shea & Yanow, 2012). The prior knowledge from the existing literature includes general statements as to how BCT will disrupt or enhance the accounting profession, but the practical effects of this assertion are unknown or still evolving in light of the non-diffusion of BCT. The research philosophical assumption which is in line with the social constructive-interpretivism paradigm assumes that multiple meanings, interpretations, realities, and new understanding from the worldviews of participants will provide a better way to achieve research objectives. All these perspectives informed the research method of this study. Thus, these assumptions enable the researcher to empirically explore where BCT has the potential to disrupt or enhance the accounting and auditing profession.

5.3 Research Design

This section discusses the research design for this study. It highlights how the research was conducted which includes the research sample, description of the participants, data collection, designing the interview guide, access to data and analysis of data. It also covers ethical considerations, evaluation of the quality of qualitative research including reflexivity and limitations of the study. These design processes are represented in Figure 13.

Figure 14. *Research Design Process*



Note. Source: Author

5.3.1 Data Collection and Sample Selection

The study used purposive sampling to select participants. Qualitative researchers employ purposive or purposeful sampling to obtain in-depth information to generate insight into the subject being studied (Jones, Torres, & Arminio, 2014 as cited in Peterson, 2019). Creswell (2013) argues that purposeful sampling is useful when respondents are required to understand or have experience of the phenomenon being studied. This sampling method enables the researcher to pre-qualify those respondents to be interviewed. However, despite that the goal of purposive sampling is to ensure the selection of sources that will yield relevant and rich data, it is not necessarily a representative sample (Yin, 2016). Yin (2016) suggests that a researcher should deliberately interview some participants who possibly hold different views of the research area to remove any form of bias associated with interviewing pro-research participants. Consequently, the researcher adopted two purposeful sampling strategies: criterion sampling and snowball (network or chain) sampling. Criterion sampling is applied when participants are selected because they meet the predetermined criteria set by the researcher; Snowball sampling occurs when the pre-selected participants are asked to refer others who understand the research topic (Bloomberg & Volpe, 2019; Moser & Korstjens, 2018).

The researcher should ensure interviewees are representative of the group (Leedy & Ormrod, 2015). The researcher adopts purposive sampling because it allows selection of a sample of individuals with experience, and knowledge relating to the study area. Besides, this approach assisted the researcher to engage with some participants who are multi-disciplinary experts which in various disciplines and industries. Hence, the target participants were those who have a basic or working knowledge of BCT. BCT is an emerging technology, and many people are yet to understand premises. Some of the participants recommended others for possible interviews. The researcher followed up with the suggestions by sending a formal invitation to request participation in the study. This practice is said to be novel provided that “the snowballing is purposeful, not done out of convenience” (Yin, 2016, p. 95). The researcher further avoids sampling bias by interviewing participants from multiple sources and across disciplines.

To investigate the claims and counterclaims concerning whether BCT enhances or disrupts accounting and auditing, the researcher first compiled the list of authors or writers of the reviewed articles, some guest speakers, and participants s/he met when attending conferences in both face-to-face (f2f) and online environments. Additionally, the researcher joined and followed some BCT-related online professional groups notably 101 Blockchains, ConsenSys, Hyperledger project, Linus foundation and BlockchainNZ. After the compilation of names, emails were sent to the selected contacts requesting their participation in this study. Invitations were sent (via email, LinkedIn or both) to 198 people across the globe to participate in this research. Telephone calls and Short Message Service (SMS) were also used where necessary. Out of the 198 contacted, 50 agreed to participate but only 44 participants were interviewed (see ***Figure 15)***

Saunders et al. (2016) recommend five to 30 participants as a typical sample size, while Leedy and Ormrod (2013) suggest between five to 25 interviews as the sample size for purposeful sampling. However, Peterson (2019) contests the practicality of these recommended numbers of interviews by these qualitative researchers and asserts further that the underlying factor for the selection of participants should be based on accessibility, recruitment, logistics, research purpose, design and questions. This is similar to the position of Yin (2016) who observes that there are no hard and fast rules concerning sample size in a qualitative study. The study's sample size of 44 participants could be said to be adequate for a qualitative study of this nature because the researcher was guided by the recommended number of participants and observance of the data saturation.

Data saturation is widely used for the estimation of the adequacy of the qualitative sample sizes (Guest et al., 2020; Saunders et al., 2018) and Fusch and Ness (2015, p. 1409) emphasise that "there is no one-size-fits-all method to reach data saturation because study designs are not universal." Guest et al. (2020) propose three approaches for estimating saturating points: Base Size, Run Length, and New Information Threshold. These approaches can be applied to an inductive thematic analysis and a one-on-one interview with open-ended questions. Similarly, (Saunders et al., 2018) highlight four different models of saturation: theoretical, inductive thematic, a priori thematic and data saturation. However, the standard agreed principle is that saturation is the point at which researchers realise that there is no new knowledge gained from the subsequent discussions with research participants (Guest et al., 2006; Saunders et al., 2018).

With the emphasis on data collection, the data saturation model "relates to the the degree to which new data repeat what was expressed in previous data" (Saunders et al., 2018, p. 1897). Using data saturation as a model, this study observed saturation points for each of the groupings as follows:

Blockchain Start-ups and IT experts (BSIT) - 9th interview
Accounting Regulatory Bodies (ARB) - 5th interview

Audit & Assurance Firms (AAF)	- 7th interview
Accountants & Auditors (AAD)	- 4th interview
Financial Analysts & Other Experts (FAE)	- 4th interview
Academics (ACA)	- 6th interview

It was observed that at these different points, the level of repetition of what was previously said by other participants was high, and little or no new points emerged from the conversations. Since the participants were not predefined, and they were allocated into categories based on their expertise after the interview, the study did not give preference to any group but, rather emphasised the need for participants to meet the criteria for selection, i.e. a basic or working knowledge of BCT.

Levitt et al. (2018) note that qualitative researchers define the context within which a phenomenon or study topic is being construed. In a qualitative study, the researcher defines the context under which a research topic or phenomenon is studied or constructed and the context of data sources. Initially, this study was to engage in a face-to-face discussion with participants in New Zealand and possibly Australia, but due to the lockdown occasioned by the COVID-19 pandemic, the researcher was able to interview (through Zoom) participants from 13 countries.

5.3.2 Description of Participants

Many studies particularly concerning BCT and its implications, conducted their surveys within a particular national context rather than across national boundaries, which raises the issue of representativeness and the generalisability of results. For instance, the participants in the studies by Brender et al. (2019) on the potential impact of BCT on audit practice were from Switzerland, Gausdal et al. (2018) on “Applying BCT: Evidence from Norwegian Companies” were from Norway and those by Maull et al. (2017) on “Distributed ledger technology: Applications and implications were from the UK. However, this study’s participants spread beyond New Zealand which has given the study a broader outlook. To the best of the researcher's knowledge and at the time this study was conducted, it is the first of its kind to have participants from 13 countries and five continents. Underlying the intersectionality of research is the diversity in the research category and membership of participants (Cole, 2009). The intersection of participants across disciplines and geographical boundaries ensure the study's sample is not only broad but a good representative of the study population.

The essence of qualitative and exploratory research is to gather multiple views from interviewees (Treiblmaier & Beck, 2019). Interviewing multiple participants aligned with the overall goal of qualitative and exploratory research which is to add depth and richness to the collected data. The common denominator of all the interviewed participants is background knowledge and understanding of BCT. It is important to reiterate that the study explored whether BCT disrupts or enhances the accounting industry but did not delve into the technicalities of BCT, as this is beyond the scope of this study. The focus is to explore the accounting practices that will change, the relevance of auditors, and the fraud prevention and detection mechanism of BCT using an adequate sample size.

The study's participants were divided into six categories: BSIT, ACA, ARB, AAF, AAD and FAE (see Figure 14). The BSIT group is composed of founders/CEOs, IT experts and managers in blockchain start-ups. Included in the BSIT group were 11 individuals from companies with blockchain footprints and managers of companies who have implemented blockchain for one or two operational processes. In the ACA group were eight academic scholars from professors to senior lecturers who have published articles on blockchain-related matters. Six participants in the ARB group were experts in technologies-related matters and board members from global professional accounting regulatory bodies such as CAANZ, CPA Australia, ICAEW, SAICA, ACCA and AICPA.

The eight participants in the AAF group were from the Big 4 Firms and this included audit partners, directors and managers, chief transformation officers as well as IT managers. The AAD group is composed of six professional accountants and CPAs who were from non-Big 4 firms and neither currently employed as auditors nor working in audit firms. Some of them were Heads of Finance, Head of Consulting Firms, senior bankers, IT auditors and directors in different organisations. The FAE group has five, and this includes financial analysts, consultants, officials from government ministries, senior editors, operational managers, and supply chain management experts. Some participants have cross-specialisations. There were diversities in job titles and fields of the participants.

The researcher observed an element of complexity regarding the classification of participants into categories. For instance, some participants were previously in practice before embarking on their academic careers. Some doubled as academics and practitioners, several others were professional accountants with IT backgrounds, and others were CPAs and co-founders of blockchain start-ups. The researcher found it easier to allocate participants to other groups except for the BSIT group. Eventually, the participants in BSIT groups were those working in BSITs with BCT footprints. All the participants were asked to rate their knowledge and understanding of BCT during the interview. The profile of all participants including how they rate their knowledge and understanding of BCT (between 1 and 10, where 10 is the highest) is shown in Appendix 1. The objective was to examine the extent of the Dunning-Kruger effect in the rating of their knowledge of BCT.

Overall, 44 interviews were conducted with participants from 13 countries and five continents. The countries include New Zealand, Australia, USA, UK, Canada, Ireland, Germany, Italy, India, Pakistan, South Africa, Hong Kong and UAE. The continents are Africa, Asia, Europe, North America, and Oceania. The interviewees were composed of 32 males and 12 females.[14] Using snowballing, the researcher received 28 referrals from both participating (8) and non-participating (19) contacts. The referrals from non-participating contact were significant because they were able to identify contacts in their network who have a fair knowledge of BCT. This is why Krippendorff (2004) describes snowball sampling as an avalanche with the likelihood of increasing sample sizes exponentially. The summary of the profiles of the participants, the geographical distributions and the classification is shown in **Figure 15**. Although participants came from different geographical locations, their knowledge of BCT is from their general understanding of the technology and has little or nothing to do with their locations. The majority of participants are from the USA followed by New Zealand. Participants acknowledged that one of the major barriers to the adoption of BCT is poor education and a lack of general understanding of the technology (see Chapter 8.4.1.1)

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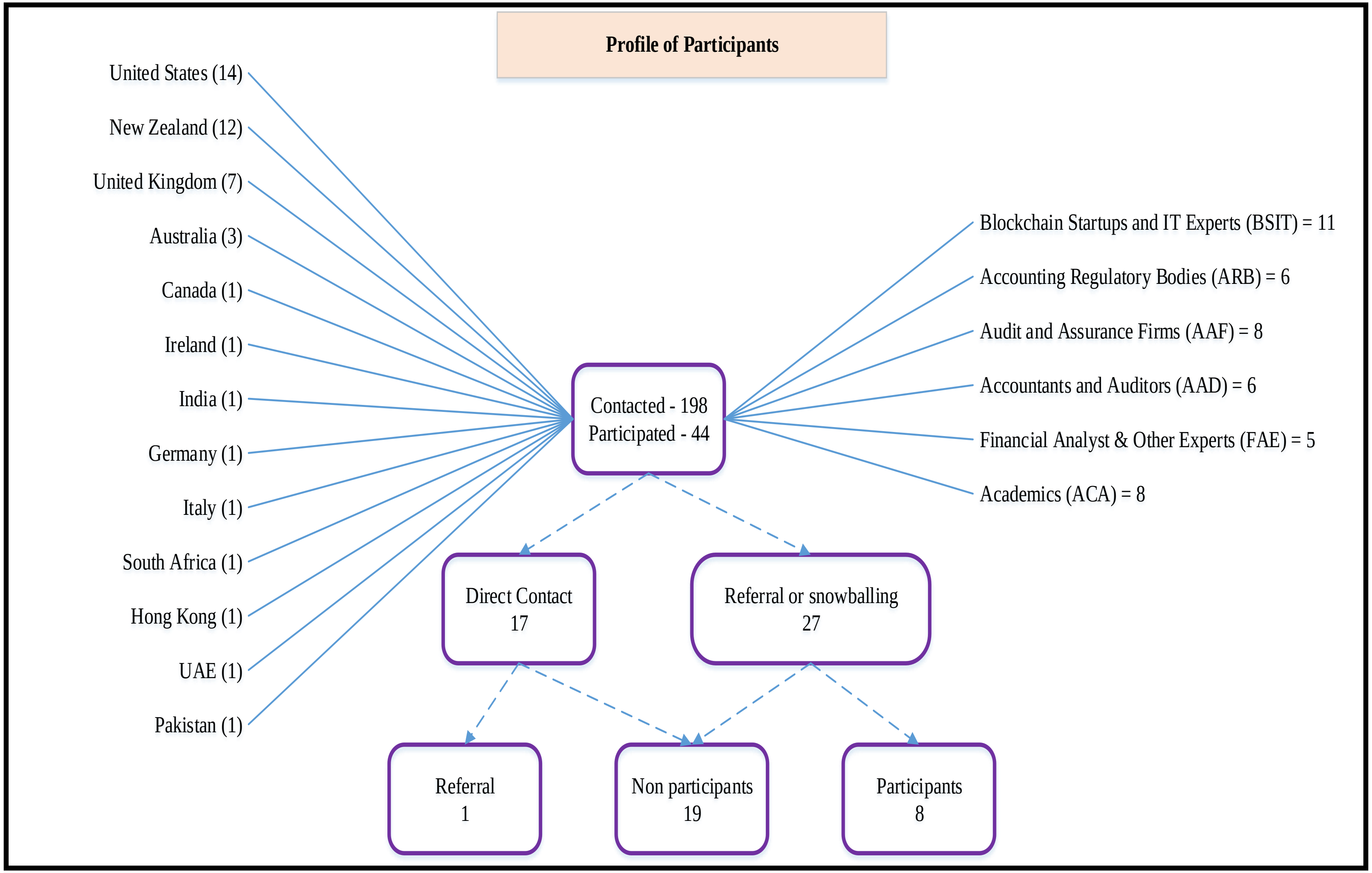
[14] To preserve the anonymity and confidentiality of the research participants, this thesis adopts gender neutrality. There is a high chance that some participants could be easily identified once their genders are revealed. Consequently, gender was not attached to information at Appendix 1.

Figure 15. *Distribution of Participants*



Note. Source: Author

5.3.3 Access to Data

Matters of access for the interview qualitative method are critical issues that require careful management because of the diverse individual backgrounds of the participants (Schwartz-Shea & Yanow, 2012). Lodhia (2019) observes that access to research data could be difficult in qualitative research, hence researchers must explain in detail how to obtain access to the research site. The access to data was conducted as follows. First, approval was obtained from the University of Waikato ethics committee (see Appendix 4). Secondly, an invitation was sent to the pre-qualified participants via email, LinkedIn, and telephone to establish personal contact and solicit their participation in this study. Included in the invitation email were the introductory letter to participants (see Appendix 5), a participant information sheet (see Appendix 6) and the consent form (see Appendix 7).

Establishing personal contact is considered important because participants are more likely to consent to be interviewed (instead of completing a questionnaire), especially where the interview topic is interesting and relevant to their work (Saunder et al., 2016). Personal contact with likely participants began by visiting some accounting and auditing firms in New Zealand if staff were available to participate in this study. This approach was unsuccessful because the accounting firms visited claimed that they were not involved in blockchain operations. The researcher met the first set of participants for this study in a seminar organised by FinTech NZ in collaboration with BlockchainNZ and Deloitte in Auckland. The seminar gave the researcher the opportunity to various blockchain start-ups, accounting firms, and IT experts. The researcher also contacted some authors of reviewed articles on BCT to solicit their participation.

The researcher tackled the challenges of accessing data by subscribing to or joining some online platforms with digital application footprints, particularly in the emerging field of BCT. The researcher also regularly attended face-to-face and online seminars relating to BCT. The researcher subscribed to newsletters, conversations from BlockchainNZ, Deloitte, AccountingToday, Journal of Accountancy (JofA) alerts, Cointelegraph, HyperLedger Events, 101Blockchains, Gilded finance, IMF, Google, Government Computing, TradeLens blockchain solution and ConsenSys, amongst others. Snowballing also aided access to some participants.

Confirmation e-mails were sent to individuals who agreed to be interviewed and this was accompanied by a letter of introduction, participant information sheet and a consent letter to enable the participants to confirm their participation. A convenient date and time for the Zoom interview were also requested. The information sheet explained to the respondents that the interview is voluntary, the data collected is for academic purposes and their participation is anonymous unless they choose to waive confidentiality.

Schwartz-Shea and Yanow (2012, p. 122) explain that "in interpretive design, researchers have little or no power in control of their research settings unlike the experimentalists do." This is because the participants may decide their level of participation than initially envisioned by the researcher." Eventually, of the 50 participants who agreed to be interviewed, 44 interviews were successfully conducted. Some participants agreed to spend more than the agreed 60 minutes to ensure that they covered all the topics, while, two of the participants who earlier agreed to spend 60 minutes decided to give half an hour due to other work exigencies. Nonetheless, the researcher was able to have a robust discussion with all participants and, where necessary, additional clarifications were obtained via email.

However, access to data is limited due to the commercial sensitivity of the blockchain business. Some of the respondents did not provide the names of their clients that are experimenting with BCT due to the confidentiality and commercial sensitivity of such disclosures. Perhaps this might have limited the depth of information available to the researcher. Despite this, the primary data obtained from interviewing professionals and practitioners help to shed light on the extent of and disruption and adoption of BCT in the accounting and auditing fields, the effectiveness of BCT systems in fraud prevention and detection, what should be audited in a BCT environment, and the impact of COVID-19 on the adoption of BCT, amongst others.

5.3.4 Qualitative Interview

In planning data collection, Leedy and Ormrod (2013) emphasise the need for a researcher to understand the types of data required; where they are located, the means to obtain data, and how to interpret data. The reviewed literature at the study preparation stage formed the basis for defining the research problem and outlining the research objective and questions. The existing literature reveals that some of the studies on how BCT will impact the accounting industry failed to obtain inputs from the practitioners and determine the extent of adoption of the technology among accounting professionals. The interviews of practitioners, including academics, have helped to shed light on the disruption of BCT in the accounting industry.

Qualitative research design can either be a mono-method qualitative study (use a single data collection technique) or a multi-method qualitative study (use more than one data collection technique) (Saunders et al., 2016). This study is a mono-method qualitative study that relied on the semi-structured interview for the collection of primary data and a purposeful sampling technique.

Interviews can be structured, unstructured or semi-structured. An interview is a key method among the numerous methods used within interpretive accounting research (Broadbent & Unerman, 2011). It can be referred to as a social practice or basis of information gathering (Dordah & Horsbøl, 2021), and a vehicle for theoretical sampling (Foley et al., 2021). Similarly, Peterson (2019) asserts that an open-ended posture coupled with a focus on participants' views and understanding of a phenomenon can provide useful and meaningful insights for a researcher. Semi-structured interviews can assist the researcher to obtain useful and relevant information to achieve the research's objectives (Saunders et al., 2016). Hughes (2016) notes that interviewing should be seen as a process with no best way to undertake it because it involves many connected events that researchers should need to consider. However, Schultze and Avital (2011) argue that even though interviewing is a widely used tool for data collection in a qualitative study, it does not give automatic assurance that rich data and meaningful insights will be generated. Schwartz-Shea and Yanow (2012, p. 4) capture the rationale behind why researchers undertake interviews:

> A researcher can interview based on the belief that there are multiple perceived and/or experienced social "realities" concerning what happened, rather than a singular "truth". In this view, the researcher would assume that event narratives are likely to vary depending on the perspective (political, cultural,

experimental, etc.) of the persons being interviewed.

The primary data for this study were obtained through interviews and the secondary data were from the available prior studies such as academic and professional journals, articles, the internet, reports, and position papers. Primary data can be collected through a face-to-face interview, telephone interview, mailing questionnaire, schedules, and observation (Kothari, 2004). In a constructionist interview approach, the researcher and the participants are actively engaged in an interactive discussion of the study phenomenon (Roulston, 2011). The study collected data using semi-structured interviews to give the participants the freedom to express their views. Additionally, the semi-structured interview format also enables the researcher to dig deep to gain an understanding of BCT as it affects the accounting industry. This approach also supports the constructivist-interpretivist methodology adopted in this study where it is believed that it is through the engagement with the practitioners that one can truly understand if BCT is a disruptive technology and the extent of disruption it has on the accounting and auditing fields. Secinaro et al. (2021) noted that blockchain research in accounting is dominated by scholars with little or no participation from the practitioners This research avoids this pitfall by interviewing both practitioners and academics Previously, scholars that have used interviews to conduct similar studies include Brender et al. (2019); Gausdal et al. (2018); Maull et al. (2017). The use of interviews is in line with scholarly practice.

Interviews are appropriate tools for data collection because participants' perspectives are important to understanding the emerging phenomenon known as BCT. Interviews are dialogical performance, social meaning-making acts, and co-facilitated knowledge exchanges (Koro-Ljungberg, 2008, p. 430). The essence of an interview is to enable dialogue where researchers and study participants share their experiences to co-construct their understanding of the research topic (Koro-Ljugberg, 2008). The primary data from interviews helps to shed light on the possible practical challenges, from academics, professional and practitioners' points of view, which could confront accountants in the prevention and detection of fraud in blockchain transactions, deciding how and what is being audited in a blockchain platform, and if the technology can eliminate audit roles and core functions of accountants.

Interviewees can use the interview as a platform to project personal organisational change (Schultze & Avital, 2011) and provide distorted data or self-serving responses because of individual bias or the emotional state of interviewees during the interview (Patton, 2015). The nature of the interview is conversational or dialogical in nature, the researcher cannot prevent participants from projecting self-serving responses or an organisation agenda. In interpretivist philosophy, where a researcher is concerned with understanding participants' views, semi-structured interviews provide an opportunity to probe and seek further clarification on participant assertions or ideas (Saunders et al., 2016). Patton 2015 recommends the use of an interactive style as a technique while interviewing "elites" or "experts".

Consequently, this study was able to probe participants and cross-reference different views by sharing differing opinions on any particular issue with the participants. Furthermore, the study adopted an interactive style because participants were experts in their various fields. This could be said to help in moderating bias or extreme comments from some participants. The study was further guided by the Dunning-Kruger effect, a situation where people claim to know so much or so little, but the reverse is the case. Similarly, the discussion with participants was facilitated with the use of interview guides and participant profile forms.

5.3.4.1 *Designing Interview Guides and Participant Profile Form*

An interview guide derived from the research questions and reviewed literature ensured the consistency of the approach during the interview (Azungah, 2018; Brewster et al., 2015). Yin (2016) describes the interview guide used for undertaking a qualitative interview as a set of reminders for the interviewer that is not organised in the same way as a formal questionnaire. The interview guide facilitates time management, ensures methodical and comprehensiveness of the interview, and assists the interviewer to anticipate logical gaps in data and bridge them. The interview guides, despite their flexibility, could make the comparison of responses difficult due to the respondents' divergent views regarding interviewer sequencing and wording of questions (Patton, 2015). The reliability and validity of the study were conducted in question-wording used for the interview. This practice is affirmed by Bell and Waters (2014, p. 121) when they suggest that "the check for reliability will come at the stage of question-wording and piloting the instrument".

With guidance from reputable academic sources, the researcher used the study's research questions as the basis to develop the interview guide and interview questions. An interview guide is designed to ensure the same questions are asked of each person interviewed (Patton, 2015). The objective was to ensure that participants were asked questions that related to their fields. The guide is the checklist which the researcher used during the interview to ensure all relevant areas were captured. The interview guides were sent to four lecturers and two doctoral colleagues to review and provide feedback to the researcher. After incorporating their comments and feedback, the researcher resubmitted the interview guides to the supervisors. Subsequently, two pilot video interviews were conducted, and the transcripts were sent to the supervisors to see the themes that emerged. From the pilot interviews, the supervisors provided additional guidance.

The interview guide provided participants with the opportunity to express their views on the interview questions without any constraint and according to their knowledge. The researcher reiterated in the letter of invitation that participants can decline to answer any question. The unexplored nature and the nascent developmental stage of the BCT supported this approach as it added depth to the richness and quality of the findings. The researcher used the interview guide to ensure that respondents did not deviate too much from the interview focus. The final interview guide is included in Appendix 2.

The Participant Profile Form (PPF) (see Appendix 3) is used to maintain comprehensive information about each participant. The template for the PPF was adapted from Bloomberg and Volpe (2019, p. 390). The form contained the name (codes), profile, type of contact, date of contact and interview date as well as a provision for additional information. It also enabled the researcher to reflect on the overall impression, concerns and issues that needed to be addressed after the interview. Other details noted in the PPF are how the researcher was treated, the tone of the conversation and the general disposition of participants. The PPF aided the researcher to make further clarifications or send reminders to the participants as deemed necessary.

The interview was conducted in English but there were differences in accents and diction of participants. The researcher was able to cope with the variation in accent or diction by using the chat message on Zoom where s/he did not understand the terminologies or acronyms used by the participants and vice-versa. Additionally, each participant had a copy of the interview guide, and this reduced communication problems. However, verbal cues of participants were noted to the extent that the Zoom video allowed. The recording of the interviews aided the researcher to watch for verbal cues that could make participants uncomfortable with wording or any other aspects that could affect the interview. Thus, the interview guide helps in the interview process.

5.3.4.2 Interview Process

Prior to interviews, Saunders et al (2016) note that credibility is enhanced when participants received interview themes. The researcher sent the interview guide to all interviewees and other relevant information before the interview which allowed participants to acquaint themselves with the research questions or direction and facilitate preparation. Consequently, the researcher gained credibility from participants before the interviews.

The interviews were opened with a thank you, a brief introduction from the researcher, and an overview of the aim of the research and its significance. Before commencing the interview, each participant's consent, and approval to record the interview electronically were obtained, and the right of the participant to decline to answer any question was emphasised. This was done in addition to the informed consent form signed by each participant (see Appendix 7). Furthermore, individual participants were asked if they had any questions or required clarification concerning the topic. Where there were any questions, the researcher responded to them before commencing the interview. Thereafter, the participant was asked to introduce themselves. This helped to begin the conversation in a friendly manner, established credibility and gained the participant's confidence. Some participants waived anonymity by authorising the researcher to attribute their comments to them. Despite this waiver, the researcher decided to ensure all participants' privacy and anonymity were maintained by using alphanumeric codes to represent them. The anonymity of participants prevents professional "jealousy", and the use of this study to project personal or organisation agenda.

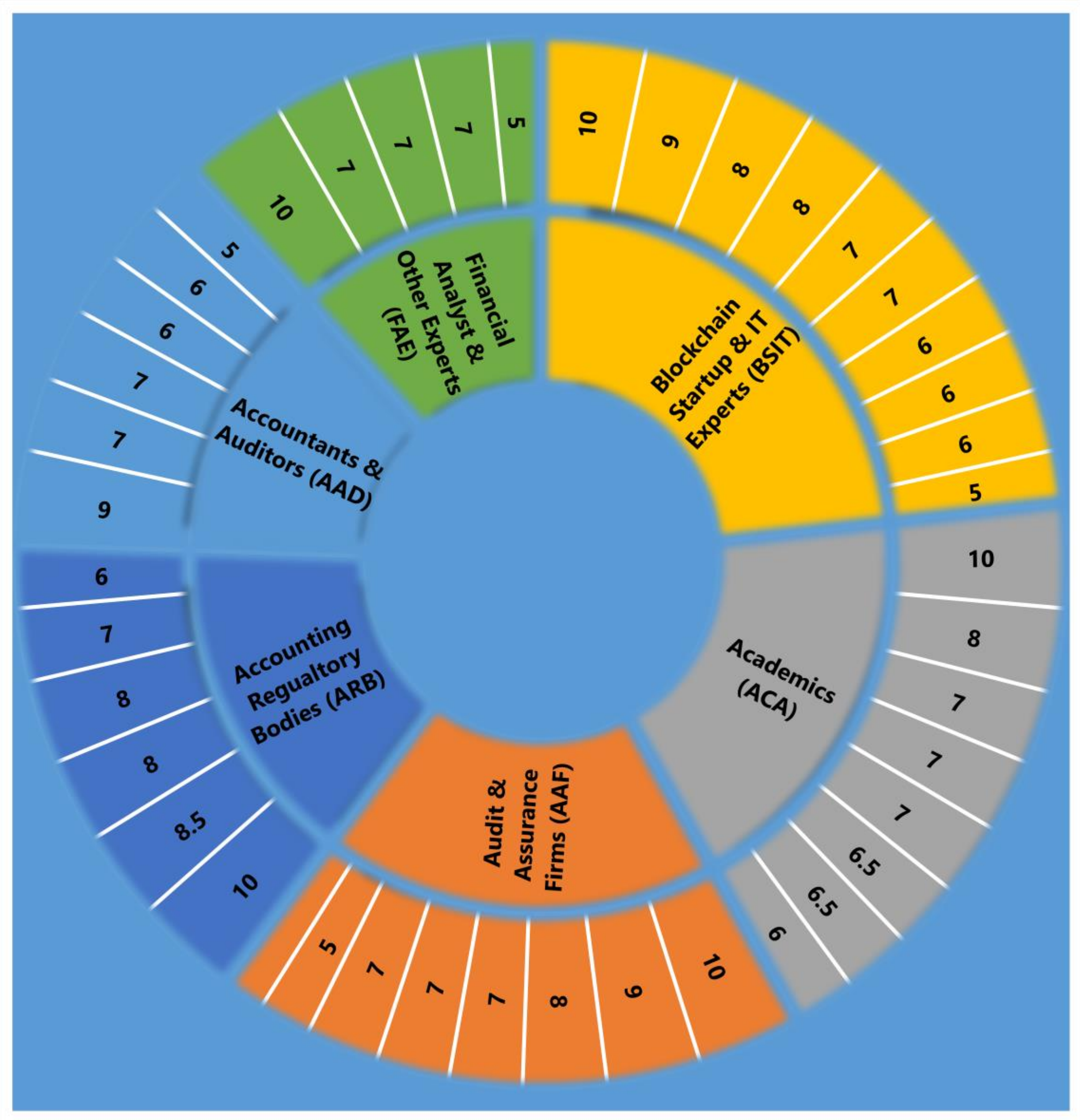
Having gained the confidence of the participants, the researcher started by asking interviewees general questions which helped to ascertain their knowledge and understanding of BCT. For instance, "are you familiar with the word BCT on a scale of 1 to 10 (with 10 being the highest), how do you rate your knowledge/understanding of BCT? (See Appendix 1). From these general questions, some participants answered some other interview questions and so the researcher followed with relevant questions and further clarification where necessary. Therefore, the order of the questions in the interview guide was not rigidly followed as it depended on the flow of the conversation. Whenever respondents declined to answer any question, the researcher of this study offered his apologies and asked the respondents to select areas they felt comfortable speaking about.

Considering the Dunning-Kruger effect (see Chapter 1.2), **Figure *16*** depicts how the participants rated their understanding of BCT. Some participants rated their knowledge of BCT as 10/10, some rated themselves as average and one participant awarded himself/herself a four. Surprisingly, this participant is from one of the Big 4 firms. Motta et al. (2018), aligning with the Dunning-Kruger effect, describe such perceptions as "knowing less but presuming more". The participant's rating of their knowledge indicates elements of the Dunning-Kruger effect which could be seen in how well some participants rated their understanding and knowledge of a technology that is evolving and immature.

Saunders et al. (2016, p. 421) acknowledge that "the research methods literature has not yet caught up with the use of videotelephony as opposed to voice-only, traditional telephony, so you will need to evaluate your own experience of access to and use of video chat apps such as Skpye™ or Facetime™ when you consider how you might set to conduct qualitative interviews." Despite this low exploration of videotelephony for a qualitative interview, the researcher was able to use Zoom to conduct the interviews for all participants. It must be noted that the researcher originally planned to conduct a face-to-face interview in New Zealand and use video telephony for other participants outside the country. However, the COVID-19 pandemic encouraged the use of videotelephony and the experience gained by the researcher could be useful to other researchers.

The interviews were both video and audio recorded. The anonymity of participants is maintained because they are represented by codes including those that waived

Figure 16. *Participants' Knowledge of BCT*



Note. Source: Author

anonymity. To safeguard the privacy of the participants, a passcode was generated for each Zoom interview. The purpose of the Zoom passcode was to prevent an uninvited person from gate-crashing the interview and to protect the privacy of participants.

The average time for each interview was about 60 minutes, but the researcher was able to ensure robust discussion, adequate coverage of any emerging issues and all relevant points were covered during the interview. An email was used as a follow-up for clarifications when necessary. The video and audio recording ensured that no important points or useful views were missed. However, it is important to note that there was a technical hitch in one of the interviews for a participant in New Zealand. A telephone call was used to complete the interview and this was also recorded to avoid missing any useful information.

At the end of the interview, the participants were thanked for their valuable time and contribution to the study and the researcher further requested them to refer him to anyone in their contacts that understood BCT. This request was considered by some participants, and it helped to get more participants. On completion of the interview, the video was transcribed verbatim according to the well-established University of Waikato ethics guidelines.

The interviews were conducted over seven months between 17 October 2020 to 15 April 2021. Participants were given the freedom to choose a date and time convenient to them. The time differences between New Zealand and other countries were one of the challenges faced by the researcher. This kept the researcher up late at night or waking up early to keep interview appointments. I observed some participants were surprised when they realised the researcher was African, not a Kiwi. This unnerved me, but it has little or no effect having studied in four different continents: Africa, Asia, Europe, and Oceania. All the interviews were conducted at the researcher's office at the University of Waikato where there is stable internet connectivity and a quiet atmosphere. Despite the use of software for initial transcription, each interview transcript took the researcher an average of three days depending on the length of the discussion and variation in accents.

5.3.5 Data Analysis

In qualitative research, data collection, data analysis, and the development and substantiation of propositions are interwoven processes (Saunders et al., 2016). The interactive nature of data collection and analysis enables researchers to identify important themes, patterns and relationships in the collected data (Saunders et al., 2016, p. 571). The methodology of a qualitative study may continue to evolve over the course of the investigation (Leedy & Ormrod, 2015, p. 270). Similarly, Creswell (2013) makes it clear that qualitative research is always evolving because the initial research plan cannot be tightly prescribed, and all phases of the research process can change at the start of data collection.

Qualitative data analysis can be achieved using a range of computer-aided qualitative data analysis software (CAQDAS) such as Excel, ATLAS.ti, Dedoose, Ethnography, EthnoNotes, HyperQual, HyperRESEARCH, Kwalitan, Leximancer, MAXQDA, NVivo QSR, QDA Miner, Qualrus, and Transana (Leedy & Ormrod, 2015, p. 318; Saunders et al., 2016). It is impracticable to recommend any of these software as the best (Bloomberg & Volpe, 2019) because the choice of CAQDAS tools depends on the researcher's knowledge and the applicability to the research data (Saunders et al., 2016). Institutional requirements and personal preferences determine the method researchers adopt for data management and analysis (Bloomberg & Volpe, 2019).

Notwithstanding the method of data analysis adopted, some approaches to analyse qualitative data are one or a combination of Content, Discourse, Data Display and Analysis, Explanation Building and Testing, Grounded Theory Method, Narrative, Thematic and Template (Leedy & Ormrod, 2015; Saunders et al., 2016, p. 619). Thematic analysis is flexible as it is not tied to a particular philosophical position and is compatible with deductive or inductive approach, essentialist, and constructionist paradigms (Braun & Clarke, 2006; Saunders et al., 2016).

This study adopts a thematic analysis to analyse data collected through semi-structured interviews with the aid of NVivo qualitative analysis software. The need to code a large volume of data necessitated the choice of CAQDAS because the manual coding of 44 transcripts could have become cumbersome and unorganised.

It is important to note that CAQDAS tools do not help in reading, coding, and sorting research data, they are just tools used for organising and aiding analysis. The use of any of this software requires training because of some of its complex features. Consequently, the researcher is proficient in the use of the NVivo software having received training on its basic use. Besides the training, there are online NVivo tutorials that support software usage. The software program has a range of features such as importing, coding, exploring, analysing and exporting all forms of data. Furthermore, it facilitates not only the analysis of unstructured text, audio and video but also supports importing of files from EndNote. EndNote is the referencing tool used in this study for the storage of all accessed publications.

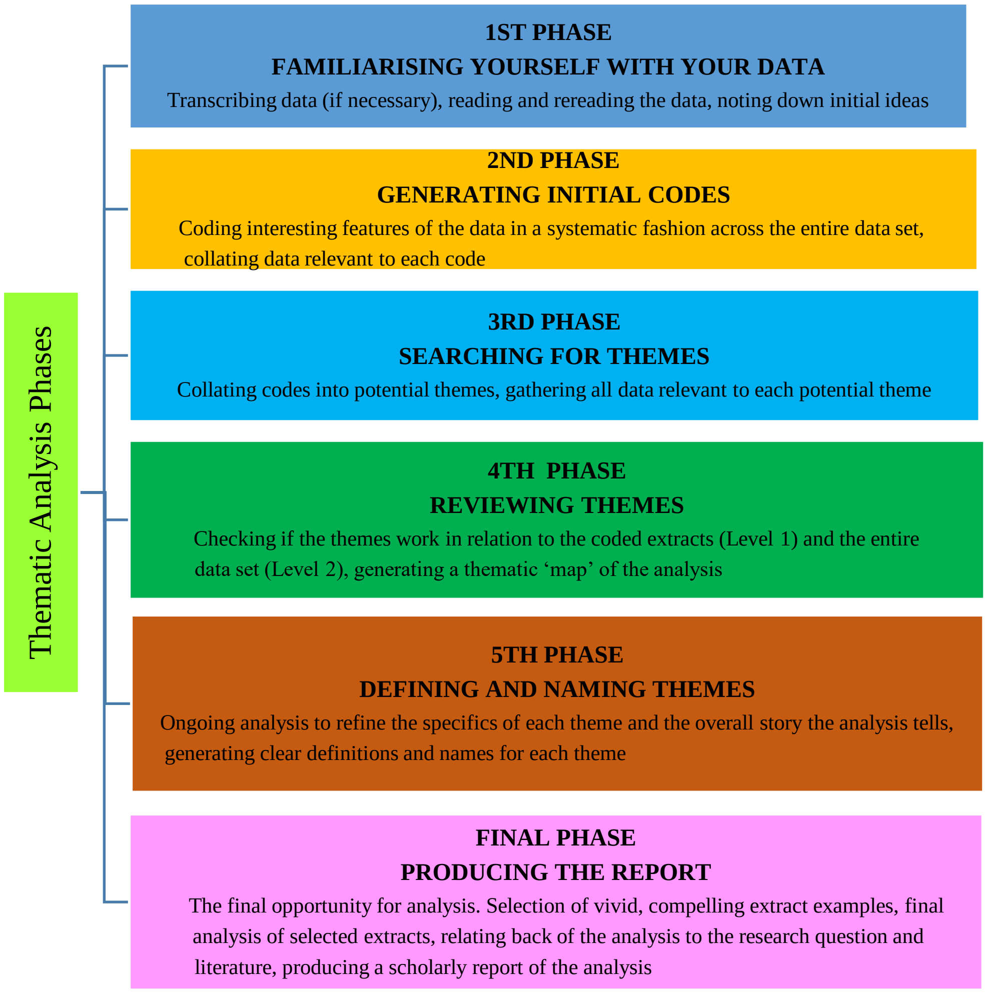
Thematic analysis is an analytic approach in qualitative research in which a researcher identifies for later retrieval the themes that emerge out of data such as interview transcripts and field notes (Byrne, 2017; Evans, 2018). Researchers need to understand thematic analysis first because it provides core skills for undertaking several other types of qualitative analysis (Braun & Clarke, 2006). The thematic analysis stages include preliminary scanning of the materials, development of a set of thematic categories and emergent “in-vivo” inspirations, coding of elements in the materials as representatives of the themes, and using a software package that facilitates the coding of textual materials to thematic nodes and sub-nodes (Byrne, 2017). However, the provision of outlines and templates by some scholars for the development of themes is inadequate for thematic analysis (Vaismoradi et al., 2016).

The researcher followed the thematic data analysis guide propounded by Braun and Clarke (2006) and which includes familiarity with data, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and report writing. Besides flexibility, the thematic analysis can provide a comprehensive and rich account of the data of the phenomenon under investigation. Further, thematic analysis facilitates creativity, intuition and innovation which are important aspects of data analysis and the development of themes (Vaismoradi & Snelgrove, 2019). These six phases of thematic analysis are shown in ***Figure 17***.

5.3.5.1 *Familiarity with Data*

Familiarity with data began with the collection of data by the researcher. As earlier mentioned 93% (41 out of 44) of the respondents were interviewed via Zoom. All the participants were interviewed via Zoom except other than three participants who sent in written answers to the interview questions. The data immersion started with the interview of participants by the researcher and repeated listening and reading of the interview transcripts. The researcher used this familiarity phase to take note notes and highlight some interesting areas for subsequent coding and analysis. Almost all the interviews were conducted online using Zoom online platform due to COVID-19 and the participants’ dispersed geographical locations. Zoom aided both the video and audio recordings of the interviews. A backup audio recorder was also used in case of a technical issue with the Zoom-embedded recording. On one occasion when there was a technical itch, the researcher used a telephone call to complete the interview. This was easy to accomplish as the participant was a resident of New Zealand.

Figure 17. *Phases of Thematic Analysis*



Note. Source: Adapted from Braun and Clarke (2006)

Scholars (Bloomberg & Volpe, 2019; Braun & Clark, 2013; Moser & Korstjens, 2018) have emphasised the need to ensure transcripts are recorded verbatims. Similarly, Oliver et al. (2005, pp. 1273-1274) broadly classify transcription into two modes: "naturalism, in which every utterance is transcribed in as much detail as possible, and denaturalism, in which idiosyncratic elements of speech (e.g., stutters, pauses, nonverbals, involuntary vocalizations) are removed." The researcher ensures that all transcripts were recorded verbatim, but where there is a need to use the element of denaturalism to keep the flow of the interview the researcher removed involuntary vocalisations. Taken as a whole, the transcripts depict the original records from the interviews.

Researchers gain a better understanding of data when transcription is done personally, and checking the transcripts back for accuracy against the original audio recordings is good practice (Braun & Clarke, 2006; Moser & Korstjens, 2018). The transcription of the interview initially commenced with the use of an Otter voice software speech-to-text transcription for all participants. The software helped to reduce the number of hours that would have been spent by the researcher on transcription, but the software does not give 100 per cent accurate results due to different intonations by the participants.

Despite the use of the Otter voice software, the researcher transcribed unaided, 41 of the transcripts based on repeated listening to the video and audio recordings. This was done to ensure that the interview transcripts reflect the language of the participants. Besides this, the researcher also enlisted three PhD colleagues to listen to the interview recordings of participants with difficult accents to eliminate possible errors and misrepresentations. Additionally, the transcripts were sent to ten participants for correction and validation. Only one of the participants returned the transcript. The transcription of the interviews gave the researcher useful insight and understanding of the data which helped generate the initial codes.

5.3.5.2 *Generation of Initial Codes*

Codes are themes that researchers identify in their data. Coding is essential to enable the seamless organisation of conceptual development and the indexing of materials for explanatory purposes concerning demonstration and argument (Byrne, 2017). It is the identification of the relevant data that connect to research questions (Braun & Clark, 2013). Qualitative coding entails the retention of data and quantitative coding is about data reduction (Bloomberg & Volpe, 2019). The coding was achieved with the use of NVivo qualitative software. Once the transcripts are imported into NVivo, the software quickly and easily assists the researcher to organise the data and facilitating coding.

In NVivo, coding starts with the creation of a new code with an appropriate theme/heading. Relevant contents from the transcripts were created under codes by simply dragging and dropping the relevant passage of the interview files. The coding can be parent or child codes depending on the identified themes and with a provision to code the same extracts under as many codes as possible. The software also has a provision for recoding where there is an error in coding or with identified themes. ***Figure 18*** is an example of the codes generated using the NVivo software.

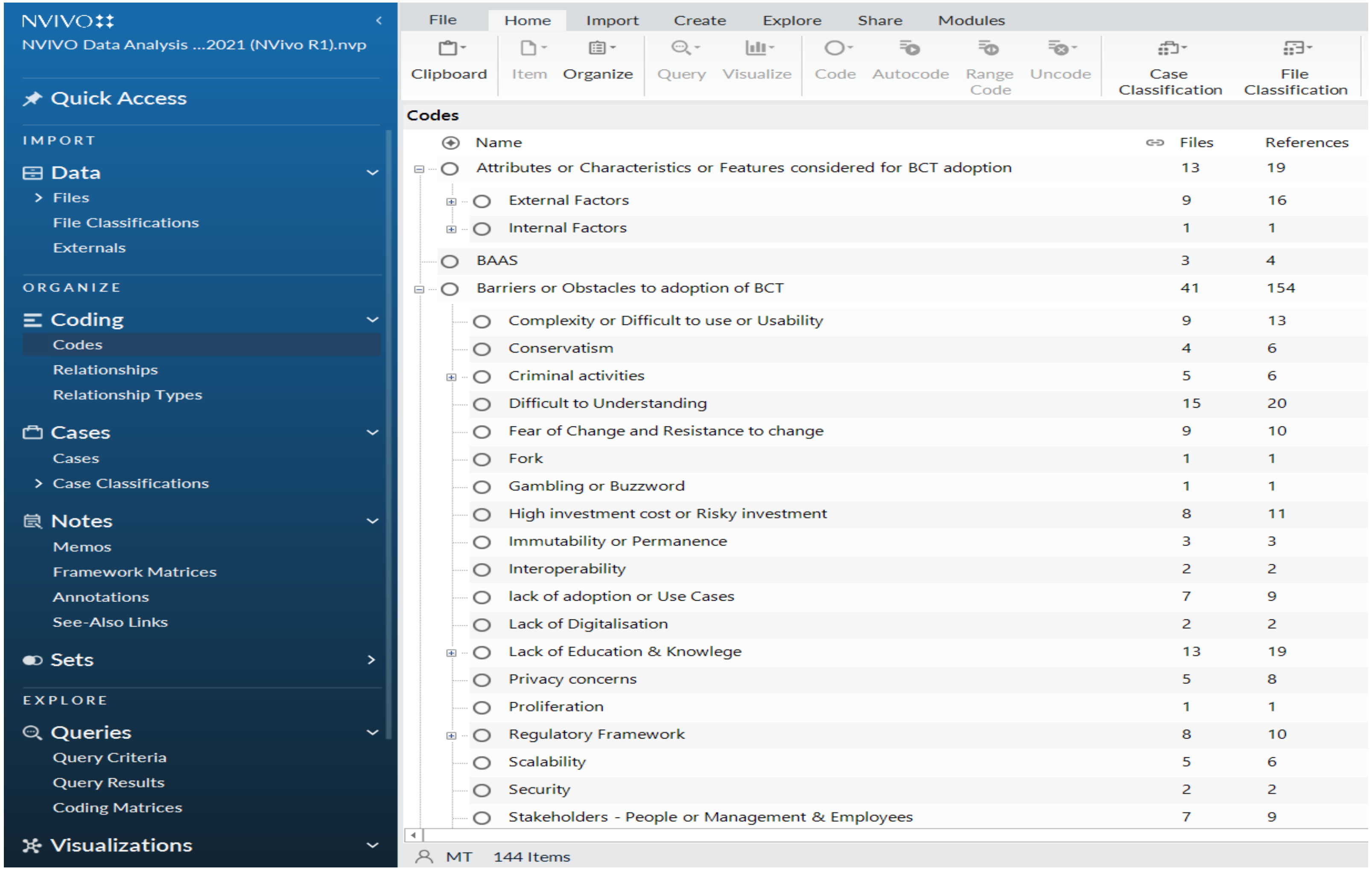
Coding depends on whether the themes are theory-driven, data-driven, the aim of coding, and the method of coding (Braun & Clarke, 2006). The two approaches that can be used are selective and complete coding (Braun & Clark, 2013). Selective coding involves cherry-picking from collected data. A disadvantage is that it is time-consuming compared to complete coding. In complete coding, the researcher codes all data that are relevant to the research questions. Similarly, in the data-driven approach, themes rely on the data while in the theory-driven approach the researcher can code data around specific questions. The researcher can also aim to code the entire data set or specific content (Braun & Clarke, 2006).

Conversely, Vaismoradi and Snelgrove (2019) highlight the importance of flexibility in navigating between methodical stages or the method of theme development because researchers should not be constrained by a particular method. The initial codes were constructed from the interview transcripts, codes and themes revolved around the research questions. Thus, the study adopted a complete coding approach by capturing everything that provides answers to the research questions. The researcher did not ignore anything in the initial coding because the entire data set was systematically coded with full and equal attention to the interview transcripts by identifying important aspects to form themes as well as retain contradictory accounts. The coding also mirrors the participants' language.

5.3.5.3 Searching for Themes

Searching for themes involved arranging the different codes into likely themes and collating appropriate extracted coded data into categories. Codes were examined for repetition, similarities, and differences to aid further analyses. In this phase, the challenges encountered include the effective organisation, and arrangement of themes and sub-themes as well as what portion of transcripts should be coded under the identified themes. The relationship between codes, themes and sub-themes were complex and the researcher often got lost as t where a certain code should be placed. A visual thematic map is a useful tool for exploring the association between these elements (Braun & Clark, 2013). Thus, this study used the creation of tables,

Figure 18. *Data Extract with Codes from NVivo*



Note. Source: Author

projects, mind maps, and drawing of figures with the NVivo visualization tools to sort the different codes into themes and explore the relationship between codes and themes, themes and sub-themes. Examples of thematic maps are shown in **Figure 19 and Figure 20**.

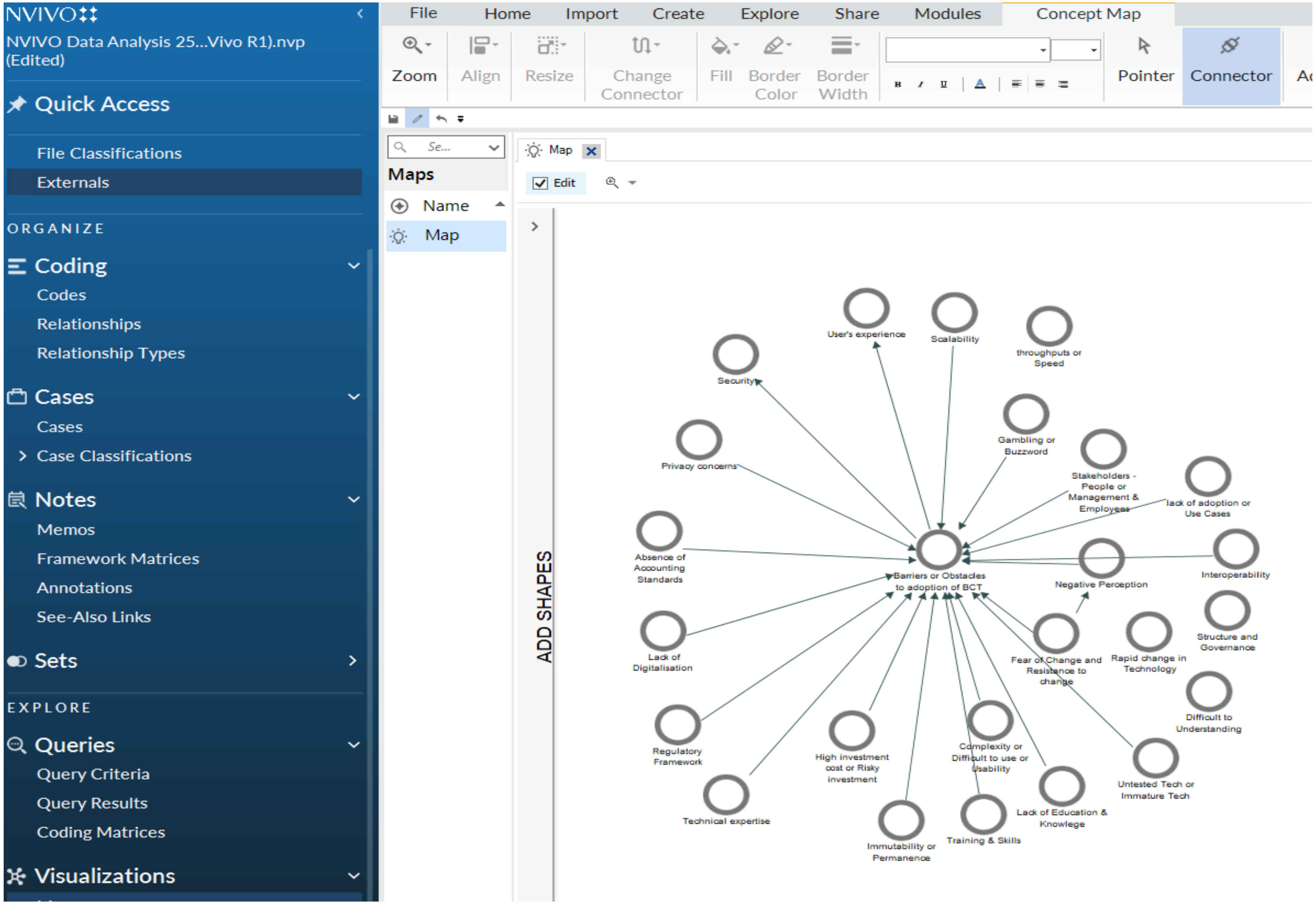
Braun and Clarke (2006, p. 90) note that "at this stage, you may also have a set of codes that do not seem to belong anywhere, and it is perfectly acceptable to create a 'theme' called 'miscellaneous' to house the codes - possibly temporarily - that do not seem to fit into your main themes." In ***Figure 20***, there is a theme tagged "internal audit" which emerged from the discussion with participants. The researcher kept this theme to understand how it fits into the main themes or sub-themes. Such codes can be re-examined thoroughly during the theme review phase.

5.3.5.4 *Reviewing Themes*

This phase involves reviewing and refining themes the former entails reading and pruning all the collated extracts for each theme to achieve coherence and the latter involves the same process but it applies to all data sets (Braun & Clarke, 2006). Themes are analytically important and useful in translating participants' viewpoints into the language of decision-making and practice (Vaismoradi & Snelgrove, 2019). After searching the transcripts for relevant themes, the review of the themes was executed by ensuring their segregation into logical and coherent main themes. In this phase, additional themes emerged from reading the interview transcripts, realignment of the identified themes and removing themes that have no supporting data.

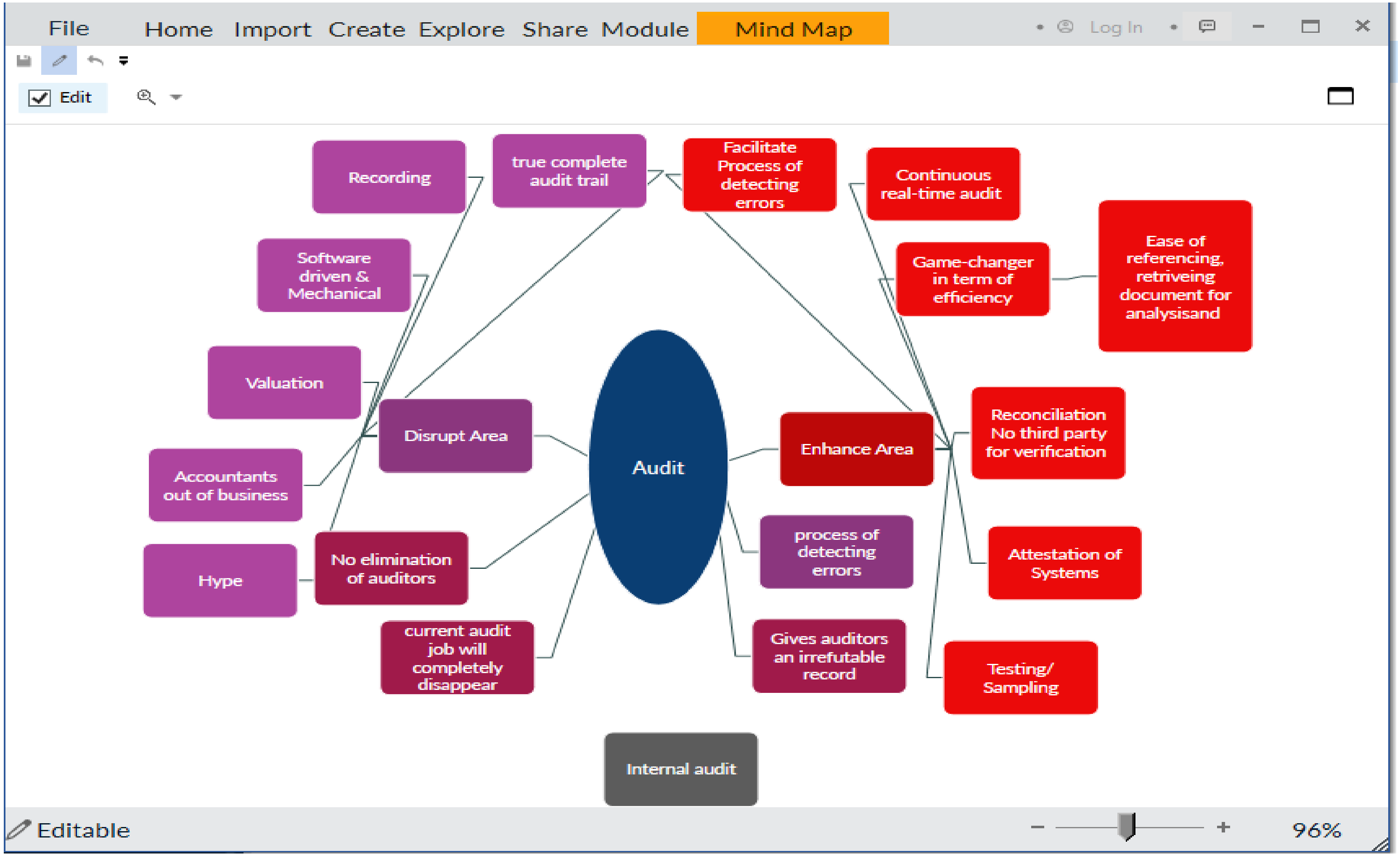
Bloomberg and Volpe (2019, p. 245) explain that "exceptions exist when you find yourself asking: Where does that go?" The exceptions were thoroughly examined and some formed parts of the overall analysis. Furthermore, each theme was considered to ascertain its coherence and fit with the overall research questions. Re-coding should not be an endless process and researchers should stop refinements once they are not adding additional value (Braun & Clarke, 2006). The researcher should stop re-coding after having grasped a fair idea of the idea behind each theme. Defining and naming themes then follows.

Figure 19. *Initial Thematic Map Showing a Theme on Barriers to BCT Adoption*



Note. Source Author

Figure 20. *Initial Thematic Map Showing Themes on the Relevance of Audit in a BCT Environment*



Note. Source: Author

5.3.5.5 Defining and Naming themes

According to Braun and Clarke (2006, p. 93) “names need to be concise, punchy, and immediately give the reader a sense of what the theme is about”. The themes were defined and named after a series of several readings, codings, and reworking of themes. The defining and naming of the study’s theme were based on the overall objectives and the research questions. The overall objectives of the study are to explore whether BCT disrupts or enhances the accounting and auditing profession, examine the extent of the auditor’s relevance and what auditors are expected to audit in a blockchain system, whether BCT can produce financial statements without the input of accountants and auditors, understand the effectiveness of blockchains in the prevention and detection of fraud, as well as examine the unintended/undesirable consequences of adopting BCT as a FinTech solution.

In this phase, themes and sub-themes were defined and named which assist in giving meaningful structure to some large and complex themes. The analysis of data depends on the definition and naming of the themes as the themes help to shape the research construct or meanings generated from the overall study data before producing the report.

5.3.5.6 Producing the Report

The sixth stage represents the final phase of the thematic analysis guide. The results are reported in the Findings’ chapters. In this phase, the study narrates the analytical story of the perceptions and understanding of the participants concerning how BCT has disrupted or enhanced the accounting and auditing industry. The report involved the narratives from the emerged themes embellished with illustrations from the interview transcripts. The researcher kept an open mind and dealt with the challenges of understanding the data and its contradictions and nuances. Writing findings involved presenting the various viewpoints and illustrating these with quotations from the interviewees. Findings are constructed inductively from raw data to a conceptual understanding by qualitative researchers (Garvey & Jones, 2021).

Bloomberg and Volpe (2019, p. 252) note that “by using the participants’ own words, the researcher aims to build the reader’s confidence that the reality of the participants and the situation studied is accurately represented." The researcher produced the report using the participants' own words and attempted to ensure an accurate presentation of the collected data. Additionally, relevant scholarly literature was used to explain the data contents and findings. This integrative approach prevents repetition between the results section and the discussion of the key findings section, and seamless incorporation of analysis on an ongoing basis (Braun & Clark, 2013).

5.4 Ethical Considerations

Bloomberge and Volpe (2019) note that it is the researcher's responsibility to inform and protect respondents. Although there are no serious ethical threats posed to the participants or their well-being, the study used various safeguards to ensure the participants' protection and rights. Firstly, informed consent was obtained in writing (see Appendix 7), before the start of each interview and it remained a main concern throughout the study. Besides obtaining written consent, verbal consent was obtained from each participant before proceeding with the interview, particularly concerning electronic recording and their anonymity. Secondly, the participants' rights and privacy were prioritised in the reporting and publication of data. To maintain anonymity, the study ensured that the names and the identities of all participants were kept confidential including those participants who expressly consented that their names could be attributed to their comments. Participants were represented by codes (see Appendix 1) and there is no mention of their genders and organisation names. For instance, all participants in ARB are tagged "Director" to further protect their identities and privacy because they could be easily identified if their real titles are used.

Also, other than the researcher, nobody had access to the interview transcripts. Both the recorded video and audio interviews were destroyed upon completion of the transcription. A copy of the full ethics approval is shown in Appendix 4.

5.5 Quality of Research

In this section, the evaluation of the quality of research was discussed. The evaluation of a qualitative study's reliability and validity is different from that of a quantitative study. As previously highlighted the reliability and validity of quantitative research are well entrenched as part of the research design. There are no universally accepted criteria for measuring the trustworthiness of the qualitative study. Nonetheless, scholars (Bloomberg & Volpe, 2019; Patton, 2015; Saunders et al., 2016; Yin, 2016) have highlighted some criteria for measuring the quality of qualitative research. These include credibility, dependability, confirmability, and transferability as well as the reflexivity of the study.

5.5.1 Credibility

A credible study is "one that provides assurance that you have properly collected and interpreted the data so that the findings and conclusions accurately reflect and represent the world that was studied" (Yin, 2016, p. 85). Confirmation bias occurs when the researcher only reports evidence that supports a preconception for or against an argument in either collection or analysis of data or both (Schwartz-Shea & Yanow, 2012). The authors further note that interpretive researchers cannot control participants' perspectives because participants have multiple views on research questions. Mollenkopf et al. (2011) also believe that evidence from multiple participants with different experiences and backgrounds supports qualitative research credibility. The credibility of this study was ensured by the engagement with different participants across disciplines and multiple geographical locations. Besides providing a detailed description of each participant, the researcher gave equal weight to the analysis and reporting of all participants' perspectives to remove confirmation bias.

A reliable way of mitigating bias is to apply member checks or participant validation, which involves sending the transcribed interviews for review by the participants (Bloomberg & Volpe, 2019; Saunders et al., 2016). During the interviews, some participants were asked if they would like their transcripts to be sent for validation. The interview transcripts were sent to some of the participants for correction and validation. To make the review less onerous, the areas in the transcripts where feedback was considered essential were highlighted. Such areas included sections of the interview that could have been misunderstood due to a participant's accent or indistinct speech. The aim was to confirm if the participants' intentions were captured correctly. All except one of the contacted participants checked and made amendments to the interview transcripts. Member checks or participant validation afforded participants the assurance that they are not misquoted in this study. Additionally, besides validating their transcripts some participants additional documents to the researcher. This process is in line with the validity or truthfulness of the qualitative study (Bloomberg & Volpe, 2019).

Credibility could be achieved by building trust and rapport through extensive research engagement to facilitate the collection of sufficient data (Saunders et 2016). Furthermore, having built trust with the interviewees, during the interview, some participants asked the researcher to get back to them with any further questions. This allowed the researcher to ask for clarification on grey areas and gave the participants chance to provide additional answers to interview questions.

5.5.2 Dependability

Dependability refers to whether one can adequately track all the processes and procedures used to collect and interpret data (Bloomberg & Volpe, 2019, p. 204). Similarly, Saunders et al. (2016) explain that in interpretivist research, modification of the research focus is an ongoing process that needs to be recorded by the researcher for evaluation by others. To address the dependability of this study, the study has provided comprehensive explanations of the research sample, how the data were accessed, collected, and analysed, as well as detailed records of the interview transcripts were kept. For instance, where the researcher had issues with the accent or diction of some participants, the assistance of colleagues was sought. Thereafter, the transcribed transcripts were sent to those participants for review and validation. Even though the researcher solely handled the collection and analysing of the data, extensive consultation was made in coding and reviewing processes with colleagues including guidance from the supervisory panel. This study's research process is well-documented, rational and verifiable.

5.5.3 Confirmability

Confirmability is said to be synonymous with the canon of objectivity in a quantitative study (Bloomberg & Volpe, 2019), but Patton (2015, p. 58) notes that "… the term objectivity and subjectivity have become so loaded with negative connotations and subject to acrimonious debate that neither of the terms any longer provides useful guidance". He advises researchers to avoid using either word because in practice there is no ideal objectivity or subjectivity study.

The use of open-ended questions which enable participants to reflect and share their experiences is a reliable way of achieving confirmability in a qualitative study (Mollenkopf et al., 2011). This study asked participants open-ended questions with some follow-up probing questions to understand their perceptions concerning the disruptive phenomenon of BCT.

Furthermore, the findings of this study emerged from the collected and analysed data and it is not an outcome of the researcher's biases and subjectivity. The researcher adopted reflexivity by noting in a PPF what went well or wrong and if there was a need further clarify something with participants. Attempts were made to examine the collected data through engagement with the interviewees. For instance, the researcher usually painted scenarios of what a group of participants thought about BCT to other participants to test the veracity of such claims with other participants. The researcher deliberately interviewed some participants with contrary views of the impact of BCT on accountants and auditors. This could reduce any biases associated with the researcher (as the instrument of data collection in qualitative studies), and reduce the chance of interviewing pro or anti-research participants. Thus, all views were represented in this study.

5.5.4 Transferability

Transferability is concerned with the ability of a researcher to provide sufficient information that could enable another researcher to replicate a similar study within the same context (Bloomberg & Volpe, 2019; Patton, 2015). However, the goal of a qualitative inquiry is not a generalisation of findings in all other scenarios, but to ensure that lessons learned in one study could be replicated and useful in others (Bloomberg & Volpe, 2019). Purposeful sampling using the snowballing technique was used to select participants, and the in-depth description of the research design has added to the understanding of BCT with regards to what the technology could disrupt or enhance, the relevance of audit, the effectiveness in terms of fraud prevention and detection and technical skills needed by accounting professionals.

The quality and trustworthiness of this study have been succinctly captured with a comprehensive description of the data collection and research sample (see Section 5.3.1), description of the participants (see Section 5.3.2), access to data (see Section 5.3.3), qualitative interview, interview guides and interview management (see Section **Error! Reference source not found.**), and the data analysis process (see S ection 5.3.5). These characteristics enable readers to assess the quality of the study (Bloomberg & Volpe, 2019).

Similarly, direct quotations from the interview transcripts with detailed interpretations are provided, in addition to respondent validation (member checks). The use of direct quotations and respondent validation enables readers to further assess the quality of the research and the authenticity of the interpretations and findings. With the aid of supervisors, the check for reliability was achieved at the question-wording stage and the validity by piloting the research instrument as recommended by Bell and Waters (2014).

5.5.5 Reflexivity

Scholars have highlighted that all research methodologies have their inherent biases and subjectivity (Fielding & Fielding, 1986; Patton, 2015; Schwartz-Shea & Yanow, 2012) and the ultimate quality control is the researcher. Levitt et al. (2018) note that the fidelity and transparency of research are guaranteed when researchers openly describe perspectives that guided their studies. Researchers could achieve this through the reflexivity of the study. Reflexivity should include the researchers' perspective, skills and experiences that shape the study, and the participants' worldviews (Patton 2015). Similarly, intersectionality adds that it should include the balance of power relationship between the researcher and the participants (Cole, 2009; Hunting, 2014). However, (Yin, 2016) suggests that the reflexive self should be kept under control to prevent confusing the readers or listeners because a split personality could lead to losing track of the main themes of the research composition. Thus, the researcher kept the reflexive self under control to avoid losing track of the themes and participants' views.

The researcher is a Chartered Accountant and has been in public practice for over 15 years. His experience includes financial and management accounting, auditing, payroll and personnel management, and taxation as well as teaching. The researcher has a fair knowledge of interviewing techniques having received training on the subject, participated in the recruitment of staff, and conducted financial investigations. He is reasonably familiar with how the accounting industry reacts to transformation due to changes in technology development. He investigated BCT as a master's student in the UK where his research focused on the challenges BCT posed to forensic accountants in fraud prevention and detection. Some of the assertions by writers that BCT has the potential to eliminate audit roles, prevent and detect fraud, and will require an accountant with a special skillset to function in a BCT environment spurred the desire to embark on this research.

The accounting industry has been said to be too conservative in embracing technology that could help to reshape some accounting practices such as the double-entry system. Also, despite assurances from the audit firms that an entity's financial statements show a true and fair view, billions of dollars of investment have been lost and companies have failed by relying on audited financial reports. Various reasons have been offered for corporate failure which has made all stakeholders, particularly investors and regulators reflect on the relevance of the roles of external auditors. This had caused some stakeholders to call for the establishment of a separate corporate body to regulate the audit profession in the UK.[15] Consequently, any technology, including BCT, that could improve the traditional double-entry system, and prevent and detect fraud should be embraced by the accounting and auditing profession. Additionally, irrespective of the adoption of any technology, the overriding factor is the human element that often interferes with such innovation. Besides the need to support technology that could bring positive changes to the accounting and auditing fields, the study's overall goal is to explore the extent of disruption or enhancement BCT has brought to the accounting and auditing fields, and the effectiveness of the technology in fraud prevention and detection from the perceptions of the practitioners and academics without the use of any complicated model or statistics data.

The researcher is also mindful of the participants' bias which could be either pro or anti-BCT. Participants are at liberty to express their views on the phenomenon being studied and what is said to be biased or subjective by a critic may not be seen as a subjective statement by the participant. The researcher considered the Dunning-Kruger effect (see Chapter 1, Section 1.2) in conversations with participants and this informed the decision to request participants to rate their knowledge and

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15 New corporate audit body would be a costly distraction. https://www.icaew.com/insights/viewpoints-on-the-news/2021/jul-2021/new-corporate-audit-body-would-be-a-costly-distraction.

understanding of BCT. This rating produced the typical Dunning-Kruger effect where some participants rated themselves too high and others too low. For instance, some participants rated themselves 10/10 but they did not understand coding or algorithms behind BCT. Some rated themselves 5/10 or below to avoid overestimating their knowledge. Interestingly, some participants acknowledged that they often exaggerated their comments about BCT for effects or to deliberately be controversial. This is illustrated by the views of ACA5 and AAF5.

> Now, I do exaggerate a little bit for effect, but I do think it's an existential threat that the profession will have to change. (ACA5)

> The hypothesis that I have is that blockchain is a fantastic and really interesting technology that has proven itself to have no real-world application of value. I am deliberately being controversial, and direct and waiting to be proven wrong on this. It was said to me probably five years ago, actually, I made that comment on TV, but is not quite as blatant as I just did then. (AAF5)

5.6 Limitations and Delimitations of the Study

The discussion in this section covers the limitations and delimitations of the study. Research limitations are restrictions which outside the total control of the researchers (Price & Murnan, 2004; Theofanidis & Fountouki, 2018). Research limitations are inherent weaknesses associated with research methodology. Delimitations are self-imposed criteria that define the scope and boundaries of any research but are generally within the researcher’s control (Theofanidis & Fountouki, 2018).

5.6.1 Limitations

The limitations of this study are those usually attributed to the weaknesses of the qualitative research methodology which have been earlier highlighted (see Section 5.2.1) and those inherent to the study’s research design. The researcher is the instrument in the qualitative study and their actions and inactions could affect the credibility of the research. Therefore, the researcher's bias is a key factor inherent in a qualitative methodology.

Moser and Korstjens (2018) note that it is important for researchers to prepare to deal with challenges such as gaining access and participants’ reluctance to open up about the study area. Another limitation was access to data because of the commercial sensitivity of BCT. Beyond the publications or reports by the “Big 4” firms, a few global professional accounting bodies, and the government, it is difficult to access industry documents concerning the operationalisation of BCT. The availability of such industry documents could have helped with the triangulation of data for the study. Some participants declined to mention clients that were experimenting with BCT. Similarly, perhaps, some interviewees might limit the amount of information provided to the researcher considering the duty of professional care and confidentiality they owed their clients.

Having identified these limitations, the study adopted appropriate measures to address these issues. First, the study ensures that participants engaged were from different industries and geographical locations. Maxwell (2013) notes that collecting information from a diverse range of individuals reduces the risk of bias and enhances triangulation. The informed consent form was used (see Appendix 7) to allay the fears of participants. To mitigate bias, interviews were coded using acronyms and participants' names were not linked to their comments, and interview transcriptions were recorded verbatim. Above all, coding was carried out with the guidance of the researcher's supervisors. Second, participants were assured that the study was for academic purposes and that the research findings may be published in journals. Also, creating a friendly environment to facilitate open discussions and dialogue possibly encouraged some participants to open up and refer the researcher to some of their contacts for a possible interview.

5.6.2 Delimitations

A major delimitation of this study was the scope of the study because the researcher does not consider the technicalities surrounding blockchain software. Another delimitation was the research sample size of only 44 participants. A critic of this research might note the lack of a model that factors in the blockchain software and accounting ledgers. Also, a critic could point out the limited possibility of generalising the results of this study. Like any qualitative inquiry, the goal is not the generalizability of research, but the replication of the study or transferability (Bloomberg & Volpe, 2019; Leedy & Ormrod, 2015; Patton, 2015; Saunders et al., 2016).

Similarly, designing a model or software involves some technicalities which are beyond the scope of this study. Nonetheless, the knowledge produced by this study was anticipated to support the understanding of the extent of disruption of BCT in the accounting industry and does not require designing a model or applying BCT software to accounting ledgers. Fulfilling the research objectives requires engagement with practitioners and academics to understand BCT disruption in the accounting and auditing fields. Additionally, the study was able to provide detailed descriptions and information concerning the diversity of participants' backgrounds, locations and disciplines which could facilitate the transferability of the same research in another setting. Despite the small sample size, the study of 44 participants from 13 countries and five continents is considered adequate. The adequacy of the sample size is supported by some scholars (Leedy & Ormrod, 2015; Saunders et al., 2016) who indicated that a sample size of between 5 to 25/30 participants is adequate for a qualitative study. Similarly, the study's selection of participants was based on accessibility, recruitment, logistics, research purpose, design and questions as suggested by Peterson (2019) (see Section 5.3.1).

5.7 Summary

This chapter provided a comprehensive description of the study's research methodology. A mono-method qualitative study with purposeful sampling and semi-structured interviews was adopted. The study embedded some elements of intersectionality-informed qualitative research. The participant sample comprised 44 purposefully selected individuals, from 13 countries and five continents, who had a basic knowledge and understanding of BCT. This study relies on the views of participants who were categorised into groups: BSIT, ARB, AAF, ACA, AAD, and FAE. It is from this engagement that the researcher constructed their world views about whether blockchain will disrupt or enhance the accounting and auditing fields. The researcher attempted to understand BCT from a context-specific perspective of the study participants. Thus, the philosophical assumption of this study has been categorised as a social constructive-interpretivism paradigm. The flexibility in the exploratory study enables the thesis to incorporate new ideas as the research processes were unfolding. This approach helped the researcher to co-construct the participants' multiple meanings, interpretations and understanding of BCT and its implications for accountants and auditors.

The quality of the research was assured by using qualitative evaluation techniques: credibility, dependability, confirmability and transferability. Other strategies used to demonstrate the trustworthiness of the study include the provision of comprehensive details of data sampling, collection, and analysis as well as ethical considerations. The study also highlighted the researcher's perspectives and values that guided the choice of research study, data collection and analysis. The collaborative nature of data collection and analysis allows researchers to identify important themes, patterns and relationships in the collected data which formed the basis for findings and interpretations of results. Interpretations and conclusions were drawn from a comparison with the existing literature, and recommendations were made for both accounting and auditing practices, as well as future research. The overall aim of the study is to contribute to the literature, policy and practice concerning BCT and areas it would likely disrupt or enhance in accounting practices.

The following three chapters deal with the study's findings. Table 3 aligns the findings with the research objectives, questions, and interview questions.

Table 3. *Research Themes Emerging from NVivo Data Analysis*

<table>
<tr><td colspan="4">To critically examine whether BCT will disrupt or enhance (or both) the accounting and auditing professions.</td></tr>
<tr><th>Sub- Objectives</th><th>Research Questions</th><th>Interview Questions</th><th>Themes from NVivo</th></tr>
<tr><td colspan="4">Chapter 6</td></tr>
<tr><td rowspan="2">1. To explore how accounting practices will change in a BCT-based environment.</td><td>RQ1. What accounting practices will change in a BCT-based environment?</td><td>*What will BCT add to the double-entry accounting system?

*Are you aware of the triple-entry accounting system? How do you think BCT could facilitate this system in accounting practices?

*What impacts does BCT have on tax accounting management?</td><td rowspan="3">Main Themes:
(i) BCT disruption of Double-entry accounting

(ii) BCT enables triple-entry accounting
Subtheme: Terminology

(iii) Implication on tax management: VAT, WHT, GST & payee
(iv) Areas Disrupted or Enhanced in Accountant's functions
Sub-themes:
(a) Disruption of manual accounting work
(b) Non-disruption of accounting work

(v) Areas disrupted or enhanced in auditor's functions
Subthemes:
(a) Non-disruption of audit
(b) Disruption of Audit
(c) Audit firm as a node and implication for internal auditors

(vi) Organisations' adoption of BCT for financial reporting & accounting purposes
(vii) Perceived relevance of auditors
(viii) Audit of BCT
(a) Chain or transactions
(b) Both chain & transactions</td></tr>
<tr><td>RQ2. What areas will BCT disrupt or enhance in the accounting and auditing practices?

RQ3. What are the organisations currently using BCT or have adopted BCT for financial accounting and reporting purposes?</td><td>*What areas in the traditional accountant's functions BCT will disrupt? In your judgement, what areas of accountant's functions BCT will enhance?

*What areas have BCT enhanced in the audit? What are the areas where BCT has disrupted the audit?

* From your experience, are there organisations currently using BCT or have adopted it for financial reporting and accounting systems?</td></tr>
<tr><td>2. To examine the extent of the relevance of the auditors and what auditors are expected to audit in a BCT system</td><td>RQ4. To what extent are auditors relevant in a BCT financial system?

RQ5. What are auditors expected to audit in a BCT accounting system?</td><td>* Are auditors relevant in the BCT financial system?
*How likely is BCT to eliminate a third-party auditor? Could you explain, please?

What are auditors expected to audit in a BCT accounting system? *Is it the chains or transactions or both?</td></tr>
</table>

Chapter 7			
3. To understand the effectiveness of BCT in the prevention and detection of fraud and the impact of garbage in, and garbage out.	RQ6. What mechanisms are in place in BCT for fraud prevention and detection? RQ7. What effect does garbage in and garbage out have on the effectiveness of BCT fraud prevention and detection mechanisms?	(a) How effective are BCT security systems in preventing and detecting anomalies or fraudulent transactions? (b) What types of fraud or anomalies can take place in a BCT environment? (c) Can blockchain reduce or eliminate financial fraud? (d) What impact does garbage in and garbage out have on the BCT fraud prevention and detection mechanisms?	***Main Themes:*** (i) BCT security system against fraud and anomalies (ii) Possible fraud in a BCT environment *Subthemes*: (a)Falsification of Reports (b)Manipulation of Internal Controls (c)Related Party Transaction & Collusion (d) Malware and Deceit (e) Money Laundering (iii) GIGO
Sub- Objectives	Research Questions	Interview Question	Themes from NVivo
4. To examine the technical skillsets required by accountants and auditors in a BCT environment and the relevance of understanding BCT programming codes?	RQ8. What are the technical skillsets required by accountants and auditors in a BCT environment? RQ9. How relevant is the understanding of the BCT programming language?	What technical skillsets do accountants and auditors require in a BCT-enabled environment? *How relevant is the understanding of BCT programming languages for accountants and auditors?	(iv) Special skillsets for accounting professionals (v) BCT programming language
Chapter 8			
5. To explore incentives, barriers and unintended consequences of the adoption of BCT in the accounting and auditing professions and whether COVID-19 has improved the adoption of BCT.	RQ10. What are the incentives, barriers and unintended consequences of adopting BCT as a FinTech solution?	*Are there barriers to the adoption of BCT? What are these barriers or obstacles to the adoption of BCT in the accounting and auditing professions?	***Main Themes:*** (i) Incentives for BCT adoption ***Subthemes:*** (a)Technological: *Integration with other technologies; *Ease of understanding (b)Organisational: * Business need; *Cost-Benefit analysis; *Top management support (c)Environmental: *Industry or market adoption; *Use cases

Chapter 8 (continued)			
	RQ11. How has COVID-19 enhanced the adoption of BCT?	*What are the unintended consequences of adopting BCT as a FinTech? *From your experience, how has COVID-19 enhanced the adoption of BCT?	***Main Themes:*** (i) Incentives for BCT adoption ***Subthemes:*** (a)Technological: *Integration with other technologies; *Ease of understanding (b)Organisational: * Business need; *Cost-Benefit analysis; *Top management support (c)Environmental: *Industry or market adoption; *Use cases (ii) Barriers to BCT adoption: ***Subthemes:*** (a)Technological: *Poor education &lack of knowledge; *Untested technology (b)Organisational: * Fear or Resistance to Change (c)Environmental: * High Cost of Investment; *Absence of Regulatory Guidance and Accounting Standards (iii)Undesirable consequences ***Subthemes:*** (a)Technological: *Hard to know; Harmful to Privacy; *Use for criminality; *Use Quantum computing to break BCT encryption (b)Organisational: *Mismatch BCT application to firms' needs; *Mass adoption of private BCT (c) Environmental: *Control tools by government and regulators; *Disruption/loss of job (iv) COVID-19 Accelerate BCT adoption (ii) COVID-19 has not accelerate BCT adoption

Note. **Source: Author**

Chapter 6

Interview Findings: BCT Impact on Accounting and Auditing Practices and Relevance of Auditors in a BCT Environment

6.1 Introduction

This chapter addresses the study's first five research questions: "What accounting practices will change in a BCT-based environment? What areas will BCT disrupt or enhance in the accounting and auditing practices? Which organisations currently use BCT or have adopted BCT for financial accounting and reporting purposes? How relevant are auditors in a BCT financial system? and What are auditors expected to audit in a BCT accounting system?

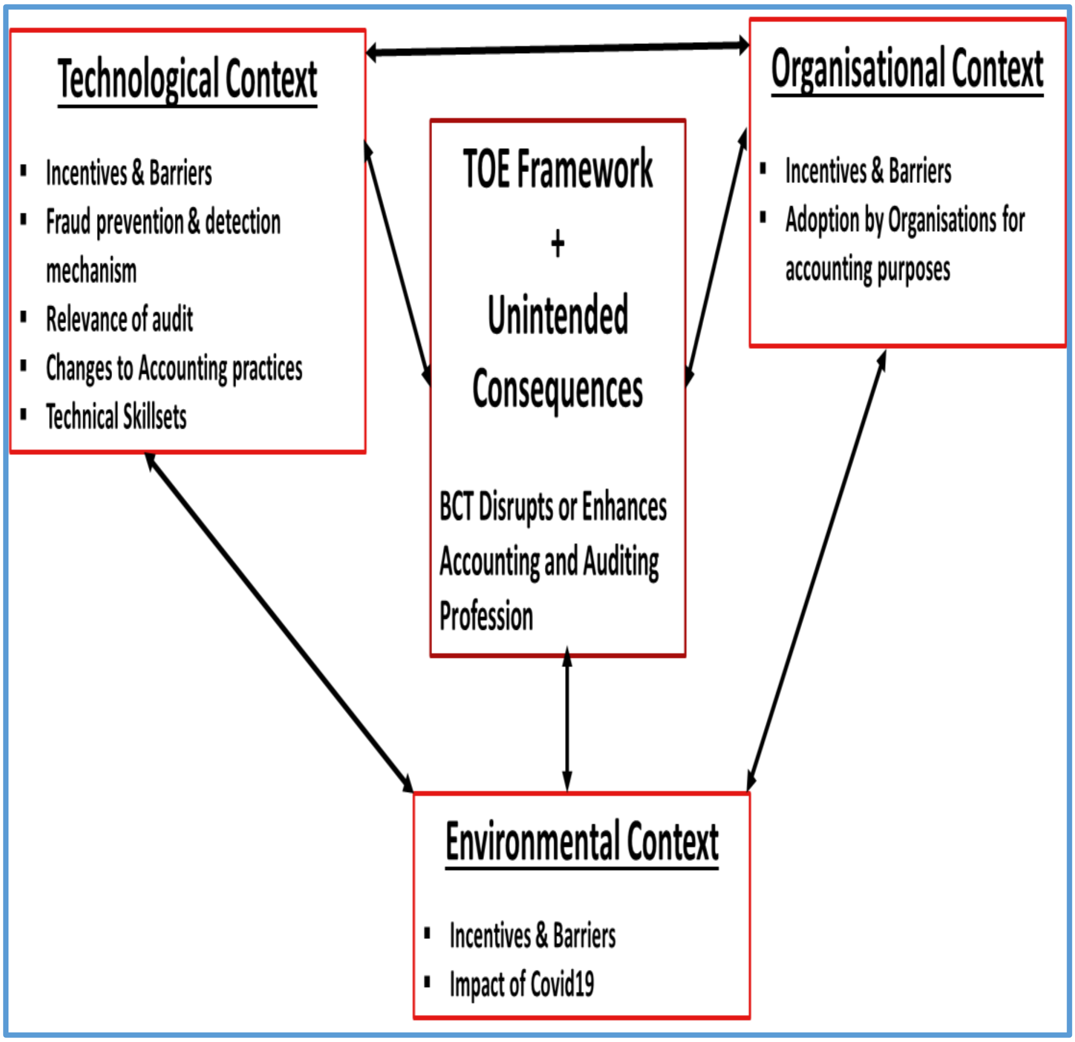
Prior research on the impact of BCT on the accounting profession lacked engagements with practitioners (Carlin, 2019; Lombardi et al., 2021) and those that did, engaged only with accounting professionals within the researcher's country. For instance, Ferri et al. (2020) acknowledged that their sample size was limited to the auditors working in Italian Big 4 firms and they emphasised the importance of future research to include participants from not only Big 4 and non-Big 4 firms but also across national boundaries

This research differs from previous studies. The study expanded the TOE framework with the innovation of adoption consequences for the analysis of its findings. The research themes were located within the expanded TOE theoretical framework (see **Figure 21**). The findings in this chapter are related to the technological context and a lesser extent to the organisational context of the TOE framework (see **Figure 20)**. The identified key themes captured the attributes of BCT as they affected accounting practices, potential areas of technological disruption or enhancement, the auditor as a node, and the relevance of auditors in a BCT environment. These are the areas where technology has a direct or indirect impact and is more related to a technological context. Similarly, the finding on the organisations that have adopted BCT is directly related to the organisational context of the theoretical framework.

Additionally, the study engaged with practitioners outside the accounting and auditing professionals and also included participants from many countries. The study sought views of those involved in BCT such as Blockchain start-ups, IT experts, academia, financial experts, accounting regulators, technocrats, senior editors as well as professional accountants and auditors (see Figure 15. Distribution of participants, p.173).

The study had 44 participants from 13 countries and five continents. To the best of the researcher's knowledge, none of the prior studies conducted interviews for participants beyond the researcher’s national boundaries. This study attempted to address the interdisciplinary nature of BCT and the need to dialogue with different professionals to understand their views concerning the perceived disruption or changes that BCT will bring to the accounting industry.

Figure 21. *Research Themes with TOE framework*



Note. Source: Author

6.2 Changes to Accounting Practices in a BCT Environment

The review of the BCT literature highlighted aspects of accounting practices that can be expected to change. These include the double-entry accounting system, the role of auditors and the tax management system (see Chapter 3). However, a lack of understanding exists about the extent of these changes from the practitioners' point of view.

This section presents the insights of the participants concerning the study's first research question: "What accounting practices will change in a BCT-based environment?" To answer this question, respondents were asked the following questions: "What will BCT add to the double-entry accounting system, how will it facilitate triple-entry accounting and what impact will the technology have on tax management?" These possible changes are related to the technological context of the TOE framework (***Figure 13.*** Conceptual Framework of BCT Disruption and Adoption 134). The aim of asking these questions was to understand the respondents' views of changes that could disrupt or enhance accounting practices with BCT adoption. The respondents' replies to these questions are detailed in the following subsections under three main themes: the double-entry accounting system (Section 6.2.1); the triple-entry accounting (Section 6.2.2); and tax management (Section 6.2.3).

6.2.1 BCT Disruption of Double-Entry Accounting System

Double-entry is the traditional foundation of accounting and financial record keeping. Various scholars have examined the impact BCT could have on the traditional double-entry system of accounting. Alarcon and Ng (2018) classify the contrasting views of scholars on BCT into 'enthusiasm' and 'scepticism' categories. The BCT enthusiasts are those who are pro-innovation and claim that the technology will disrupt many business models, while the sceptics assume that BCT will not add any value to the existing business model. For instance, the popular viewpoints are that BCT will transform and disrupt the accounting profession (Appelbaum & Smith, 2018), and the technology will facilitate financial record-keeping beyond the double-entry system (Carlin, 2019). Other scholars held different views; BCT may not be useful in tracking accounting transactions (Coyne & McMickle, 2017), and de Meijer (2016) notes that BCT cannot distinguish between tasks such as data tracking, reconciliation and auditing.

The findings of this thesis show that there were different perspectives among the interviewees on how BCT will change the traditional accounting principle of the double-entry system. Participants gave diverse opinions on whether BCT has the potential to disrupt the double-entry system. The themes that emerged from the findings are: BCT will bring ‘disruption’; ‘add no value’ and ‘enhance’ the double-entry system. The participants’ perceptions are discussed according to these groupings in the following sub-sections

6.2.1.1 Blockchain Start-ups and Information Experts’ (BSIT) Perception

In the BSIT group, the majority of the participants were of the view that BCT will bring significant disruption to the double-entry accounting system. They believed that BCT will disrupt this system by not only enabling one ledger and one account that is interconnected and verifiable but will also eliminate the double-entry constructs. The BSIT group believe that the BCT ledger will be more accurate and facilitate trust where the chain is secured and reliable, and protocols are good when compared to the existing debit and credit systems

BSIT3 states that it is difficult for humans to keep pace with huge data and transactions, and the BCT algorithm can provide information and help to build a trusted public accounting system and tax beyond debits and credits. BSIT4 asserts that with BCT the double-entry system is no longer relevant. Henke (1995) suggested that the accounting practice of the double-entry system is outdated because it is based on past historic information. The disruption BCT will bring to the double-entry system is represented by the views of BSIT4 and BSIT7:

> The double accounting method that necessitates auditing, things like invoicing and accounts receivable, account payables, and all those accounting constructs around moving money around will really go away with blockchain because smart contracts manage all the business rules around the transfer of values. So, I'm not an accountant, but from a businessperson’s point of view, it’s in blockchain we trust, all others can use auditors. (BSIT4)

> Basically, it’ll make it more accurate and better. When you do a double entry it could be wrong, just because you put a debit and a credit and they match, doesn't mean it's right. If the chain is secure and reliable and the rules or the protocols good, then you can be sure that entry is right, accurate and fair too. It's like correct. A double-entry still could be wrong that's why you have to do an audit, that's blockchains can do it if they make the rules right. (BSIT7)

BSIT7 view is correct because the double-entry accounting system may be showing an account as balanced, but there could still be errors. Such errors are often due to human mistakes and not because the accounting principle is faulty, and it could be due to the misclassification of items. Similarly, anecdotally, the use of smart contracts has been suggested by scholars (Liu et al., 2019) to change accounting constructs through automation. However, it could be argued that BCT as underlying technology may not be able to solve the misclassification of accounting items. Therefore, misclassification of items or transactions could still take place in a BCT.

However, a few of the BSIT participants held contrary views. They think the double-entry system will remain and BCT may not add any value to it or at best evolve with BCT. They were of the view that the double-entry system has been in use for hundreds of years and building BCT for that purpose is not economically viable. This aligned with the position of (Coyne & McMickle, 2017) that accounting ledgers have existed for many centuries and BCT cannot replace the current transaction ledgers. This was explained in the comment highlighted by BSIT9.

> I don't think it changes that construct, that construct has been around for at least 1000 years. I think what it does is, it provides that operational execution layer. On top of that, the transaction constructs of debit here and credit there are laid in. This system isn't a debit credit system, it's a transaction system just like blockchains a transaction system. There's no reason to build a blockchain that knows about debits and credits because it doesn't make any sense. Build a blockchain to record transactions in a shared state, and then leverage those transactions into a different representation. (BSIT9)

That the accounting practice of double-entry has been in use for many centuries cannot be enough justification to adhere to such practice if there is an alternative and more efficient method. However, up till now, there is no universally agreed alternative accounting system to the double-entry system in the accounting profession. Nonetheless, the majority of participants in the BSIT group believe that BCT will disrupt the double-entry accounting system.

6.2.1.2 Audit and Assurance Firms' (AAF) Perception

In the AAF group, the majority of the participants held the view that BCT is a possible addition to the debit and credit system and a way of sharing information.

They argued that the concept of the double-entry system will still exist and the flexibility of BCT is that it can have a double-entry or triple-entry. However, a participant asserted that the double-entry system will be disrupted.

AAF7 noted that BCT is an information-sharing platform and may not disrupt the double-entry. S/He explains:

> Some people call it like a triple-entry accounting system because now you have not only your double-entry but then you have a third copy of it on the other person like the person who is on the other side of that contract. Blockchain doesn't need to adopt that at all, it's just a way of sharing information.…. If you're just looking at yourself, you're still only doing double-entry accounting there's just another copy of your entry somewhere else on that distributed ledger (AAF7)

Similarly, AAF5 explained further that the most important thing BCT brings to the double-entry is in the distributed ledger and not even the encryption which is regarded as impenetrable by hackers.

> I think the techniques of blockchain and certification. Ultimately, multiple eyes on transactions increase the security of those transactions. Blockchain, I think its greatest value would not be in the encryption, but rather in the multi-party visibility. (AAF5)

AAF5 believes that the distributive nature of the BCT ledger is more significant than the technology's cryptographic encryption because everyone can see how transactions are added to the chain. In practice, there are other distributed ledger technologies (DLT), but it is the BCT cryptographic encryption that makes this technology unique (see Chapter 2.5). The BCT distributed ledger is what the participants thought could be a potential addition to the double-entry system. How this will pan out in the accounting world or practice is yet to be seen. Similar optimism was expressed by some scholars (Henke, 1995; McCarthy, 1982; Melse, 2008) when Ijiri's triple-entry framework was proposed, but that system has never seen the light of day. Melse (2008) noted that triple-entry momentum accounting could be a novel way of enhancing information analysis, disclosure and decision-making of the financial accounting system. However, AAF4 notes that the double-entry system has outlived its usefulness. S/He explains: "Blockchain technology will allow that we only have one ledger and one account, and we can transact, or we can record everything on this one account, we don't need a double system anymore."

Killmeyer et al. (2017) state that BCT is a distributed consensus ledger with a single shared record among all parties to a transaction instead of each party keeping individual debit and credit of transactions. Even if BCT facilitates one ledger, this may not be enough grounds to assume that the double-entry accounting system will be eliminated. Overall, the AAF group's perception is that BCT will not disrupt the double-entry accounting system.

6.2.1.3 Accountants' and Auditors' (AAD) Perception

The AAD group were of the view that BCT could enhance the double-entry system. BCT distributed nature may enhance the integrity and transparency of the debit and credit system through BCT distribution processes and the immutability of transactions. It was explained that it would be difficult for an individual to roll back a transaction without the concurrency of other parties in a BCT system. The comments by AAD1 state that BCT is there to provide additional entry that will connect all parties to the transactions using the technology-distributed ledger. S/He explains:

> Yeah, it is not part of blockchain technology, the double-entry, for every debit there is a credit. For blockchain, there has to be a distribution when there is an entry there will definitely be two legs of the entry: debit and credit, and then for blockchain, there is another leg that is going to go to all the connected systems. That is really the core strength of blockchain technology, that aspect of the distributed ledger process, that is what gives the system integrity. (AAD1)

Similarly, AAD5 claims that the debit and credit will still be there because BCT will be built on top of the double-entry system. S/He elucidates:

> I think the concept of the double-entry system is still there. I think the flexibility of blockchain is that it can have a double-entry or triple-entry. Previously, I've worked in the accounting departments where we find it very difficult to reconcile our ledgers with our suppliers and major customers. I think this is one thing it will add to it because your supplier and you both have the double-entry system, but none of your entries is always connected so that's a third entry for you maybe. Blockchain will help reconcile those differences. Definitely, it would be built on the double-entry system, it's a system that everyone knows and I think it will be there for a long time, but it lends it to other external systems, and create a bigger pool of information for you which

> is more important and relevant. I think this is how it enhances the double-entry system. (AAD5)

Many of the previous studies (Cai, 2021; Grigg, 2005; Kiviat, 2015) also claimed that BCT will be built on top of the double-entry accounting system. BCT technology could be said to be an addition to the existing debit and credit. AAD5 further explained how BCT will enhance the double-entry system. S/he illustrated this with an example:

> If I can expand on the double-entry system if you are recording that you have to pay Rs10,000 to a supplier or in whatever currency. How does this supplier record Rs 10,000? So, I think reconciling those differences is important. I think that's where blockchain enhances the double-entry system because it does not know what your supplier is recording. I think blockchain will make it easier for reconciling those differences, and I think it enhances double-entry and the ability for something to be built on top. (AAD5)

The participants' argument for enhancement of the double-entry system hinged on BCT's transparency, immutability and distributed ledger. The proliferation of pilot tests and discoveries indicate that BCT is a possible addition to the debits and credits because, from the available literature (see Faccia & Mosteanu, 2019; Ibañez, 2021, May 27; Ibañez et al., 2020), no study has demonstrated yet that BCT will not use the double-entry construct.

6.2.1.4 Accounting Regulatory Bodies (ARB) Perception

Like other groups, the ARB group shared two contrasting views as to what changes BCT could bring to the double-entry accounting system. Some held the view that BCT will disrupt the double-entry system and others were of the view that the technology may add no value to the existing debits and credits. These two contrasting views are captured by the ARB3 and ARB4 respectively:

> I think blockchain technology will allow we only have one ledger and one account, and we can transact, or we can record everything on this one account we don't need a double account system anymore. Would you agree with that? (ARB3)

> I don't know if the blockchain has much to answer the double-entry bookkeeping. I think it has a possibility for helping to verify and to work on some of the aspects of record-keeping, but I don't think it changes the fundamental nature of how we measure businesses which is via this very well-evolved system. (ARB4)

The possibility of having a single BCT-enabled account system as suggested by ARB3 may be possible within a group company and its subsidiaries because blockchain can be the underlying technology for that purpose. It may be infeasible in practice among different companies with different ERPs and across international borders with different regulations guiding financial record keeping to have a single account. If it follows existing BCT propositions and models, the technology will not change the fundamental construct of debit and credit systems.

ARB4 further explained the reasons some people were sceptical about the changes BCT will bring to accounting practices.

> I think it's got a lot of interesting shapes and structures that could be of use to accounting, but it isn't as perfect as people first thought of when the hype was starting to build around the technology four, five or six years ago. I think that scepticism has kind of been borne out by the fact that we haven't seen a massive uptake of blockchain solutions since that time. I think there are some good promises but hasn't yet come to fruition and I don't know whether they will or not. (ARB4)

Overall, the BSIT group's findings show that BCT will disrupt double-entry accounting principles. BCT's potential benefits include multi-party reconciliation, transparency, auditability and integrity (Baliga et al., 2018). The proposition that BCT will disrupt debits and credits could have been informed by the general features of BCT: distributed ledger, transparency, and immutability which some writers note are missing in the current double-entry accounting system. However, critics of this viewpoint out that the propositions were made by pro-blockchain biased or BCT enthusiasts.

This finding on the potential BCT disruption of the double-entry system is supported by some scholars. Cai (2021) notes that blockchain can provide a new accounting concept to address the issue of fundamental trust and information transparency among company stakeholders. Similarly, Mantelaers et al. (2019a) argue that BCT can provide solutions to overcome the inadequacies of the double-entry system, while Faccia and Mosteanu (2019) assert that the technology can bring modify the double-entry system. This thesis also found that BCT is a new concept in accounting that will not only enhance the double-entry system by adding multi-party visibility to transactions but could also evolve the concept of triple-entry accounting. This finding is in tandem with the position of Karajovic et al. (2019) and Wang and Kogan (2018) who believe that the BCT triple-entry system will enhance the current debit and credit system. It is also similar to the position of Dai and Vasarhelyi (2017) that BCT will enhance double-entry bookkeeping by adding a corresponding account for every transaction.

Additionally, this study found that BCT may not add value to the existing double-entry system or change the existing configuration. This is similar to Alboaie et al. (2018) view that "the triple-entry accounting is not an alternative for the double-entry accounting, but rather part of a solid system when the two types of accounting are combined" (p.14). The WEF 2017 report also classified BCT as high risk with the low benefit of all the emerging technologies (World Economic Forum, 2017). However, this may be because BCT is yet to be used for full financial recording and reporting purposes, as revealed in this study (see Section 6.4).

Limited experience with BCT could be why participants expressed various reasons for the likely disruption the technology could bring to the double-entry accounting system. (Centobelli et al., 2021) identified the reasons behind these contrasting views as the knowledge gap between blockchain developers and accounting experts, and the lack of awareness of BCT concepts and infrastructures among academic researchers and accounting professionals. It could also be because BCT is in the infancy stage and some big players in the accounting industry are experimenting with it to harness the technology's potential (Kokina et al., 2017). Perhaps, it will become clear the extent of the disruption BCT will have on accounting when the technology is used on a wider scale.

6.2.2 The Triple-Entry Accounting System

As with the double-entry system, there are contrasting views about whether BCT will facilitate a triple-entry accounting system or not. The triple-entry-accounting system has been a subject of debate since the late Professor Ijiri mooted the idea of "Trebit" in 1986. Many writers have argued for and against the workability of this proposition vis-a-vis the well-established double-entry system. The advent of Bitcoin Blockchain has made some scholars (Bonsón & Bednárová, 2019; Cai, 2021; Crosley & Anderson, 2018; Kiviat, 2015) conclude that the technology will facilitate a triple-entry accounting system, while others (Coyne & McMickle, 2017) claim the technology has no such potential. Similarly, Ibañez et al. (2020) also note that despite the novelty associated with the BCT triple-entry accounting concept, it does not change the fundamental principles of the accounting system beyond improving the transparency and integrity of the recordkeeping. In light of these diverse views, participants were asked about their understanding of the triple-entry accounting system and the likelihood of BCT facilitating it. The thematic analysis brought to the fore the appropriateness of the term ‘triple-entry accounting’ and the possible facilitation by BCT.

The findings in the following sub-sections reveal there is a disagreement among the participants as to the meaning of the term ‘triple-entry accounting’. However, despite this disagreement, the study found that the majority of the participants held the view that BCT can facilitate the triple-entry accounting system.

6.2.2.1 The Terminology – Triple-Entry Accounting System

Participants considered the term BCT triple-entry accounting system is considered jargon and confusing terminology that has nothing to do with accounting. This is contrary to the assertion of Cai (2021) who claims that BCT triple-entry accounting is a generally accepted definition; the view of Brandon (2016) that BCT accounting applications are referred to as triple-entry bookkeeping; and Gröblacher and Mizdraković (2019) that triple-entry bookkeeping is frequently used within the BCT’s context. Other scholars that have mentioned BCT triple-entry include (Bonsón & Bednárová, 2019; Bonyuet, 2020; Bradbury, 2015; Hildebrand, 2020). When the participants were asked if they were aware of the term triple-entry accounting, the majority responded they were aware, but the term does not fit with accounting practices. Most academics refrained from discussing such contestable terms. The following comments illustrate the participants’ views.

6.2.2.2 Blockchain Start-ups and IT Experts’ (BSIT) View

The participants in the BSIT group noted that the term BCT triple-entry accounting is a popular catchphrase but acknowledged that the use of this terminology did not sit well with the accounting professionals because they believe it is a term coined by accounting academics. BSIT10 notes: “I don't know how accountants like the phrase, but everyone that I know is calling a triple-entry accounting because of blockchain capabilities.” BSIT9 claims further that the term triple-entry accounting was said to be coined by accounting academics and it does not represent what BCT ought to mean. S/He narrates:

> There was a conversation, we did an event for the American Accounting Association which was opened to all the academics in the accounting profession a couple of years ago, and they really took offence at the concept of triple-entry accounting because apparently that's a term that had already been coined in the academic accounting world and it didn't mean what blockchain said it was going to mean. (BSIT9)

6.2.2.3 Academics' (ACA) View

However, while some participants in BSIT assumed that the term triple-entry originated from accounting academics, the majority of the participants from the Academics (ACA) group believe the term is confusing. ACA5 states: "I've heard the phrase, I don't think it describes terribly well what's going on, but triple-entry bookkeeping is what some people call these blockchain accounting systems." Further comment from ACA4 provides an additional explanation:

> Yes, which is a kind of made-up term. To be honest with you, I don't really understand what that means, because we understand double-entry accounts, debit and credit, and balance at the end; One goes in, one goes out. What they mean by that is that the transaction, each transaction needs to be verified before it gets processed, or accepted as valid. This goes back to the idea of Proof of Work. So, when we're talking about the triple-entry thing, the triple-entry part of that has to do with whether or not those transaction has been validated. It isn't really anything that has to do with accounting at all, is not to do with the transactions that those two people agreed with that stuck, it has to do with the mining function and its validation process. So, as I said, it is a made-up thing. I personally don't see it as being necessary or useful as a term. I think mostly is to confuse people further really, to be honest. (ACA4)

6.2.2.4 Accountants and Auditors' (AAD) View

The AAD group viewed the term triple-entry as a misconception and suggested that the same concept is also referred to as a universal accounting ledger. Baliga et al. (2018) assert that even though people often confused BCT as an alternative to relational databases or big data solutions, still the technology is far from being a replacement for any of these. This is because the technology is ideal for applications in areas such as data sharing, multiparty reconciliations, and transparency (Baliga et al., 2018).

AAD2 argued that triple-entry accounting is a misconception but could be used to help validate debits and credits. The views of AAD2 and AAD6 could be taken as the representative views of this group.

> Just because you use a blockchain doesn't mean you have a third thing. It could be used to help validate debits and credits, but it's not triple-entry because again it's only doing part of it and the things that involve the ledger. I would say things like XBRL and XML technology and tagging and other things are potentially considered a triple-entry. Blockchain may be part of your accounting system, but it's not your whole accounting system. I think that term sounds cool, but I don't know that it's really true in every case. There are cases where the blockchain again provides validation or confirmation to numbers that are going in as debits and credits, but it's not going to validate every debit and credit and be another set of books for you. I think that's a misconception. (AAD2)

> I've just never heard the term triple-entry accounting, I've heard the term universal ledger… I never thought of two things coming together, making it a third thing, yeah I thought double-entry going down to one entry, just into a single-entry system, not a triple-entry. (AAD6)

The AAD's view findings are emphasised by Ibañez et al. (2020) who write "To call triple-entry bookkeeping 'single-entry would lead to misinterpretation and confusion" (p.5). Even if BCT validates debit and credits as suggested by AAD2, it may be difficult to see the double-entry becoming a single-entry or triple-entry system because of BCT. It is yet to be seen in practice how storing an entry in a BCT ledger would be enough justification to rename the double-entry system as a triple-entry system.

6.2.2.5 Audit and Assurance Firms' (AAF) View

Like the AAD group, the majority of the participants in the AAF group consider the term BCT triple-entry accounting inappropriate. Despite the AAF's view, Chowdhury (2021) describes the BCT-enabled accounting system as triple-entry. BCT will facilitate a paradigm shift from debits and credits to the triple-entry shift in financial accounting (Chowdhury, 2021).

AAF8 asserts: "I'm not aware that there is a triple-entry accounting system." AAF2 notes further that interaction with some clients who intend to use BCT often shows that it is difficult to assign a concise definition of the technology. S/He explains "it's not a particular technology or method, and so it's hard to pin down a precise definition."

6.2.2.6 Accounting Regulatory Bodies' (ARB) View

The ARB view is captured by ARB4. S/He described BCT as a universal entry bookkeeping and regarded a triple-entry system as jargon.

> The universal entry bookkeeping turn of phrase came out because I saw people talking about things like triple-entry. A transaction between two companies is already quadruple-entry. If I buy something from you, I do debit and credit, you do debit credit, so we've already got four. People have also used the term triple-entry bookkeeping for like four or five different things over the years. For whatever reason, it's a popular idea that people see comments when people talk about stuff like momentum accounting and all these kinds of things so I don't think it's a very helpful term because it's not got a single universally one understood meaning, I tried to steer clear of it. I think it's more of a jargon thing or it's exciting for people to think about because they're like if we have double then surely triple is better. I don't think it necessarily works that way. (ARB4)

However, ARB3 weighed in on the use of terminology. S/He suggested the need to refrain from using any terminology to avoid losing the relevance of BCT in the accounting system. ARB3 explains: "You know what, don't call it a triple-entry, don't call it anything, don't use the jargon and don't use the term, just know that entries happen at the same time, and everybody can see it. Don't give it a name."
Despite the use of the BCT triple-entry accounting system in the research literature (Bonsón & Bednárová, 2019; Brandon, 2016; Cai, 2021; Grigg, 2005; Gröblacher & Mizdraković, 2019; Hildebrand, 2020; Ibañez et al., 2020; Karajovic et al., 2019; Simoyama et al., 2017), this study found that participants believed that the term 'BCT triple-entry system accounting' is a confusing term in BCT literature. Most participants note that the use of such terminology is a misconception and adds to the complexity of understanding BCT.

However, a participant cautions on the use of terminology which could negatively impact the potential changes BCT could bring to the accounting system. Perhaps, in time, academic scholars and practitioners will agree on the appropriate term to use for BCT entry.

6.2.3 BCT Triple-Entry Accounting System

Having discussed the participants' views about the appropriateness of the term BCT triple-entry system, this section addresses whether BCT can facilitate the proposed triple-entry accounting system. Despite the controversies regarding the term 'BCT triple-entry accounting', some participants believed that BCT is capable of facilitating the triple-entry accounting system. Many of the participants asserted that BCT will facilitate a triple-entry accounting system because it adds algorithms of blockchain as a third layer to the double-entry in real time. These views were in tandem with Cai (2021); Faccia and Mosteanu (2019); Patil (2017); Peters and Panayi (2016); Schmitz and Leoni (2019); and Ibañez et al. (2021) who argued that BCT could facilitate a triple-entry accounting system and transform the current accounting ledger. However, there were a few participants who argued that BCT is unlikely to enable the triple-entry system because the technology is inherently complex, expensive and very slow.

It is important to note that the interviewees were not directly asked about the technicalities surrounding how BCT algorithms would facilitate triple-entry accounting because it is beyond the scope of this study. The participants' views are discussed below.

6.2.3.1 Blockchain Start-ups and IT Experts' (BSIT) View

The majority of the participants in the BSIT group believe that BCT is capable of facilitating the triple-entry accounting system. They believed the third transaction that will be on the BCT will bring more transparency and auditability to financial transactions. It could be said that this position hinges on the general features of BCT which have been explained earlier (see Chapter 2 2, Section 2.5). This finding corroborates the view of prior studies (Bonsón & Bednárová, 2019; Grigg, 2005; Gröblacher & Mizdraković, 2019) that transparency and auditability are among the benefits of using BCT as a financial ledger.

BSIT7 asserts: "Blockchain can facilitate triple-entry accounting as long as the chain is secured". Similarly, BSIT2 notes that "I think basically that blockchain actually does the triple-entry." S/He further explained that despite the BCT's potential to enable triple-entry, the technology may not be able to undertake proper classification of entry and transaction controls. BSIT7 believes that the control and classification of accounting transactions are higher-level accounting functions that probably will be handled by accountants. S/He explains:

> Like buying something from Amazon is a great example where I could have a buyer, I could have Amazon, I could have the third party and the triple ledger entries being entered, but that doesn't give us any context on whether how it should be classified especially from a buyer standpoint. I could buy something from Amazon that supplies, something that I'm going to use in my manufacturing that was a fixed asset, all of these things required classification so I think that's one thing there. So, everything coming up to the point where we have a transaction now if the blockchain is the endpoint of the transaction. I think there is still a need for controls before the transaction hits the blockchain. So, there's still that piece which is again a higher-level accounting function. (BSIT7)

The entry and classification of transactions in other accounting software are performed by people, so it is unlikely this practice will change in a BCT system. Consequently, this may not be a technology problem. The findings from these participants are similar to those of Bonyuet (2020) who states that the absence of controls over transactions outside BCT can impact the fundamental assumptions of completeness, valuation and classification in accounting.

Another participant, BSIT3 lent credence to the proposition that BCT will enable triple-entry by asserting that the immutable BCT algorithm is the third entry which may reduce dependency on accountants and enhance the identification of anomalies. BSIT3 explains:

> It is going to provide the ability to review the transaction much faster, the algorithm of the blockchain technology is going to be that third when we think about the triple-entry. The technology and having the algorithm trust takes the dependency of the accountant to ensure consistency, they'll still be needed whether being a public or private ledger when certain participants have access to it, you can still use technology to automate or AI to look for the fraud. That's a little bit of a self-regulated environment or a shared environment to where all of the stakeholders are having access. Again, that helps to reduce the dependency on the accountants, but also when you've immutable records or an immutable ledger, you are able to do reconciliation and reporting as well. I think that triple-entry accounting and blockchain will help in that regard. Triple-entry accounting using blockchain allows for the identification of fraud and errors. (BSIT3)

However, Ibañez et al. (2020) argue that anomalies and fraud would not be eliminated with the use of the BCT triple-entry accounting system because the shared ledger system itself cannot prevent fraud nor change the fundamental philosophy behind accounting. The authors further suggest that it could affect the current roles of bookkeepers in the accounting system. The idea that BCT integration with other technologies such as AI could mitigate the control issue when they are built into the system, thereby reducing dependency on the accountants, remains to be seen in practice. BSIT3's position may be ideal where BCT and other technologies are possibly integrated, but such a situation currently exists only in the laboratory.

However, BSIT5 stated that BCT will not affect how journal entries are recorded and triple-entry is not like an actual entry, but more like an audit record attached to data to enable integration of transactions by all parties. S/He elucidates:

> It's not actually like an entry. … it doesn't change anything with how you record journal entries. The name triple-entry accounting doesn't mean that you're creating another entry. A triple-entry system basically all it does is, it creates an integrated record of transactions that could be shared with both parties so that copy of transaction details: purchase order invoice, whatever other transaction details and other data associated with that transaction is stored on the blockchain and shared equally with both counterparties so that you know each counterparty doesn't keep their own separate set of kind of backup and support, it's shared through this third like blockchain system… That's why they call it triple-entry accounting it doesn't actually affect the debits and credits. (BSIT5)

Grigg (2005) acknowledges that the proposed triple-entry will work better side by side with the double-entry system rather than in isolation. Many of the existing triple-entry propositions are based on the expansion of the debit and credit system (see Faccia & Mosteanu, 2019; Ibañez et al., 2020; Patil, 2017). Thus, the view of BSIT5 seems to be in tandem with the proposed BCT triple-entry framework which shows it as an addition to the double-entry accounting system. This could mean that the triple-entry system brings no disruption to the traditional debit and credit system.

6.2.3.2 Audit and Assurance Firms' (AAF) View

In the AAF group, there are contrasting opinions concerning the potential of BCT enabling the triple-entry system. AAF6 noted that triple-entry will enhance inter-entity collaboration and reconciliation of accounts but pointed out that the consolidation of group accounts with different accounting policies could be an issue.

> What triple-accounting means is that you can do real-time reconciliation, we can see actions between counterparties so you've gone from intra-specific into inter-entity. The only issue I see with triple accounting, for example, is in a large consolidated group with minority interests with different accounting policies. I think I can see value in the triple accounting concept for organisations with complex accounting and complex group structures because the information is recorded and you don't have to go back to trace it since you can trace information through. (AAF6)

However, AAF2 argued that BCT could be used for triple-entry but its adoption may be jeopardised because the technology's technique is unnecessarily expensive and slow.

> You can use a blockchain, but you don't need one though. I mean you can, ultimately, if you could say blockchain is a database, you can use it. You don't need a blockchain though. As a database blockchains are inherently expensive; more expensive than a centralized solution because they have redundancy. You could argue that blockchains will hold back the adoption of triple-entry as they will make the technique unnecessarily expensive and slow. (AAF2)

6.2.3.3 Accountants and Auditors' (AAD) View

The majority of the participants in the AAD group were of the view that BCT has the potential to provide a distributed ledger that could enhance accounting practices and make records alteration impossible. This finding is similar to the position of Bonsón and Bednárová (2019) who found that "BCT adds some value to this concept by creating an immutable history of all the transactions within a system" (p.733). For example, AAD3 referred to BCT as a simple and immutable big spreadsheet that will be accessible to all parties.

> Yes, it facilitates that because all parties have access to that database and one-way people explain it, is to think of it as a simple big spreadsheet that we have all have access to and somebody verifies those transactions so that I can verify those transactions, it can't be modified once it is in the blockchain and is being mined and verified. (AAD3)

This is further elucidated by AAD1 who noted that in addition to integrity derivable from the BCT distributive ledger, a well-structured BCT triple-entry system could add value to the accounting system and reduce fraud.

> … the core strength of blockchain technology, that aspect of the distributed ledger process, that is what gives the system integrity, that is what makes it impossible for one person to just go in and say, hey if I take one million naira cash out of the till or out of the vault and I will go to the system and delete sales of one million. ... it means that it makes it impossible for one person to roll-back any transaction. I can't just log in and say, I cannot even collude with maybe we are two accountants in the office, and I say ok let's agree to delete the transaction, that is not going to work. That triple-entry is actually an advantage if well-designed. (AAD1)

6.2.3.4 Accounting Regulatory Bodies' (ARB) View

In the view of most of the ARB group, BCT will facilitate a triple-entry accounting system because it adds a third layer to the double-entry accounting system in real-time, enables transparency and reduces reconciliation. ARB2 explains:

> It is actually triple-entry accounting because it adds a third ledger to the traditional double-entry bookkeeping or double-entry accounting almost real-time verification process of transactions. It reconciles the data the moment it is validated and entered blockchain. (ARB2)

ARB3 further highlighted that besides changing the double-entry system, the BCT triple-entry system will enable transparency. BCT will provide the third link as an expansion of the double-entry ledgers and transparency which eventually could enable easy detection of any error or fraudulent entry in the accounting system (Gröblacher & Mizdraković, 2019). ARB3 explains:

> It changes. This double-entry was created about 500 years ago, now we talk about triple-entry accounting. Why? Because you have all the parties to the transaction see the entries at the same time. It's not just you do your double entry and I do my double-entry, we do our entries simultaneous in a shared ledger, that is the concept of a triple-entry accounting. …But it changes because never in the history of humankind you could have thought that you could give the buyer and the seller and the regulators and the bank and everybody to get the same version of the truth that for me it's an incredible challenge. (ARB3)

However, ARB5 expressed scepticism about the possibility of BCT facilitating the triple-entry system because of the lack of use cases, "Yes, it could, but again I haven't seen yet any use cases. So hard to know, but that was all the talk as well." ARB5 acknowledged the importance of having practical use cases of the BCT triple-entry system to determine if the technology can facilitate a triple-entry accounting system or not. This is a similarity between the view expressed by ARB5 and the one described by Schmidt and Wagner (2019). They highlight the importance of deploying BCT to determine its efficiency because examples of successful blockchain applications are scarce (Schmidt & Wagner, 2019).

6.2.3.5 Financial Analyst and Other Experts' (FAE) View

Of the five participants in the Financial Analyst and Other Experts (FAE) group, only one participant commented on whether BCT will facilitate the triple-entry accounting or not. Most skipped the question because it was considered too technical and outside their area of expertise to address. Nonetheless, FAE3 noted that BCT will be the third layer to the existing debit and credit system and the technology got people excited because of its potential to facilitate triple-entry accounting.

> I'm glad you asked that specifically because I totally left this out, a big reason people are excited about blockchain is that it creates triple-entry accounting, so, you have the credits and the debits but you also have the nodes. You have the transactions being written to the blockchain so it creates another level to verify everything. This digital distributed ledger becomes the basis from which you can derive all the financials. It's essentially a third layer of being able to check and confirm that everything is adding up like it's supposed to, that's theoretically how it would work. Again, trust is going to be a huge issue. (FAE3)

Overall, the discussion revealed that there were contrasting views among the participants as to what changes BCT will bring to the double-entry accounting system and whether the technology can facilitate the triple-entry accounting system. Possible reasons for these divergent views could be that the technology is a new concept that may not be relevant to the accounting system. As noted by Coyne and McMickle (2017) the use of BCT as an accounting ledger is infeasible because the technology's verification method and immutability of transaction records are not fit for purpose in the financial reporting system. Similarly, Ibañez et al. (2021) observe that it will be an unfair assumption to assert that the triple-entry accounting that has not been deployed for commercial purposes has architectural merits over the existing system. The authors further note that " … it is easier to announce a feature in a white paper than to materialize it in a commercially deployed, usable, cost-effective and user-friendly manner."(Ibañez et al., 2021). The next section deals with changes that BCT will bring to the tax management accounting system.

6.2.4 Tax Management

The perception of the majority of the participants in this study revealed that BCT has implications for tax management. The findings showed that BCT, where it is widely adopted, could be used particularly for Goods and Services Tax (GST), Value Added Tax (VAT), Withholding Tax (WHT) or company tax, but not for income tax due to computational complexities and regulations, especially in some jurisdictions with multi-tax regulations. This finding is in line with the position of some scholars (Demirhan, 2019; Hoffman, 2018; Nemade et al., 2019; Wijaya et al., 2017) that BCT will facilitate the smooth administration of VAT and GST.

The findings further indicate that a BCT-based record and accounting system must be established for the technology to have any impact on tax management. The study also found that BCT has the potential to reduce collusion and tax fraud. The participants also believe that companies could resist adopting the technology because people and companies want to hide information from tax authorities. Khan and Syed (2019) state that BCT will not only support the VAT administration but also reduce tax fraud and aid tax collection globally. Revenue generation will be exponentially increased when government utilise BCT for tax collection (Nemade et al., 2019)

The study did not delve into the taxation of blockchain Bitcoins and other cryptocurrencies because there is no universally agreed accounting treatment for crypto assets. Moreover, many governments are yet to grapple with the means and ways of taxing crypto assets. Thus, the scope of this study does not cover this area.

6.2.4.1 Blockchain Start-ups and IT Experts' (BSIT) View

The majority of the participants in the BSIT group were of the view that BCT has the potential to disrupt the tax administration. They believe that BCT will not only enhance tax collection, particularly VAT and GST but ensure that citizens can monitor how government disburses public funds. Besides facilitating VAT and GST, BSIT9 argued that BCT-enabled tax management has the potential to reduce tax fraud and overall tax compliance costs. S/he explains:

> … I think when you look at things like VAT, sales tax, GST, and even payroll tax, there's a real opportunity to remove the intermediaries and streamline the process for these pretty straightforward taxes. In other words, you could

> compute them at the time that they occur. In Income Tax you can't, you got basis, what's your other positions or loss carry forward all these complicated stuffs, but payrolls pretty simple and so is sales and VAT and GST taxes. I think there's a real opportunity there to reduce the cost of regulatory compliance and reduce the fraud, reduce the cost and speed up the flow of money to governments. I've even talked to the former treasurer of the World Bank, in doing so, allowing revenue bonds to be created off the revenue streams once they're blockchain-enabled. (BSIT9)

BSIT1 and BSIT3 noted further that BCT will make the tax administration simple, enable people to exert more control over public funds and facilitate automation. This finding is consistent with that of Demirhan (2019) who states that BCT will bring transparency, accountability, reduction in tax evasion and improved tax audits to tax administration, as well as increase the revenue generation capacity of government. BSIT1 and BSIT3 explain:

> When people pay income tax, they pay their taxes using a digital dollar on a blockchain that allows them to have more control over their government, know where those tax dollars are going because they can essentially follow the money. You can see on the ledger exactly where their dollars are going, how they're being spent by their government. (BSIT1)

> Yes, I think it will. I think that the impact the blockchain is going have when it comes to tax is more of automation because we are going to have this information, we're going to have transaction information available to us in real-time when the transactions happen, and we will have all of them and we will be able to build machines and algorithms to assess all of those transactions at a much faster rate. So, we are going to see more automation, especially in jurisdictions that have what we call simpler tax codes, the US has very complex tax codes. I think it will be a little more challenging in the US. (BSIT3)

The automation is said to prevent anomalies, reduce costs and enable merchants to file their GST returns without cumbersome paper works because everything will be done in online real-time, says BSIT1. S/He elucidates:

> It reduces a lot of fraud such as tax evasion and increases different use cases that facilitate both automation, but in such a way that it's creating less fraud and less costs for everyone involved. The merchant doesn't have to figure out what their GST is and file all this paperwork, they can essentially not have to worry about it because it's done in real-time. That's just one tiny example. (BSIT1)

BSIT9 noted that BCT will eliminate the role of corporations as intermediaries in the receipt of transaction taxes and enhance the effectiveness of tax processes. BSIT9 illustrates:

> What happened is the government's historically made corporations responsible for collecting VAT and sales taxes they basically said, you're nominated as a tax collection agent of the government. It's not the company's money. It's like whenever you pay your taxes for a sale, it's doesn't go into their coffers, it just passes through them and goes to the government. They're intermediaries and they don't want to do that; they don't want to be responsible for it. We're looking at can blockchain remove the need for the corporation to be an intermediary in the collection of transaction taxes? That's the type of problem where, in the pre-digital era, there was a need for a responsibility to be assigned to an actor in the ecosystem. In the digital world, do we need that anymore? Can we remove that actor and streamline the process? (BSIT9)

BSIT9 suggested the need to eliminate corporations as government tax agents. The feasibility of removing corporations from the tax processes appears illusionary because they are parties to the transactions that bear the incidence of tax. Without corporations initiating transactions or rendering services, governments have nothing to tax. It is yet to be seen how this idea will pan out in practice.

Some of the challenges that participants envisaged concerning the impact of BCT on tax management included the issue of complex tax rules in some jurisdictions such as the US and the inability of many governments and tax regulators to keep abreast with the technological development. BSIT10 clarifies:

> I think from a tax perspective, there are a couple of interesting things going on. Certainly, because tax codes are so complicated and there's still so much that tax authorities have yet to define, it really makes it a challenge for the accounting professionals to value and to manage the reporting of taxes. The United States, England and some other countries are trying to do it. At a technology level, it becomes a bit easier because you can use some of these providers like [xxxx, xxxxx][16] and so on that do the transactions from the exchanges and value those transactions could create reports for tax reporting purposes, for example, IRS 1099 forms in the US. Part of the other challenge from a tax perspective is that the technology is evolving so quickly it's hard for tax regulators and tax preparation providers to keep up. (BSIT10)

Kimani et al. (2020) suggest that the complex and slow pace of change in tax

[16] Protection of the participant's identity.

regulation and legal system could inhibit the progress of applying BCT for tax administration. BSIT2 and BSIT9 pointed out that income tax is complicated in the US and some other jurisdictions. This is said to be due to the number of states, counties within the states and the localities and municipalities within the counties. However, the same cannot be said of countries like the UK and New Zealand where tax systems are not so complicated. Despite these issues, some countries such as the US and the UK were working on ways to harness BCT for tax management.

Similarly, another participant, BSIT8 argued that the manipulative nature of government and politicians is another challenge. S/He was of the view that governments could also be a hindrance to the use of BCT because they do not want a transparent system like BCT in place. S/he explains:

> I believe that politicians like to socially engineer human beings. I don't think the government and the politicians are going to want to give up control over manipulating tax policy. But as far as technology is concerned, if we didn't have to worry about politicians, IRS Tax Returns being honest, siphoned off or mint a certain amount of coins cryptocurrency every year for the government. (BSIT8)

Demirhan (2019) suggests that the use of BCT will allow a tax authority to have an effective control system over taxpayers, reduce tax administrative costs and boost government revenue. If governments aim to have effective control over taxpayers, boost revenue, and ensure transparency, they may likely employ BCT for tax management. However, it is also possible for a government to shy away from such transparency associated with the BCT solution to keep manipulating tax policy as opined by BSIT8.

6.2.4.2 Audit and Assurance Firms' (AAF) view

Participants in the AAF group were of the view that BCT has potential in the tax system but this is subject to the adoption of the technology for financial and accounting records purposes. They also believe BCT could be useful for GST or VAT collection systems, but subject to the government and people having an appetite for such technology. BCT could enable the automatic calculation of VAT and payment of deducted tax to the appropriate authority thereby reducing the incidence of tax fraud (Karajovic et al., 2019). BCT integration into the tax system is a new concept that requires governments to create an enabling framework or model for its adoption (Demirhan, 2019). This is because the technology is still in various experimental stages.

AAF1 elucidated that BCT could be used for WHT or GST but the environment and BCT-based accounting system need to be in place. S/he explains:

> I don't see why it can't, it absolutely could have a role, but the environment is a bit difficult…. Going back to the front-end, where I talked about blockchain and programmable smart contracts I see absolutely no reason why you can't program into the contract the withholding tax or the GST or the ultimate tax treatment of an item whether it's capital or revenue. You could code to one account that goes into within the transaction. I think you can deal with the tax, all upfront if you so desired. I see no reason why can't make those decisions. So, I see it as having possibilities and both the tax payment and tax certainty, but those are way-way no one really has an appetite for it, probably won't come until what you said earlier your question about whether people are using accounting systems based on blockchain records. If you're using blockchain-based records and accounting system, then you should be able to pull out from the accounting system and go back up to the beginning and the program from there. (AAF1)

AAF4 notes that tax payment systems would be enhanced and automated if governments adopt BCT. This was also the position of the majority of the participants in the BSIT group. AAF4 elucidates:

> On the tax sure, if the authorities will allow blockchains to get into the system. Basically, then it will also enhance all the tax payments because if we for example buy anything in a shop. For example, I have a company, and you want to buy a stapler for your company. At the moment you have to get the receipt, you have to take the receipt, you have to show to the tax authorities and say hey I really bought it so I want to reduce my taxable earnings, but still, with this stapler or with the cost of the stapler. If everything would work on a blockchain basically including the tax authority systems, then this could be recorded automatically. You could get a certain key which is only eligible for your company, if you buy something with this key, then it can automatically reduce your tax payments, which you have to pay in this year, month, day or whatever. And so it will also enhance the process because you don't have to send anything back and forth and you don't talk to anyone because everything will be automated in a perfect world. Let's see how far we can go. (AAF4)

Contrarily, AAF2 cited the ongoing effort in Australia where the government wants online real-time access to the financial activities of companies for tax purposes but argued that governments do not need BCT to achieve this integration (and the technology is expensive and slow), as there are alternative technologies available. AAF2 narrates:

> So, you can see that that trend is definitely happening the tax office is trying to integrate, but it is doing it piece by piece. In Australia, we are having real-time payroll reporting now. When you are paid in large companies in Australia the tax office knows at the same time you do. Sales tax / GST was done some time ago. So rather than integrating to the GL, the tax office is demanding real-time access to these different views into a firm's financial activity. Logically the way to deal with this as a firm is to build a set of real-time synchronised "local ledgers" that provide different views into the firm's finances. Functionally this is something like a blockchain, but it doesn't require blockchain technology. Will we use a 'blockchain' for this? Probably not as the problem you get with blockchain is that it tends to be not economic, it's expensive (and slow) to run for what it does. There are other cheaper and more effective technologies that we can use. (AAF2)

However, AAF2 did not mention other technologies that could be used instead of BCT. Swan (2015b) believes technology such cloud storage could be used for BCT sequential, public, and distributed data storage. It may be too early to assume that BCT is uneconomic and expensive for tax administration as claimed by the AAF2. Similarly, AAF7 argued that BCT has little or no impact on tax administration beyond what the existing financial technologies have been doing such as capturing financial information.

> I wouldn't say much again they're kind of a recipient again of information just like financial reporting is so really it's the same as any other tech implementation, you need to make sure if there's a tax consequence it's captured on the blockchain. But beyond that, not much like in the issuance of ICOs, tokens and that sort of thing there is a lot of tax advisory for how to structure those. But, day to day with an enterprise blockchain, I wouldn't say there's hardly any impact at all. (AAF7)

Another participant, AAF8 noted that it is too early to predict the impact of BCT on tax management. S/He explains:

> I think tax planning or tax management, or tax advisory is very premature. I rarely heard from our tax accountant saying that they got the need from clients rely on the crypto. I think maybe in the coming years, maybe a lot of businesses, but for Hong Kong in particular not a big opportunity on the tax management or tax advisory on the crypto thing. (AAF8)

The absence of a global information sharing system for management of cross borders information coupled with the lack of transparency are chief reasons BCT should be deployed for the global tax administration (Hoffman, 2018). The real-time tax collection using BCT is said to have problems due to complexity, governance and regulatory framework. Kimani et al. (2020) argue that hindrances to BCT include complex tax laws in different jurisdictions and the exponential increase in the development of technologies coupled with the slow pace of regulation. They note that potential benefits associated with the BCT tax system have eluded most governments due to a lack of IT specialists and the fear of the technology becoming a potential tax evasion tool (Kimani et al., 2020). However, tax administration in many developed countries is in online real-time mode, yet this has not reduced the incidence of tax evasion and fraud. What the BCT will do differently in tax administration is unknown because there is no use case yet. It could be argued it is too early to ascertain the impact BCT will have on tax management.

6.2.4.3 Accountants and Auditors' (AAD) View

The majority of the participants in the AAD group believe that BCT could disrupt tax management by facilitating tax collection online in real time, providing transparency, and reducing tax fraud. They noted that a hindrance to a BCT tax management system would be resistance from corporations. AAD5 explained that companies could resist using BCT because it may open their transactions to governments and third parties. The use of BCT for tax purposes is also said to bring transparency to the disbursement of public funds. Nonetheless, this is subject to the adoption of BCT for financial record management.

AAD4 thinks that the use of BCT for tax management would benefit both the taxpayer and the tax authority because once a transaction occurs, all parties involved are aware of the tax incidence thereby facilitating the collection of taxes in online real-time. AAD5 further explains:

> This is very interesting. I think that with tax management there's always a lot of extra regulations as well. We always heard that big companies are not paying taxes, even a lot of tax frauds probably all over the world. Blockchain will bring more transparency over there, not just in the tax management but it will also have an implication to the government in the way that the public money is being spent. People will have more visibility of that, it will change

> the tax management system quite drastically. There are some other regulations people can't play around with, it will definitely disrupt tax environment. I can see a lot of companies being resistant, simply because of tax purposes and that certain transaction is visible to the government or to external parties which are responsible for tax collection or maybe a tax department in the government. It will have serious implication for the taxes if it is adopted widely. (AAD5)

AAD2 noted that regulators are applying different tactics to the use of BCT, but with caution. S/He pointed out that IRS in the US has issued some guidelines to that effect. Similarly, the New Zealand IRD has comprehensive guidelines regarding the taxation of crypto assets (NZ Inland Revenue Department, 2019). AAD2 explains:

> On the other hand, to the credit of the regulators, you ever heard the saying, be careful what you ask for because you might get it. Some of the regulators are sitting back a little bit and saying let's see how this matures and others have been very aggressive. The securities exchange commission (SEC) in the US has been going after people that have blockchains and certain things, enforcement actions. The IRS in the US, the tax people in the US, they come out with some guides and they take enforcement actions as well. (AAD2)

6.2.4.4 Accounting Regulatory Bodies' (AAF) View

There are divergent views as to the impact of BCT on tax management in the ARB group. Some participants supported the view that BCT will enhance tax management with transparency, provide online real-time access and reduce 'cooking of book'. Others were of the view that BCT may have no meaningful impact on tax management.

ARB3 believes that with BCT, the tax administration will be transparent because companies, tax authorities and shareholders will have online real-time access to the same financial record thereby eliminating fraud. S/he explains:

> In the blockchain, what happens is that all the parties to a transaction see the ledger at the same time. Everybody verifies the accuracy, gets the ability to have what is called cryptography, which is a mathematical formula that prevents any of the parties from cooking the books and nobody can cheat. There cannot be collusion, people cannot collude to cook. It enables the regulators to get the ledger real-time. Your taxes could be paid real-time based on the same information that you've got internally that you give to your shareholders. You don't have three different sets of books. Today we cooked

> the books, why? Because we have internal books, a management account, the financial statements and the tax returns. All based on supposing the same transactions, but we have three sets of books that could be totally different from each other. (ARB3)

However, ARB4 challenged the notion that BCT will have an impact on tax management. S/He claimed that BCT may not have a meaningful impact because what the tax authority is after is the translation of the financial records into a tax template for revenue collection. S/He went on to explain:

> Tax is an interesting one. I think that it probably is not going to make a huge difference in tax rules. They don't care how you keep your records, they just care about you translating what you've been doing into tax terms. The main issue we've seen with tax and this space is just thinking about tax for cryptocurrency holdings and transactions. I think that most tax authorities are kind of settled on their treatment now most have settled on that sort of treating things like capital gains and using that written back kind of tax rules so I don't think there's much. (ARB4)

ARB6 shared the same view with some participants in the AAD group about the fear that BCT could facilitate tax fraud but further acknowledged that it is premature to ascertain the impact at this stage of BCT development. ARB6 explains:

> I mean in the UK, there's something called making tax digital where they're trying to automate elements of the tax workflow, but it's very basic. It's basically traditional automation and being able to ensure that smaller businesses can file on their returns online, for example, being able to reduce paper-based processes. Now that sort of links eventually to aspects of the relevancy to the blockchain, but with things like tax there's a big concern around potential for fraud and so forth and I think those sorts of things will take time to mature, for sure. (ARB6)

Hoffman (2018) notes that BCT is not a cure for all the gaps in tax administration, but its application could reduce tax administrative costs, reduce fraud, and add value to the economy. However, Hoffman also acknowledges there is a need for use cases to ascertain the true impact of the BCT on tax management.

6.2.4.5 Financial Analysts and Other Experts' (FAE) View

The participants in the FAE group were of the view that BCT will enhance tax administration with its distributed ledger. FAE2 notes that BCT could facilitate the integration and interaction of key stakeholders in tax management. S/He explains:

> In the future, I anticipate people with independent accounting, financial and tax elements in a distributed ledger, whereby they are able to execute transactions between themselves and the tax authorities. The whole point of distributed ledger, is that everyone, it's an unarguably attestation of record and the tax system will be based on it. (FAE2)

However, another participant, FAE3 argued that BCT could help with tax management but it is too early to predict the form it will take. S/he explain, “In terms of tax management, theoretically, it could help with planning, but I think that'll be more of an AI, machine learning type of thing. Again, there’s still several years out on that.” The discussion showed there were contrasting views among the participants regarding what practical impacts BCT will have on tax management. Undoubtedly, BCT has potential for tax management, but it is important to have more use cases.

The findings of this study show that BCT could aid the collection of GST, VAT and WHT, but not income tax. This finding is similar to some scholars’ positions (Demirhan, 2019; Hoffman, 2018; Nemade et al., 2019; Wijaya et al., 2017) that BCT can enable the administration of VAT and GST. However, to the best of the researcher’s knowledge, there is no previous study that has highlighted BCT's possible implications for income tax collection in multi-tax jurisdictions This study further reveals that BCT could be a potential platform for tax evasion and fraud. The finding indicates that a BCT-based record and accounting system must be established for the technology to have any impact on tax management. The next section examines areas that BCT can disrupt or enhance in the accounting and auditing profession.

6.3 Areas in which BCT can Disrupt or Enhance in Accounting and Auditing

The potential impact of BCT on the accounting and auditing profession has garnered much attention due to its fraud reduction capabilities. From the literature reviewed in Chapter 2 and Chapter 3, it was evident that many writers, including professional accounting bodies believe that BCT will disrupt the accounting and auditing profession (Bible et al., 2017; Dai & Vasarhelyi, 2017; Fortin & Pimentel, 2022; Lombardi et al., 2021; Mantelaers et al., 2019a). However, Smith (2018a, p. 118) emphasises that BCT is “not a financial tool, an accounting platform, a journal entry tool, or a replacement for existing accounting software".

Similarly, Perkinson and Miller (2016) suggest that despite the technology potential for record management, the intricacies of accounting standards and financial reporting could be hindrances to BCT's suitability for accounting purposes. Bonsón and Bednárová (2019) note that many other technologies could serve as alternatives to BCT. Consequently, scholars have acknowledged the need to seek the understanding of the practitioners of accounting and blockchain start-ups in areas where the technology could have a mentionable impact (Lombardi et al., 2021; Risius & Spohrer, 2017).

To shed light on the possible areas that BCT could bring disruption to or enhance the accounting and auditing fields, participants were asked: "What areas in accountant's and auditor's function will BCT enhance?, and What areas will BCT disrupt in accountant's and auditor's functions?" This study also regards the likely effects of BCT on the accounting industry as a part of the technological context of the TOE framework. Participants were further asked to explain if they were aware of organisations using BCT or have adopted BCT for financial accounting and reporting purposes (see Chapter 4, **Figure *13***). The study participants' view is an element of the organisational context of the TOE framework. The participants' responses to these questions are explained in the subsections under the themes: areas of disruption to or enhancement of the accountant's function (Section 6.3.1); areas of disruption to or enhancement of auditor's functions (Section 6.3.2); and organisations that have adopted BCT for financial accounting and reporting purposes (Section 6.4).

NVivo was used to search the interview transcripts to find the most frequently used words by participants concerning areas BCT will enhance or disrupt in the accounting and auditing practices. Using the word frequency search in NVivo, the criteria set were words with at least five characters, stemmed words and some common phrases such as blockchain, audit, account, disrupt, enhance and other common words were added to the word stop list to exclude them from the query result.

The most highlighted areas of disruption by participants in the NVivo thematic analysis relate to reconciliation, bookkeeping, checking and verifications of transactions, access to information and inventory management. **Figure 22** is the NVivo Word Cloud that identifies the most frequently used words by the participants.

Figure 22. *Word Cloud - Areas BCT disrupt or enhance in Accounting and Auditing*

Note. Source: Author

6.3.1 Areas of Disruption to or Enhancement of Accountant's Functions

One of the objectives of the study was to understand what areas BCT will disrupt in the accounting and auditing profession. The possible areas that BCT is expected to enhance are similar to areas the technology is said to have the potential to disrupt. Besides automation of transactions, bookkeeping and elimination of some manual accounting processes, the majority of the practitioners who participated in this study believed that BCT can facilitate real-time accounting, inter-entity transactions, reduce the cost of maintaining and sustaining accounting ledgers. These findings aligned with the findings of Schmitz and Leoni (2019); Yu et al. (2018) on the likely effect of BCT on the accounting industry.

A few of the participants suggested that BCT's disruption could put accountants out of business with the elimination of manual bookkeeping. Similarly, Bonyuet (2020) asserts that BCT can eliminate reconciliations and confirmations in accounting tasks. However, the study found that without the digitalisation of records, BCT or any other emerging technologies may have little or no impact on the accounting industry. In general, the participants believed that BCT has not disrupted accountants' functions because some existing software applications have disrupted accounting functions already. The participants' perceptions are discussed in line with their groupings.

6.3.1.1 Disruption to Manual Accounting Work - Blockchain Start-ups and IT Experts' (BSIT) View

The majority of the participants in the BSIT group note that BCT has the potential to disrupt manual accounting work, reconciliation and bookkeeping. They believe that with BCT, a smart contract accounting system could be automated without any human intervention. They assert that BCT time-stamped and the immutability of records could provide evidence-based transactions for the financial recording system. The view of BSIT1 could be taken as a representative view.

> There's a lot to be said around the development of smart contracts and automating accounting systems in such a way that a human doesn't need to touch them. We can reconcile transactions in real-time without the need for a bookkeeper… The roles that I think blockchain will disrupt will be a lot of manual labour, that is, the direct bookkeeping, the direct auditing, but it will never replace the need for problem-solving, strategic thinking and strategy development. While it helps reduce major costs in businesses, there's still going to be a need for people who can understand a balance sheet, and make strategic decisions. (BSIT1)

Li et al. (2017) note that BCT smart contracts can facilitate transactions between mutually distrusted parties without any trusted intermediaries. The roles (reconciliation, bookkeeping and other manual accounting) listed for disruption have possibly already been automated in the accounting processes. However, smart contracts could be an innovation that may affect the basic manual accounting functions as suggested by BSIT1, but it is unlikely this will work for accounting processes without an accountant's intervention. Mutually distrusted persons can easily undertake cryptocurrency transactions because it is a linear and predictable process, but the preparation of financial records involves multiple processes for which smart contracts cannot be designed to cater for everything. Additionally, BCT smart contact use cases for accounting are probably in the development stages. BSIT1 went on to explain that reconciliation after the fact is no longer going to happen in accounting, "You don't need to reconcile after the fact, the transaction is the settlement and reconciliation, so you can prove exactly that transaction happened." However, confirmation of the occurrence of transactions is not sufficient, it is important to know the nature of such accounting transactions (Bonyuet, 2020). BSIT5 also pointed out that BCT will impact the back-office system, disrupt all manual accounting processes and virtually everything could be automated and integrated. S/He argues:

> The most impactful, it's going to be your back-office system. Going back to transacting on the blockchain, by transacting on the blockchain you can actually automate various accounting reconciliation processes because you can basically view and verify transactions that are occurring in real time and you can automatically kind of record and update your balances in real time, based on the way that turns out, digital currency transactions occur. So, because of that, it's really going to disrupt a lot of the manual accounting processes that occur today. You'll have a lot of those processes that become automated like an automated reconciliation and automated verification of payment and an automated recording of those transactions into your back-office accounting system can occur. So, I'd say like speed on automation and those kinds of back office accounting tasks start to be reduced or eliminated. They're going see a lot of value added to businesses through that. (BSIT5)

Similarly, BSIT7 further emphasised that it is not only the journal entries, reconciliation, and financial statements that BCT is capable of automating, but everything that does not require human judgement in the accounting and auditing system. This view is similar to BSIT1 in that BCT will automate accounting bookkeeping. It could be argued that existing accounting software has automated recording, verification and reconciliation of these accounting functions. BSIT7 posits:

> I'd say like account reconciliations, it's such a tedious, silly job to the least auditing team that even preparing it that will probably be impacted. Even journal entries could be automated. We're already seeing some of that accruals and stuff that can be automated. Financial statement preparation can be automated. Basically, anything that doesn't require judgment will be impacted. That's where the skill sets will come in and we have the judgment, we're still humans, AI might affect us but it'll take a little bit of time. (BSIT7)

The evidentiary proof from BCT hash time-stamped on documents is considered by BSIT9 is another area the technology could bring disruption to the financial record system. The BCT-enabled digital documents could help to prove the existence and validity of any transactions. The provision of immutable evidence for transactions is important as this could help in the audit verification of a company's assets and liabilities. Reliable proof of transaction comes from immutable BCT because no single party can override the technology's time-stamped transactions (Wang & Kogan, 2018). Bizarro et al. (2018) note that BCT could enable auditors sufficient time to test internal controls and the company's complex transactions. BSIT9 explains:

> I think the other important use is evidence because these blockchains are time-based systems and immutable, you can stamp into the blockchain a hash of something, and that is proof that it existed in that state at that time. This could be a document you can prove that a transaction occurred. For example, you bought a house or something, and someone says no you didn't buy that house. That's my land, my grandfather gave it to me and you can go back in time and look for the document. Here's the digital document, here's the hash of that document and it's timestamp back 20 years ago when I bought the house. I think that aspect of it is pretty important that it's time-invariant. (BSIT9).

BSIT2 notes: "the big benefit is that we're going to see the streamlining of this transaction." This was further explained by a participant, BSIT3, that with BCT it is possible to have transactions in real-time, thereby reshaping the accounting information from its current historical focus to being future focused. Accounting information is based on historical or past data, but the information on how the use of BCT will facilitate such insight is still scanty. The majority of the BSIT participants think BCT will disrupt the traditional accountants' functions.

6.3.1.2 Disruption to Traditional Accounting Functions – Accountants and Auditors (AAD) View

The participants from the AAD group were of the view that BCT could disrupt transaction clearing, reconciliation and other clerical accounting jobs, but the final accounts still require an understanding of accounting regulations. Without full digitalisation, BCT may have little or no impact on the accountant's function because some organisations are still using pen and paper.

AAD2 notes that "I think it will disrupt internal organisational transactions such as clearing and verifying a transaction, payment systems." S/He explained further that "it's not going to replace accounting we still need to do accounting; we still need to do valuations, I actually work on valuations for blockchains. Furthermore, AAD4 explains "Again, the reconciliation bits and the clerical bits are there. That's the one that will be automated. Apart from that, in the final accounts and you will still have to know the accounting regulations and the value-added bits."

AAD5 believes BCT is another tool for accountants because basic accounting tasks of preparing, recording, analysing and summarising transactions will still be done irrespective of the adopted technology. Participants in academia also shared the view that BCT could be another tool in the hands of accountants. S/He illustrates:

> The accounting function will still be organized in the same way, it's just that there's a new technology, in my opinion, it is similar to that of the audit industry. It's just another tool for them which helps them build on their existing works. In the accounting department, it doesn't matter what underlying technology they're using, they're still recording those transactions, relating it to prepare summaries of the system and analysing those accounts. It's just like for me as a management accountant, if I have more visibility of the entries in my environment and how they are recording the same transactions now before how I interface with them. If I have that information, it will enhance my analysis concept. At the same time, the accountants are there to run their business as well, it's another tool for them. (AAD5)

It is possible for BCT to become an underlying technology for the processing of financial transactions, thus becoming a tool in the hands of accountants. (Ferri et al., 2020) suggest that BCT will a tool to enhance the performance of accounting professionals. Perhaps, it will enhance the analysis and reporting system, but this is yet to be seen in practice. AAD5 further notes that without digitalisation, it may be difficult to have any BCT disruption because currently, many companies still maintain paper and electronic records. S/He notes: "Yes, of course, BCT will still require digitalization if a company has not reached that stage of digitalization, it's very hard to imagine the company fully adopting blockchain." The paper trail is important for some government entities and regulatory authorities to ascertain who does what.

6.3.1.3 Disruption to traditional accounting functions – Financial Analysts and Other Experts' (FAE) View

FAE1 believes that areas BCT could disrupt are "Mostly clearing, settlement, and a possibility to execute peer-to-peer payments". Similarly, FAE3 thinks that BCT will enhance accounting jobs by making them easier and forward-looking. S/He explains:

> I think by the time blockchain comes in it might actually make things easier for the accountants, but the accounting profession is going to have to change from being compliance-oriented tasks in audit because those services are becoming commoditized. With those services you essentially looking backwards in time. The importance of data, access to big data, the ability to pull information instantly and as 5G comes in to do it in massive quantities and at unbelievable speeds almost real-time to the point where we can have driverless car systems like where they're all talking to each other. That's going to change, you guys [accountant]) have to be looking forward. The technology will be able to do looking back, you'll just need to be able to have people go in and make sure it's looking back correctly. That's where we get into the flagging items and stuff, and where blockchain fits into that I'm not sure. Some people who are technology experts and accountants, I know some people who don't think blockchain is going to end up being the technology that plays a key role. I have others that think it will. I don't know enough to know I just kind of have an idea of where this is going. (FAE3)

However, FAE2 asserts that BCT could eliminate accounting functions, "It's going to put some accountants out of business but which I guess it's really not necessary a bad thing." This view aligned with AAF4 who suggested that BCT could eliminate accounting functions. Birch (2021) emphasises: "cryptographic proofs will replace auditing and apps will replace auditors."

FAE4 believes that a low level of digitization where many organisations still record information on paper needs to be improved before considering BCT.

> What I am seeing is a very low level of digitization anyway and yet, people are getting being asked about blockchain. It's almost like you're missing out this huge bit in the middle which is before we start talking about blockchain and security of information, etc. You're writing things on pieces of paper. …That's the problem I've got people who are shouting about blockchain etc. and we've got so much more to do before we get there. (FAE4)

It is important to get data into a usable form as information before considering the disruption the technology will bring. It is said with the BCT automation mechanism, the technology may not disrupt accounting processes, but where organisations are not fully digitised, such disruption is infeasible.

6.3.1.4 Non-disruption to Accounting Work – Audit and Assurance Firms' (AAF) View

In AAF's view, some participants believe that the traditional functions of accountants are already disrupted by the existing technologies and BCT may not be a disruptor of basic accounting functions. AAF1's view could be seen as the representative position:

> No, I don't think so because the traditional role of an accountant is disrupted already. And by that, I mean that there's a lot of technologies now that can do the engine, can do the calculations, can do the crunching for you. Where accountants are involved and important is probably in the front-end, which is the thinking, the advisory, the interpretation, the input, if you like, and sometimes the input is just getting data into the calculation engine. A lot of that is becoming automated separate to blockchain, but I think the accountant's value is more modern now and it's about the approach and advice and then it's the output and the analysis and the forward-looking aspects. (AAF1)

Some participants stated that accounting is already disrupted, and it has nothing to do with BCT. AAF5 notes: "I think that the auditing and accounting profession, from a regulatory perspective, has already been disrupted". AAF1 expressed the same view: "I don't think blockchain is necessarily going to be the disruptor for accountants because accounting is already being disrupted." In financial reporting, software such as Xero and MYOB have enabled many small businesses to prepare their basic financial statements without the help of accountants (CAANZ, 2020b). The participants' perception that accounting functions are already disrupted could be because existing software applications such as Xero, Peachtree and SAGE50 are used to record and process financial transactions, and produce statements and reports.

AAF7 posits that where BCT smart contract is employed, accountants overseeing items such as accounts payable and receivable may not be needed as these functions may be integrated into the BCT ledger. AAF1 supports this view, "I think the accountants are less involved or will be less involved potentially if they're using blockchain for programmable functionality because they won't be involved like they apparently are now, which is at different stages of time." AAF4 took a radical view and emphasised that BCT will make accountants redundant, "… a lot of people in the accounting departments they will be redundant as soon as we adopt the blockchain technology and as soon as it works." BCT is said to have the potential to eliminate financial statements audits due to the digital currency self-confirmation mechanism (Bizarro et al., 2018). However, AAF7 notes that the elimination of these accounting functions depends on when central banks put fiat currencies on blockchain and the digital currencies become operational. AAF7 clarifies:

> You wouldn't necessarily need people in accounts payable (AP) or receivable (AR) if you didn't want to or you'd have very limited people if a smart contract executes everything and then it goes into your ledger. There's no running around for approvals because it's already approved before it even gets onto your books. You could straight go to payment right from the moment it gets to your ledger if you want. All the AP or AR person would be doing is just when they want the payment to be released. Our fiat currencies aren't on blockchain right now you can't just let the payment go because it's not digitally connected yet. If we get central bank digital currencies all sorted out, it's possible you could get rid of those functions almost entirely. If you don't want someone kind of doing that like I don't know why you'd redo the work if you already had a blockchain doing for you. (AAF7)

The participants that support the idea that BCT will disrupt the traditional accounting functions predicate their argument upon when the BCT is fully adopted or used for digital currency applications. Some of these participants did not realise using BCT for CBDC does not translate to decentralisation associated with the Bitcoin blockchain. It could be argued that blockchain for CBDC is unlikely to be the way Bitcoin blockchain operate.

AAF8 suggests that BCT will not disrupt accountants' roles but there will be modifications to their duties. S/He thinks digitalising the accounting process is important. AAF8 clarifies:

> That's why I said the blockchain environment will not remove all the accountants, but the job duties will be changed. This because digitalising the accounting and the auditing processes, it just the people instead of doing the entry they may have to upload the PDF if they are still in the physical paper, the invoice. The long-term goal is we may skip the physical thing and everything is online. I think it is a long-time vision, but with papers, we can still digitalize. (AAF8)

AAF4 states further that a certain degree of digitalisation is important for streamlining the financial records of the company. BCT may not be possible where there is no full digitalisation of records. AAF4 illustrates:

> The digitalisation, I don't know how it is in New Zealand but in Germany, for example, most companies are not very digitised. And so, they need to set up

> systems in which they can use the blockchain technology before they actually can certainly set up a blockchain in their company. If you use paper records, blockchain won't help your company. (AAF4)

From the participants' view, the digitalisation of financial records is critical to the operationalisation of BCT. It appears where organisations are not digitised, BCT will have little or no impact on accounting roles.

6.3.1.5 Non-disruption to Traditional Accounting Functions – Academics' (ACA) View

In the ACA's view, the argument was that the technology will serve a complementary role to accountants but accountants need to understand how to account for BCT crypto-assets vis-a-vis fiat currencies. The view among academics is represented by the comments from ACA1 and ACA4.

> What I'm seeing for the blockchain as a potential that can bring for accountants is that some people say, Okay, these technologies are going to reduce the amount of job for people that are technical in those areas, but what I'm seeing is a complementary role of these technologies for accountants. (ACA1)

> I think Xero has the ability to capture and process some Cryptos now. I know (…) quite a common retail trading platform that a credit card trading platform. (…), some of the credit card trading platforms that are used for websites, shopping carts, they also are able to transact in cryptos. So, accountants are going to need to be able to account for cryptos and understand how they relate to fiat currency transactions. Aside from that, I suppose we still end up with a balance at the end that has to be met. (ACA4)

According to ACA4, the conversion of cryptocurrencies to fiat currencies is a basic task that average accountants are expected to understand. However, s/he notes that such a task is automated in practice, besides currency translation is unlikely to pose any challenge for professional accountants.

The findings show that BCT will disrupt manual accounting processes such as reconciliation and enhance automation of transactions and bookkeeping. The technology can facilitate real-time accounting, inter-entity transactions, and reduce the cost of maintaining and sustaining accounting ledgers. Additionally, the study found that without the digitalisation of records, BCT or any other emerging technologies may have little or no impact on the accounting processes.

6.3.2 Areas of Disruption to or Enhancement of Auditor's Functions

Concerning the disruption of the auditor's function, the majority of the participants were of the view that BCT has no significant disruption in the auditing profession beyond a change in audit sampling, reconciliation, and confirmation processes. Despite the potential revolution attributed to BCT, the technology should not be seen as a replacement for auditors' professional work because auditors apply professional judgement (Ferri et al., 2020). BCT will be another tool in the hands of auditors to enhance their performance (Ferri et al., 2020). Conversations with the participants also highlighted the implication of having an external audit as a node in a BCT accounting system as proposed by Yu et al. (2018).

From this study, concerning the engagement with practitioners from different fields beyond accounting and auditing, there is no evidence that BCT will disrupt the accounting and auditing professions. The finding from this study contradicts the position of Lombardi et al. (2021) who claimed that: " BT is disrupting auditing" (p.3).

6.3.2.1 Non-disruption to Audit – Blockchain Start-ups and IT Experts' (BSIT) View

Some participants said BCT will not bring a major change to audit because auditors require qualitative judgement beyond numbers. They believe that the professional judgement of audit cannot be replaced by a machine. BSIT10 notes that areas BCT will disrupt are sampling, valuation, data recording and other repetitive work, but auditors still need to undertake qualitative work. S/He explains:

> I think the very basic sample-based audits will go away at some point. They'll be disrupted anyway because so much will be able to be done "real-time" by plugging into different blockchain platforms. I think blockchain will disrupt a whole bunch of the accounting space broadly accounting and audit. The work associated with valuation, a data collection and recording will definitely be disrupted as a function of the accountants and the auditor, because repetitive work is going away. If someone's doing basic tax reporting or very basic accounting, that kind of repetitive work is going away. The quantitative work associated with research for audits, for example, that's going to start to fade away because blockchain will be able to power by smart contracts to do that automatically. The auditor will need to focus on the qualitative aspects so their role within the firm. (BSIT10)

Additionally, sharing a similar view, BSIT5 posits that with BCT 100% sampling of transactions is possible. S/He went on to explain that BCT guarantees certainty of occurrence of transactions. BSIT5 clarifies:

> You don't have to perform specific manual kind of testing to verify that transactions occurred because you can gather 100% of a population of transactions on a blockchain and because that data is there, you know that those transactions occurred. (BSIT5)

Audit relies on a sampling of transactions, the idea of having 100% sampling appears attractive but auditors may still need to dig into the authenticity of those transactions, when necessary. Even if BCT is said to guarantee the occurrence of the transaction, Bonyuet (2020) notes that there would be a need for auditors to obtain evidence concerning the nature of such transactions. This is because fictitious transactions could still occur in a BCT environment, hence, the verification of such transactions will show their true nature.

Another participant, BSIT9 states that BCT time-stamp and immutability of records could help provide evidence-based transactions. The BCT time-stamp and non-repudiation features could assist auditors in gathering audit evidence. Where auditors place reliance on the BCT time-stamped transaction, it may reduce the number of third-party circulations/verifications undertaken by the audit team. The availability of immutable and timestamped evidence-based transactions could make reconciliation and authentication of transactions easier for auditing purposes. Auditors may not require third-party confirmation of transactions in a BCT environment (Liu et al., 2019) It could be argued that the materiality concept may compel auditors to request a third-party confirmation where transaction materiality is significant. BSIT9 illustrates the importance of BCT evidence-based transactions:

> I was at an event and I talked to the former Prime Minister of Haiti at a blockchain conference and he said, I wish we would have had this after the hurricane because all the relief dollars that went into Haiti got squandered and nobody knows where they went. So, if you could attract a timestamp of the transactions you could then unwind it on an evidentiary basis to understand where the money went. (BSIT9)

It has been indicated that BCT smart contracts can classify and execute transactions if programmed correctly (CAANZ, 2017). Everything can be coded into BCT smart contract. BSIT2 explained that accounting is underpinned by the correct classification of entries which BCT cannot undertake without input from accountants, but acknowledged the possibility of AI helping with this aspect. Ferri et al. (2020) emphasise the roles of auditors in ensuring the proper classification of accounts. BSIT2 said that "Everyone was like we're not going to need auditors, we're not going to need accountants. I think they forget that it's not just about the entry, but it's about the classification of the transaction." Irrespective of the technology, transactions classification will still be within the purview of accountants. This is illustrated by BSIT2:

> Like buying something from Amazon is a great example where I could have a buyer, I could have Amazon, I could have the third party and the triple ledger entries being entered, but that doesn't give us any context on whether how it should be classified especially from a buyer standpoint. (BSIT2)

Another reason participants state that BCT may not disrupt audit is the need to have controls in place and an independent person is required to verify the adequacy of control put in place by management. Transparency of the distributed ledgers will make reliance on the auditor's opinion or assurance firms unnecessary (Birch, 2021). BSIT2 stresses:

> The big part that blockchain does not necessarily have in it is the controls. So, everything coming up to the point where we have a transaction now if the blockchain is the endpoint of the transaction. I think there is still the need for the controls before the transaction hit the blockchain. So, there's still that piece which is again a higher-level accounting function. So blockchain is going to replace a lot of the lower end functions with coding, possibly with some elements of coding. Although, AI will play a greater role in replacing that piece. (BSIT2)

Furthermore, BSIT3 elaborates on the importance of controls and the need to audit BCT controls. S/He explains:

> Well, if you use blockchain technology and you can trust the information, you can trust the transactional data coming from the blockchain, then it's less about auditing the transactions coming into the audit, and it's more about auditing the controls that gets the information and the data onto the blockchain. So, I think that's one of the big changes that the blockchain will have in auditing. And so right now, I wouldn't necessarily say that it is very well suited for auditing, but I do think that it will eventually be very well suited for it, we're just not quite there yet. (BSIT3)

BSIT3 view might be because BCT is not a robot that understands the information that is going into it. The technology will still require controls and other functions for it to work effectively for accounting purposes. This finding is similar to what (Bonyuet, 2020) describes as a lack of controls in BCT in authenticating the validity of the occurrence of real economic events. ICAEW (2018) notes that in BCT-based transactions, auditors may not require third-party validation or the existence of transactions because they can place reliance on the output from the technology. In an audit, verification of transactions is important irrespective of the technology adopted by the client. Unless auditors place absolute reliance on information provided by the client's BCT solution, verification and testing of internal controls will still be undertaken by auditors.

BSIT3 sums up the likely disruption envisaged from BCT to include the possibility of the technology providing real-time data, verifiable and trustable information as well as changing the audit focus from risk and fraud sampling. Bonsón and Bednárová (2019) assert: "there are alternative technologies that would deliver similar outcomes to blockchain for accounting purposes, such as distributed databases or ERP systems (p.735)." It could be argued that other cutting-edge technologies can provide these features for audit purposes.

6.3.2.2 Non-disruption to Audit – Audit and Assurance Firms' (AAF) View

The majority of AAF does not see any disruption beyond changes in audit approach such as sampling, data entry, control, and testing. AAF8 suggests that the audit team will no longer need to undertake testing, data entry and control. AAF7 acknowledges BCT will change the audit approach but quickly pointed out it all depends on what is permissible by the accounting and auditing standards. S/He elucidates:

> I only think it's going to be whether we look at it more of a risk-based kind of approach to understand how the information is getting into the financial statements, so we might forget that if accounting or auditing standards will let us. I would just look at that one smart contract instead of sampling, I think that changes your audit approach. Otherwise, not a lot of things are going to change from what I've seen so far because how the information got there doesn't mean that you know anything about is it correct or is it not fraudulent all that sort of stuff so you still have all kinds of other work you would normally do in an audit that remains. (AAF7)

The essence of testing controls in an IT environment cannot be over-emphasised because the review of controls cuts across all layers of the organisation's structure and procedures. It includes basic things like access to data, approval threshold, backup plan and so on. It is unlikely that using BCT will change the audit review of IT control. Reviewing organisations' controls by auditors has not stopped fraud from being perpetrated (Faccia & Mosteanu, 2019). However, Ferri et al. (2020) suggest that BCT can reduce the control duties such as circularisation, reconciliation and verification performed by auditors because validation of transactions takes place at the technology point of entry.

For Bitcoins and cryptocurrencies, validation is easy to confirm at the point of entry since all parties know ahead of time how much each party has in its crypto-wallet, but such validation becomes impossible in multi-party transactions where data is generated based on the company's activities and not based on any predetermined codes or figures. Ferri et al. (2020) acknowledge that it is yet to be seen how the auditing activities will change regarding the audit of BCT controls.

AAF5 argues that BCT cannot help to resolve the complexity of the accounting, business and economics, as well as the audit expectation gap AAF5, explains:

> The challenge that we have at the moment is that accounting rules have become more and more complex as our economies have become more complex and businesses become more and more complex, and it is harder and harder for the profession to keep up. The result of that is mistakes are made, things are missed, auditors have more and more burden placed on them to spot issues in the profession and there's a gap in the expectations. We've got the expectation gap between what an auditor is actually contracted to do, and what they're expected to do because of the complexity of the accounting rules. I think that blockchain is not the solution for that by any means, but visual reporting in a variety of forms, including borrowing from some of the things that we've learnt through blockchain absolutely has a role to play. It's around simplification, and transparency and continuous disclosure. (AAF5)

Killmeyer et al. (2017) mention that despite the associated benefits, BCT is not a one-size-fits-all solution because it has inherent technological challenges that are yet to be overcome. BCT may have a role to play in the accounting and auditing profession, but it may not be the solution to all its problems. Faccia and Mosteanu (2019) suggest that BCT can be programmed to accommodate accounting standards and regulations. Undoubtedly, making BCT an underlying technology will neither resolve the complexity of accounting rules nor eliminate the public expectation gap of auditing.

6.3.2.3 Non-disruption to Audit – Accountants and Auditors' (AAD) View

Most of the AAD group are of the view that audits will not be disrupted by BCT and the technology will be useful for verification and consolidation of financial statements. They believe that professional judgement of auditors is required in ascertaining the true financial position of companies. Auditor Professional judgment why most participants considered that BCT would not disrupt the audit profession. Auditor's judgement is needed in the recognition and valuation of transactions in a BCT accounting system (ICAEW, 2018). Schmitz and Leoni (2019) emphasise that the expertise and professional judgement of accountants and auditors are required in complex accounting entries.

Aligning with this view, AAD4 also states that BCT can cut down on some paperwork but emphasises the importance of qualitative judgement of auditors, "It can reduce the amount of work or unnecessary reconciliations, paperwork and everything else. But there has to be some analytical work and that's a judgment. A higher rate of work will have to be there." AAD2 argues that BCT will not make any major changes in auditing, but audit procedures will need to change. S/He explains:

> But again, it's not going to replace accounting we still need to do accounting, we still need to do valuations, I actually work on valuations for blockchains. There's a lot of areas where it's not going to make a big difference. Auditing would be another one because I have to audit a blockchain in a totally different way. (AAD2)

Valuation, revenue recognition and asset impairment require some intricacies that technology could not replace. BCT automated transactions may not be a substitute for such accounting procedures. However, AAD3 notes that it is the perception that often makes people refer to BCT as a disruptor, the technology is an enabler with the potential to improve transparency, accuracy, and real-time information. S/He explains: "… people like myself think this (BCT) has the potential to increase trust, accuracy and real-time information and we would say it's an enabler rather than a disruptor. So, it's kind of perception."

AAD2 further states that despite the fact that sampling and third-party verifications are unnecessary in BCT, some items are secured and required no audit, yet the technology has new risks which auditors need to examine differently. Cao et al. (2018) posit that traditional audit procedures will still be undertaken by the auditors to sample off-chain transactions in a BCT environment. AAD2 highlights:

> You can't use this sampling I told you about. There's a lot of things that are inherently more secure on a blockchain that I don't even need to audit. There are new risks on a blockchain like smart contracts, transaction combinations, protocol code and consensus mechanisms that are new risks and assertions on a blockchain that have to be audited differently. I'd say those areas I mentioned payments, confirmations, validations, tokenisation and futures accounting, those kinds of things all have a right for use by blockchain and many people are doing that now. (AAD2)

AAD3 acknowledges that BCT could disrupt the calculation of audit fees or cost and the cut-off procedure, but audit judgement is still relevant. S/He suggests that BCT can facilitate continuous and real-time audits. AAD3 explains:

> Oh yes. Yeah, they're still judgment and somebody has to manage the audit process. But the tools they use and the processes they use are going to change. Just like I mentioned [xxxx and xxxx tax, and xxxx][17], they're going to use those tools, but they'll also have confirmations and they'll have to do their same audit procedures, they may be more real-time. It could change the audit to more of a real-time ongoing service which I've always been a proponent of for 25 years. Why do we just cut it off and have an audit as of one day of the year? Why don't we have an audit service that goes throughout the year? And the best answer I could get from major audit firms is they didn't know how to price it, or the market wasn't used to it. And I say well that's changing perception and changing values. And I think now may be a good time to change how audit fees are calculated and how audits are done. So, I think it's definitely going to have some disruption, but I think it's also going to enable the auditors to add more value. They can be focused on that data and what that data really means into the future rather than just be historical recorders of cost and looking backwards. (AAD3)

AAD3 view on the determination of audit fees is a concern for many stakeholders' vis-a-viz the value of auditing. Some scholars (Bizarro et al., 2018; Cao et al., 2018) also assert that BCT will significantly affect the computation of audit fees since other manually related work that the auditor charges for will be eliminated. Where

[17] Deleted to preserve participant's anonymity.

BCT enables continuous audit, this may affect the pricing of audit fees and enable auditors to have all-around year access to the client's record thereby enhancing audit quality.

6.3.2.4 Non-disruption to Audit – Accounting Regulatory Bodies' (ARB) View

The ARB group believes that audit procedures will change since there is a possibility of auditors having real-time online access to the financial records and operations of companies. The after-the-fact audit and circularisation could give way to instantaneous audit where an auditor becomes a node in a BCT-enable environment.

ARB4's comments capture the view of this group:

> In the case that blockchains were to become frequently used sources of information within all businesses which as I mentioned hasn't happened yet. If they were to become more common, certain parts of an audit would probably change a little to adapt to that. ... There are some of the audit assertions that I think blockchain could disrupt if it were broadly accepted, but it's not like it gets rid of the need for auditors or accounting because it's not just about how much money moved from where to where it's also it is about judgments, estimates, and other aspects which the blockchain won't help you with. (ARB4)

Similarly, ARB3 believes that the current audit procedures will end, but procedures can occur in real-time. Auditing will no longer just take place at end of the year if auditors become one of the real-time nodes on BCT. This will provide auditors with immediate alerts regarding company's financial activities and enable them to see if transactions are recorded as they should be. Regulatory guidance in the form of the accounting standards or rules will need to be provided to ascertain the level of reliance auditors need to place on BCT generated information.

6.3.2.5 Disruption to Audit - Academics' (ACA) View

Many participants in the ACA group think the auditing process could be disrupted because of the BCT tamper-proof evidence and the provision of an auditable ledger. ACA2 suggests: "I think the main thing in the auditing process because it is tamper-proof technology, which will help you to keep evidence for each transaction and how it happens." This corroborates the view of some participants in the BSIT group. Similarly, ACA3 observes that BCT will have a great impact in the accounting and auditing space because it has auditable ledgers. ACA4 notes that the consensus protocol in BCT makes the technology useful for auditing purposes because it will be fairly easy for users to follow. S/He explains:

> I think that the way the database that the blockchain uses is configured, it makes it very easy for auditing practice. The consensus protocols that are mostly used on blockchains require a sequential right process. Although it's a batch mode system, transactions are in effect immutable, so they can't be changed after the fact easily, which means that anyone who needs to trace a transaction path ought to be able to using links, find that pathway fairly easily. (ACA4)

ACA5 believes that the disruption of BCT is beyond removing lower-level jobs in the accounting industry as highlighted by AAF7. S/He stated that the technology is self-auditing and there is no longer the need for auditors. ACA6 slightly differs by saying that "there will be fewer, you won't need as many auditors, but you'll still need some auditors. Bizarro et al. (2018) highlight a similar view that where the financial statements are automated there would be a reduction in demand for auditors to do manual jobs. ACA5 states:

> I think the audit function is probably the most vulnerable that people who come in and check the work of the company that validate the truth of the journal. I tell my students that the blockchain is really a self-auditing ledger, that there's really no more need for the auditor, if this is implemented as the standard bookkeeping system. So, the accounting field has quite a few components to it but I think that people who are actually on the front lines, checking the books looking for errors, looking for fraud are the ones who essentially will give way to software engineers who operate these blockchains. And so, the audit function is going to be much more mechanical and really software-driven and not involve human judgment. (ACA5)

ACA5 went on to offer a different view about the importance of an auditor's professional judgement. S/He notes that the audit judgement which many have relied upon over time is fraudulent. ACA6 subtly supports this view too by saying, "We know that the auditing system does not work all that well and also never seen a benefit directly connected." ACA5 went on to say that:

> The judgment of the auditor's over time has been shown to be subject to all kinds of conflicts of interest that auditors don't bring expert judgment. Instead, they look for some rationale that allows the company to characterize the transaction in a way that helps the company. Yeah, that's the whole system is

> just full of corruption and conflicts of interest, and you know as well as I do, how many big accounting scandals there have been with the wrong things have been capitalized and, you know, things have been estimated and self-serving ways. So, I don't put a lot of value in giving another tool to the auditor to corrupt the system even more. (ACA5)

This view contradicted the submission of the professional accounting bodies who maintain that an auditor's judgement is still vital (ICAEW, 2018), and CPA auditors will need to consider the reliability of data extracted from BCT (Bible et al., 2017). Scholars like (Schmitz & Leoni, 2019; Tan & Low, 2019) also note that complex accounting entries require accountants' and auditors' expertise and judgement. However, (Karajovic et al., 2019) assert that BCT can reduce the bias associated with professional judgement by accounting professionals. ACA5 and 6's views could be because of the public expectation gap of what auditors' roles should be and the various financial scandals where some audit firms have been found wanting particularly the recent WireCard fraud in Europe.

6.3.3 Audit Firm as a node in a BCT environment – Blockchain Start-ups and IT Experts' (BSIT) and Accounting Regulatory Bodies' (ARB) Views

One unanticipated finding was the suggestion of an external auditor as a node in a client BCT accounting system (See **Figure *20*** for this theme). A few of the participants from BSIT and ARB groups commented on this. It was an interesting finding that may require future empirical research. The adoption of continuous audit (Schmitz & Leoni, 2019), BCT real-time accounting (Yermack, 2017), or auditors becoming a node as proposed by (Yu et al., 2018) could affect the role of internal auditors.

Practitioners were asked about the disruption or consequence of having external auditors as a node in a BCT environment. ARB3 believes that the internal audit department will be eliminated. S/He explains:

> Internal audit will disappear. Already in South Africa, we have companies that have automated the internal audit process so much that they don't need internal auditors. Everything has been automated because remember that all these audit procedures internally about looking at ratios, projections and whatever. All that can be automated. A company called Bidvest has automated everything. I think they have 125 companies in the group and they eliminated all the internal

> auditors because they do this with Bidvest Alice robot. In a real-time, you can do all the verification test and they save a lot of time. That's the future. (ARB3)

Contrary to the view of ARB3, BSIT5 believes internal auditors will not be dispensed with and there will be overlapping of jobs with external auditors in a BCT environment. Similarly, BSIT7 argues that the role of internal auditors will shift to ensure internal processes are still minting tokens following the rules, and therefore will not be eliminated. Li and Ma (2021) think that the adoption of BCT will enhance organisations' internal control systems. However, the practical implications of external audit becoming a node for the internal audit function can only be ascertained where there is full adoption of BCT for financial recording and reporting systems. BSIT5 asserts that:

> You're still going to need the internal auditor to be doing their job correctly. They're still kind of like implementing internal controls around different areas and providing insight into different areas. So, there's overlap, but I think there's still a place for them (internal auditor) and there will be a place for them. If anything, to eliminate additional hours by the external auditor that would happen on the back end. (BSIT5)

The findings show that the majority of the participants were of the view that BCT will not disrupt auditing practices but will be a tool for their enhancement. There is no empirical evidence from the participants to support the assertion that BCT has so far disrupted accounting and auditing as noted by Lombardi et al. (2021). The finding further indicates that there is no consensus among the participants on whether an external auditor becoming a node in a BCT environment will eliminate the function of the internal audit department.

The next section examines organisations that have adopted BCT for financial reporting and accounting systems.

6.4 Organisations' Adoption of BCT for Financial Accounting and Reporting Purposes

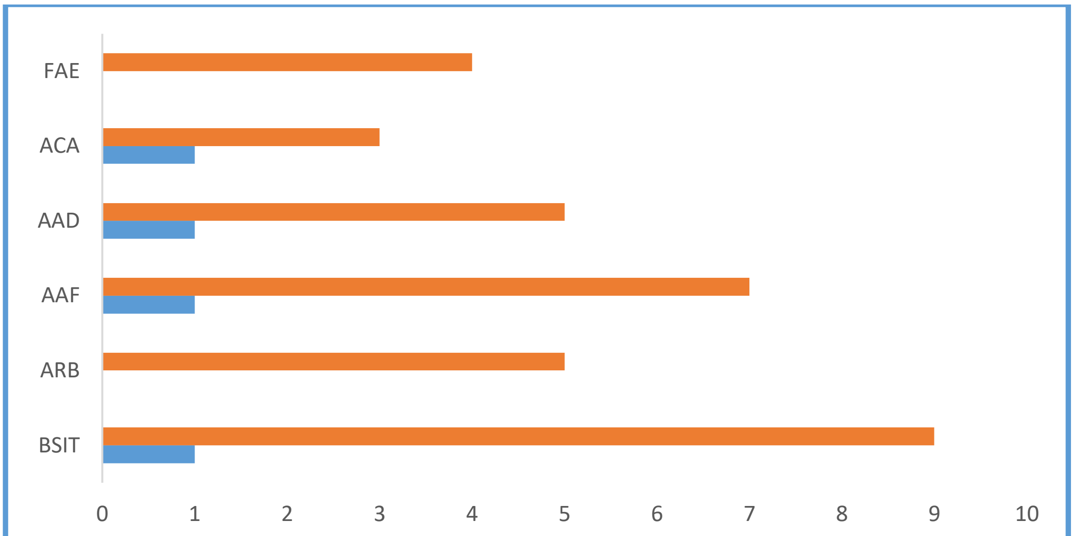
As a follow-up to the questions on areas where BCT could disrupt or enhance the accounting and auditing fields, the study further requested that practitioners and academics share their experiences about companies or organisations that use BCT for financial accounting and reporting purposes. BCT has been suggested by many writers including some global accounting regulatory bodies as a technology capable of disrupting the accounting and auditing profession.

Woodside et al. (2017) reported that the top global accounting firms, particularly the Big 4, have been researching and heavily investing in BCT. This report is supported by different claims made by the Big 4 about their breakthrough thereby assuring their clients of their ability to support them if they adopt BCT. For instance, EY claimed it can help clients integrate BCT into their ERP systems (Brody, 2020); PwC deployed a cryptocurrency auditing software solution for auditing blockchain networks (O'Neal, 2019b); KPMG launched digital asset services (La Quercia, 2018); and Das (2021) reports that Deloitte has completed an audit of a permissioned blockchain system operated by an MNE. In the previous chapters, some of the efforts of the Big 4 to employ BCT were mentioned (see Chapter 3.5). Some of the firms' BCT breakthrough claims are yet to be made known to the public; perhaps because of commercial sensitivity. However, Tan and Low (2019) observed that "usable blockchain-based AIS for financial reporting is not yet commercially available (p.316).

None of the participants had heard of any company that has deployed BCT for financial accounting and reporting purposes beyond the supply chain, shipping documentation, and crypto-currencies operations. Thus, this finding shows that no organisations have adopted BCT for financial reporting and accounting systems. Atlam et al. (2018) note that BCT use is on the increase, but the technology has not witnessed large-scale adoption in the commercial market.

Cong et al. (2018) note that most big organisations are reluctant to migrate their ERP systems because of the process involved and the stability of the existing applications. Instead of migrating their ERP system, organisations prefer to adopt a system that can integrate with the existing ERP (Cong et al., 2018). Bonsón and Bednárová (2019) suggest that the transformation of accounting and auditing to possibly a BCT ledger system is feasible. This study shows that such transformation is yet to materialise in practice. **Figure 22** depicts the participants' responses to their awareness of companies that could adopt BCT for financial reporting. The participants' views are further discussed in the following subsections.

Figure 23. *Responses to Awareness of Organisations using BCT for Financial Accounting and Reporting Systems*



	BSIT	ARB	AAF	AAD	ACA	FAE
No	9	5	7	5	3	4
Yes	1	0	1	1	1	0

No Yes

Note. Source: Author

6.4.1 Blockchain Start-ups and IT Experts' (BSIT) View

From **Figure 22**, nine out of 11 participants in the BSIT group said that they have not seen BCT adopted for financial accounting and reporting purposes. BSIT11 has this to say, "None that I'm aware of, but the ones using it are primarily for changing evidence, and authenticity and basically to follow supply chain bits, that's pretty much what's used so far." The view of BSIT10 is typical of the group members' view:

> The technology doesn't necessarily need to be implemented by all accounting practices at all, but having access and understanding what access to different blockchain platforms, would entail is critical. I don't know any public companies that are fully using blockchain for auditing or reporting. I know some of them are experimenting with it. I know several firms are using some of the reporting services I mentioned for things like crypto asset valuation, leveraging firms that are already plugged into different blockchain technologies. (BSIT10)

Similarly, BSIT4 believes it is too early to talk about industry adoption but companies are using BCT for some specific processes such as commercial paper and settlement of payment based on the delivery of the service. For instance, BSIT6, a participant from a multinational company in New Zealand that is using BCT for transport documentation (electronic bill of lading blockchain solution) was asked about how they integrate the technology with accounting processes. BSIT6 notes that the company is not using BCT for payment. S/He describes what they are currently doing as follows:

> [xxxx[18]] systems are all integrated and the payment just happens as normal. It's not a blockchain payment mechanism. It's still a normal foreign exchange process. We haven't changed anything to the blockchain when it comes to payments, it's only this document of title, transfer of title we use blockchain and not payments. (BSIT6)

However, BSIT1 notes that people might be unaware that BCT has been the underlying technology in their operations. S/he explains:

> When people say there are adoption issues and it's going to take a long time, but millions and millions of people today are already using it and are quite unaware that they're using it. I think those adoption things are very short term and it's being used under a roof or under their hats where people don't even realize that they're using them. In many ways, I would say it's already been adopted. (BSIT1)

6.4.2 Accounting Regulatory Bodies' (ARB) View

All the participants in the ARB group maintained that they have not seen any organisation that has deployed BCT for financial accounting and reporting purposes beyond the ongoing lab tests and experiments. ARB2 states: "I haven't come across an organisation that actively uses blockchain for accounting or financial reporting, or auditing and assurance services. No. No. I haven't heard of any." However, ARB6 further provides an additional explanation:

> I think the kind of broader use cases is relevant in terms of their potential to offer scale, but I'm yet to see examples where I feel that this is a core business for an organization. A lot of this is still very lab-based where people would test a few things out, but they still carry on doing what they would normally do rather than migrating everything. They have to trust the blockchain, I don't think I'm seeing that certainly what I'm seeing is a lot of lab testing type initiatives. (PAB6)

ARB2 went on to explain that BCT is the least mentioned technology (among CPA members) of the emerging technologies which further confirm that there is not

[18] Deleted to protect the participant's anonymity.

much adoption in the field. S/He narrates her/his experience as follows:

> ...we have heard from many CPA members that have started to adopt AI and machine learning tools as well as data analytics, data visualisation tools, robotic process automation, cloud computing and so on, but none of them has referred to blockchain technology. So, in other words, none of them has adopted blockchain technology or has come across a client that uses blockchain technology. (ARB2)

6.4.3 Audit and Assurance Firms' (AAF) View

Just one participant in the AAF group has seen companies using BCT for their entire financial accounting and reporting systems. Some of the participants stated that what they have seen so far are pilot cases and innovation research. AAF8 claims that some organisations in Hong Kong are piloting the use of BCT: "Yes, on a small scale in Hong Kong, but more like a very limited scope and they are like pilot cases not really a commercial like a scale. It's just a pilot phase."

Sharing the same view, AAF1 states, "I don't think I've seen anyone saying here's my blockchain-based accounting system. I don't know what that would look like if that's what you're asking, I haven't seen that." According to AAF1, the closest s/he has seen are some clients who have some of their transactions recorded in a blockchain and these transactions have to be converted to the traditional accounting system. S/He explain:

> Actually, I should probably go straight, in my current role I do see some clients coming in, they have records of transactions that are recorded on the blockchain. But you've still got to take those records, and then had to put them into the traditional accounting system and go right, what were the sales and what are the transactions and that kind of thing? (AAF1)

6.4.4 Accountants and Auditors' (AAD) View

The majority in the AAD group note that apart from companies that trade in crypto-assets they have not seen a full BCT accounting system. They acknowledge that many BCT applications are still at different pilot stages. AAD1 argues that there is a huge investment in BCT research and knowledge, but the actual utilisation of the technology is still in its infancy across many sectors of the economy.

AAD3 notes that from experience, BCT applications have been used in cross border payments, bills receivables and payments. S/he explains:

> Not for total accounting system, but companies are accepting cryptocurrency and they have blockchain applications for payments, particularly cross border payments. Like if you were to send money to a relative in another country, it would be much cheaper, more secure and faster to do it on blockchain than it would be to go to a wire service or a bank. And so yes, we're seeing accounting applications in bill payment, receivables, but not an overall accounting system yet. That may be that may happen sooner rather than later but right now it's pieces of the accounting functions that are being built on the blockchain. (AAD3)

Contrarily, AAD6 argues that cryptocurrency companies using BCT for the management of digital assets and payment systems could be said to have adopted BCT for financial accounting and reporting purposes since most of their transactions are on the blockchain. AAD6 explains:

> Yes, they would be in the areas of cryptocurrency or digital assets and also in payment systems, payment system companies that have been utilizing cryptocurrency…. Also, the cryptocurrency funds exchanges, hedge funds, hedge fund managers are all involved in currently using Blockchain and adopting it for financial accounting and reporting because most of the transactions, if not all of them that they are involved in blockchain transactions. So, if you think of a cryptocurrency fund, I mean that is the business, so, they'll be using it to a very significant degree. (AAD6)

The position of AAD6 sounds convincing but using blockchain for managing cryptocurrencies cannot be fully considered as a BCT financial reporting and accounting system. Additionally, some participants who have audited crypto-exchange firms note that they have to pull out the information from their BCT to the traditional accounting platform to audit them. It is unclear whether this approach is adopted because the audit team lack knowledge of BCT, or because there is yet no BCT financial reporting and accounting system.

6.4.5 Academics' (ACA) View

Out of the four participants that expressed their view on this issue, one of them offers a different view. Most of the ACA group acknowledged that they have not seen BCT adopted for financial accounting and reporting purposes. They believe that technology is still evolving. Using the ACA1 view as the representative view, s/he notes:

> But based on my understanding and reading is that they are just doing some sort of trial and error that's based on science, they don't know exactly which

> route they should follow, what is the best strategy or their roadmap to develop the technology. (ACA1)

Conversely, ACA5 contends that the present BCT application in shipping entails keeping track of financial accounts and those payments will form part of the financial statements. However, it is safe to argue that tracking shipping transactions is part of a company's financial transactions. The clarification made by BSIT6 on this type of transaction becomes relevant, where it was emphasised that the company does not have a BCT accounting system despite using a BCT-enabled bill of lading solution. Thus, it could be stated that while those transactions involving the shipping of items will go into the financial statements, they should not be construed as BCT financial reporting and accounting systems. ACA5 explains:

> It's a hard question to answer, precisely because if you look at things like the TradeLens platform much of what goes on in shipping is keeping track of financial accounting. So, I may have a letter of credit that is issued by a bank that takes a lien on the goods in transit, and that becomes an obligation of the bank when the ship puts out to sea, and that obligation ends when the ship reaches the next port of call, and maybe there's a customs transaction involved in the payment of customs duty. So, all of these involve financial accounting entries that are going to be made and updated as the voyage is in progress. So, that would be my first example is simply the Maersk TradeLens is really all about keeping track of the financing of goods and shipment. And so, the by-product that the real audit trail that's generated by the blockchain is going to go directly into the financial statements of the shipping company, the owner of the goods, the bank that wrote the letter of credit and many other people. (ACA5)

6.4.6 Financial Analysts and Other Experts' (FAE) View

All the participants in the FAE group stated that they have not seen BCT is adopted for financial accounting and reporting purposes. This response could be because they are not involved directly with the financial operations of their organisations. FAE1 asserts that there is no evidence to support the existence of such adoption. FAE3 highlights her/his experience in the food industry:

> The use of blockchain I have not seen it first-hand. The issue with blockchain is the way it is being promoted and talked about. In the food industry, it's normally a low value and high-volume industry and people are reluctant to spend money on anything if it doesn't help unless they're forced to. (FAE4)

Cai (2021) claims: "few triple-entry accounting blockchain products and services are fully live in the accounting area." However, the author did not mention companies that are using BCT-enabled triple-entry accounting. There is no evidence to substantiate the use of BCT for financial reporting and accounting purposes. It is difficult to comprehend the reasons there is no mass adoption of BCT despite all the potential benefits or hype about it (Cong et al., 2018). In this study, there were no organisations known to the participants use BCT for financial reporting and accounting. However, considering the ongoing efforts to harness BCT for such applications, it could be argued that there is a chance that there could be an organisation(s) with a BCT accounting system, but perhaps they are yet to deploy the technology on a large commercial basis as observed by Tan and Low (2019) and Atlam et al. (2018).

The next section discusses the relevance of audit and what are auditors expected to audit in a BCT environment, the chain, or transactions?

6.5 Relevance of Auditors and What Auditors Need to Audit in a BCT Environment

This section explores the participants' views on the relevance of audit and what auditors should audit in a BCT environment, part of the technological context within the study's TOE framework (see ***Figure 12***). To answer this research question, participants were asked the following questions: What is the possibility of BCT eliminating third-party auditors? What are auditors expected to audit in a BCT environment, the chains, or transactions? This is important as scholars (Cao et al., 2018; Fortin & Pimentel, 2022; Pimentel et al., 2021; Tapscott & Tapscott, 2017; Wang & Kogan, 2018; Yermack, 2017; Yu et al., 2019) have described BCT as a disruptive technology with the potential to revolutionise accounting and auditing fields with a possibility of eliminating third-party auditors.

6.5.1 Perceived Relevance of Auditors in a BCT Financial System

The relevance of auditors in a BCT environment has been a topical issue among practitioners, academic scholars, and technology enthusiasts. BCT has been said to have the potential to lead to "the death of accounting" (M. Singer, 2019b), "the death of traditional accounting" (Tucker, 2020), "audit dead in a decade" (Arrowsmith, 2018), and replace accountants' functions with software developers and miners (Fortin & Pimentel, 2022). The technology will disrupt and disintermediate the current trust-based transaction systems and the services of middlemen such as auditors in a financial system (Beck & Müller-Bloch, 2017; Beerbaum, 2018; Smith, 2018b; Tapscott & Tapscott, 2017; Yermack, 2017). In contrast, scholars such as (Coyne & McMickle, 2017; Tan & Low, 2019) assert that BCT is hyped, and the technology cannot disintermediate accountants' and auditors' roles, and Ferri et al. (2020) consider BCT will be a tool for auditors in the performance of their duties.

The findings showed that the majority of participants believed that auditors will still be relevant in a BCT environment but with a shift in focus or roles. The findings further show that almost all participants believe there is no chance that BCT will eliminate auditors from financial systems. The perceptions of participants are discussed according to their groupings.

6.5.1.1 Blockchain Start-ups and IT Experts' (BSIT) View

The majority of participants in the BSIT group note that auditors will still be relevant in a BCT environment, and the technology is unlikely to eliminate their roles. The technology is expected to shift the roles of auditors and the audit risks and facilitate real-time reporting. The shift in roles is said to be in the lower-level tasks like data entry, which will be eliminated, to higher-level thinking tasks, but overall, BCT will become a tool for auditors to work with. The auditor will be needed to check and validate if the transactions and codes are what management said they are. This view contradicts the claim that BCT has a self-auditing mechanism and does not require third-party auditor examination of its processes. Rîndaşu (2019) believes that the adoption of BCT cannot lead to the extinction of professional accountants, but the technology could be a tool to support their operations. Taking the view of BSIT10 as a representative of this group:

> I don't think it eliminates the third-party auditor. One of the things we often talk about is it evolves the audit function, like I kind of referenced a moment ago. If a firm is doing basic simple audit with no value add and no ability to innovate that function is going away, but I don't think the auditor goes away. I think there will be so many more transactions that we need so many more different types of firms. There'll be so many different types of public and private blockchains that will be connected across a universe of different organizations that the audit function becomes more important at a qualitative level. Basic data reconciliation or basic data gathering for audit, that's going

> away. It may not be tomorrow, may not be 10 years or may not be 30, but the systems will do the basic data stuff for us. (BSIT10)

BSIT11 further perceives auditors as relevant in a BCT environment because the financial fraud arising from companies maintaining secret ledgers, agreements and related party transactions is still there since there are going to be many blockchains. BSIT11 explains:

> The answer to all depends on how and why but you know the reality is it's just another system that auditors are going to need to have to come up to play with. But the benefit is of course with Blockchain is that inherently it's got some concept of auditability built in because of the chronology of a chain of things happening. That said though, any one of those blocks or blocks on that chain could have another system elsewhere, which has computers setting values for them anyway. So, I guess all the traditional issues that auditors have had around hidden ledgers and secret agreements and all those kind of things, real world cash payments and transactions to hide things, money laundering, all those partnerships will still play people even if they are fully embracing unless all transactions happen on a given chain. But the issue was there is no one blockchain everything that has implementation has a different blockchain. To suddenly see that we have payments using BTC or you know Bitcoin, then been some of these chains may not be accessible, you know, so. Yeah, interesting. I guess the answer is interesting. There's no silver bullet here or panacea or solution to all the problems. No, there is no general solution here with blockchain. (BSIT11)

The view of BSIT11 about the proliferation of blockchain is the reality in practice because different blockchains exist for different operations. For instance, as previously mentioned BSIT6 confirmed that the blockchain is used for managing their global e-bill of lading is not integrated and likewise, some participants who have audited cryptocurrencies attest to this. Where there are multiple blockchains, it is possible to still have secret ledgers with hidden transactions. Management accounting fraud can still take place when management can override internal controls and circumvent the BCT system (Rückeshäuser, 2017). This confirms BSIT11’s concern that hidden ledgers and secret agreements could still take place in a BCT environment, maintaining the need to have independent third-party auditors to examine the financial records.

Additionally, BSIT5 notes that where businesses have real-time transactions, auditors could be created as a node for verification of such transactions, and this can lead to real-time financial reporting. Nodes have permission to create, verify and see the entire transactions in a BCT (Dai & Vasarhelyi, 2017). It is still unclear at this moment how the audit is going to take place in a BCT environment, the idea that auditors become a node is yet to be seen in practice.

In contrast, BSIT1 claims that BCT will eliminate financial audits because the technology can ensure audit in real-time that is accessible to all interested parties but adds that there could also be an audit of transactions. S/He emphasises that "there's going to be auditing of smart contracts and software, I know that's not on the accounting side." BSIT1 went on to explain:

> Talking about financial audits, I think it's going to eliminate almost all of them in the next 10 or 20 years because what's the need for a financial audit when it's auditing real-time and anyone in the world can access that. I'm talking about audits that exist today there may be a change in the way audits work or their purpose in the future. There might be an audit of the transactions on the blockchain to see if those funds have been used efficiently. I think there's going to be audit in the future but they're not going to be the same as what we're using today. (BSIT1)

In practice, audit and assurance firms often undertake an audit of IT systems and the associated software as part of any organisation's internal control system. Where organisations deploy smart contracts for business undertakings, the audit team must examine the workings of such smart contracts. Underscoring the importance of audit, Li and Ma (2021) note that accountants and auditors could support clients with requisite accounting standards and regulations to be encoded into smart contracts.

BSIT9 disagrees with the idea that smart contracts will replace auditors, "Saying that smart contracts will replace auditors that's not happening. It's causing more work for auditors." S/He is of the view that BCT has not hit a critical mass yet and that the technology is not going to have a significant impact on the audit profession because an audit is still being done the same way. BSIT9 claims: "We don't quite know; I think the fear of it's going to put auditors out of work was way overblown."

BSIT4 also thinks that there will be auditors for smart contracts because it is necessary to have experts check whether BCT is working as intended. The smart contract auditors could be other experts who examine software and codes to ensure they are functioning properly. Dai and Vasarhelyi (2017) suggest that auditors would be required to examine if the smart contracts are performing according to the pre-established rules. In practice, the audit team is usually composed of accountants and other specialists depending on the nature of the audit engagement. BSIT4 clarifies:

> Yeah, I mean, we can have auditors for smart contracts, I think there's a really good role for auditors for smart contracts, you should look into that. You get all of the technology like people are going to trust blockchain, they need an accredited third party to come in and just audit the blockchain to make sure that blockchain is doing what it says it can do. This is about codifying the rules and letting the software just run, so if the software runs I mean it should run every time. It's not like a human being you can have a bad night and come in with hang over and make mistakes, but someone needs to check the code, which is why I think smart contract auditors are important and probably technical engineers that can just look at the software and make sure it is written properly and the code is good and there's no bugs in the code and all that sort of stuff. (BSIT4)

Similarly, BSIT9 believes that the technology may give rise to two types of auditors: coders and smart contract auditors which are currently outside the purview of the accounting and audit profession. S/He further notes that the audit functions may not change but there could be a collaboration with other technical experts in auditing the technical aspects of BCT applications. BSIT9 explains:

> Oh yeah, absolutely. I think there'll be two types of auditors. There'll be those who were coders, who have chosen to hang out a shingle as an auditor, you see those today in the trail of bits and consensus diligence and there are firms out there who will audit smart contracts. You're basically auditing an application to look for gaps and security risks in the application, that's one type of auditor that's not traditionally what the accounting and auditing profession has focused on. They focused on the integrity of the financial accounts of an entity. So, I think they'll work hand in hand, I think that you'll still have the same audit functions within the accounting firms, but they will rely on or may even build within their organisation probably specialists who will come in and look at the more technical smart contracts applications. They may even change themselves to attest to the integrity of those and then the financial auditors would rely upon that and do much of the same work that they've been doing, adding in the proof of existence and proof of access. (BSIT9)

In an audit, professional competence is one of the fundamental principles that audit and assurance firms are expected to observe in the discharge of their duties. This principle entails the deployment of an audit team with the requisite knowledge to undertake audit engagement at any given time. The practitioners confirmed that the practice in the audit firms is that each audit team often consists of staff with requisite and different skills. It could be argued that if all audit firms are required is to include technical experts in the engagement team auditing BCT-enabled transactions, it is unlikely the technology will eliminate auditor's roles. Also, the excitement associated with having BCT with a self-auditing mechanism with the potential to disintermediate external auditors may not be realisable.

6.5.1.2 Audit and Assurance Firms' (AAF) View

All the participants in the AAF group believe that audit function is more relevant in a risk system such as BCT and the technology will not eliminate audit functions. They think that the adoption of BCT by a company will create additional tasks for auditors and spur investors to request the technology be examined by a CPA. The investors would like to know if BCT is doing what it is expected to be doing.

AAF3 observes that the perception of a higher risk associated with BCT underpins the importance of the audit function in examining the technology for accuracy. S/He states: "And so if something that has the perception of higher risk like blockchain, I think the importance of the audit function looking across it is probably more important than pre-blockchain." AAF4 justifies the relevance of audit by noting that investors require financial statements to be audited by independent auditors irrespective of the technology being adopted.

> I always say if somebody says who needs auditors? I always say okay those with investment in a company where the financial statements are not audited by an auditor. This is the same is true for blockchain technology if a company uses a blockchain system or a blockchain-based system, then you probably want an auditor to check the system if it works correctly, set up correctly so that you as a third-party individual can trust the company that they work with systems which are correct. (AAF4)

AAF2 argues that BCT is unlikely to eliminate audits because technology rarely displaces people, but instead creates more jobs with different roles and generally, employment goes up until it reaches saturation point. S/He explains:

> Very unlikely, very unlikely. It'll make them [auditors] more valuable. So, one

> of the things you learn by looking at the history of technology is that technology very rarely displaces people, and it very rarely forces you to re-train, but what it does do is, it tends to increase employment. ... What it will do is, it will force the auditors and all of that community to move up from the simple validating of transactions to providing advice. This automation will reduce costs, increasing the addressable market for auditing, and likely result in more work (and more jobs) for auditors. (AAF2)

Similarly, AAF1 thinks that even if historic transactions or assets are recorded by the blockchain, auditors are expected to test assets valuation and revaluation in addition to testing the accuracy of disclosures. S/He illustrates:

> If you find $200 million of assets, it is right you have to go and look at all the valuations of all the assets, that is separate from trusting the blockchain because you got to check the updates that happen along the way. So yep, the auditor will still be needed and they won't be redundant, they will have to work, and think differently, but in a good way. I think they'll be more into evaluate and like I said you can move to more of a risk-based approach. (AAF1)

However, AAF4 thinks the BCT disruption could impact the whole audit process with the potential to eliminate current auditing practices. S/He thinks that where transactions are standardised both the financial statements and audit report could be generated automatically. This scenario may be feasible where investors and regulators place absolute trust in BCT and management. In practice, it may be unlikely for stakeholders to rely on BCT without any third party verifying the transactions that go through it. (Mahbod & Hinton, 2019) claim that BCT will not replace the financial statements or audit and auditor’s professional judgement. AAF4 explains:

> The whole area of audit. I would say from the transaction to the setting up the financial statements, to setting up actually the audit report in the end because at the moment you still have to go back to the statements, get the numbers, etc. And if you have everything on a blockchain in a standardised way, even the audit report in the end can be created automatically because everybody has to choose the same processes, and it only has to be set up for one company one time and then can usually recreate it every year. So, every step of the audit process can be influenced by the blockchain technology and most importantly, the real disruptive part will be that the current audit job will completely disappear, probably. (AAF4)

The AAF group’s position is not surprising, a critique could point out that it is self-serving since the participants are all from Big 4 audit and assurance firms. It is unlikely for this group to assert that BCT will eliminate their roles. However, it could be argued that, at this moment, because BCT is yet to be fully adopted for financial reporting and accounting purposes it is unlikely the technology will eliminate audit roles.

6.5.1.3 Academics' (ACA) View

The participants in the ACA group question the relevance of audit and assume the technology could disintermediate the auditor's role. Some participants think BCT will change the nomenclature of auditors' activities while others believe that the technology could eliminate auditors from the financial system. These views may not be unconnected with how technology has impacted other professions and the general perceptions that the accounting industry lags in embracing technology. However, the ACA group agreed that their view is conditional on the adoption of BCT for financial reporting and accounting.

ACA7 notes that "the role of auditors become less relevant if blockchain or BCT based technology in audit reporting comes into play." S/He explained that where BCT is used from the inception by any organisation for capturing all transactions, it significantly can reduce the roles of auditors, auditing firms or manual audits because everything will be automated. S/He explains:

> The role of auditors become less relevant, if blockchain or BCT based technology in audit reporting comes into play. Because if BCT is being implemented, from the first place in a business organization or a firm, then automatically all of the transactions are coming into place with the help of BCT. So, then the role of auditors or manual auditing or auditing firms, I think will reduce significantly because this becomes automatic, otherwise the transaction will not proceed, transaction will not close. ACA7

ACA6 asserts that auditors will still be needed to check the accuracy of the information on BCT, but there will be fewer auditors. Furthermore, S/He is sceptical about the value of the audit itself because the work of auditors is based on outdated information in the financial statements, "We know that the auditing system does not work all that well, and also, never seen a benefit directly connected." ACA6 explains:

> One of the things is some people initially first argued that you wouldn't need auditors at all, but I think you do need the auditors to find the information

> that's put was accurate in the first place because there can still be a problem… Yes. Maybe their role has to change a little bit, was the information put on blockchain accurate? There will be fewer, you won't need as many auditors, but you'll still need some auditors. This is what happens with a whole lot of other professions. (ACA6)

However, ACA5 states: "You can take an extreme position and say that auditors won't even exist." S/He likens the BCT revolution to the way computers change the role of engineers. The participant view could be said to be extreme, in which s/he acknowledges this, but there is the view of BCT-enthusiasts who strongly believe that BCT can bring the desired change to the auditing profession and accounting industry in general. Smith (2018b) claims that BCT can lead to the elimination of the audit function and other associated lower-level tasks as well as significantly impact the entire accounting industry. ACA5 explains:

> Now, I do exaggerate a little bit for effect, but I do think it's an existential threat that the profession will have to change. In the same way that computers change the role of engineers, think about the way engineers did their job before you had CAD drafting and so forth, they did everything by hand with protractors and the technology comes and makes them 100 times more efficient, and the best engineers are the ones who can use those computer terminals. (ACA5)

Contrastingly, ACA3 asserts that BCT will not replace auditors, but their job description may change and certain aspects of auditor's activities may be eliminated. ACA3 explains:

> I don't think there is a technology ever exists that will replace the human hundred per cent. Probably, it's going to eliminate certain activities, but it's going to create different activities. We are going to rule this universe man, technology will never ever replace us. However, I think, it would eliminate certain activities, get rid of certain activities. But in the meantime, it's going to create other activities for auditors probably. So, yeah, auditors will be there, but probably the description of their job and what they do might change. That's what I think I'm not expert in the financial industry. So yeah, but that's what I believe. (ACA3)

However, ACA3 did not mention the activities that BCT will create or eliminate from audit activities. Karajovic et al. (2019) note that blockchain can impact job creation in the long run by making some roles obsolete except those involving human judgement such as IT risk and advisory services.

ACA5 insisted that BCT can eliminate not only the roles of both auditors and bookkeepers but also other professionals because the technology is there to do the job. S/He explains:

> And I think for people like auditors and bookkeepers the job that they do today may not exist at all, in five or 10 years because you've got a ledger that more or less does the work for you. An auditor doesn't have to go back and sample transactions because you can tell right away if the books have been kept accurately. I think the risk to quite a few jobs of people no longer being needed is the very essence of disruptive, it's a labour killing technology. And unlike a lot of technologies that go after the low wage labour, this goes after some fairly high value-added jobs, a lot of professional white-collar workers I think are very much at risk to the blockchain making their positions obsolete. (ACA5)

In an integrated audit, the auditor's responsibility encompasses checking if misstatements in the financial statements were due to material or significant weakness in internal controls (Johnstone et al., 2016). BCT or any other IT system is part of the organisation which falls under management's internal control system. Auditors are expected to review and examine an entire internal control mechanism of an organisation for possible deficiencies or weaknesses. Consequently, auditors will still audit BCT as part of the internal control system to assess its functionalities. It is yet to be seen how the auditor job will become obsolete by BCT as claimed by ACA5.

In the view of the majority of the study's academics, the main proposition is that even if the technology did not eliminate the audit function, it will bring significant changes to the auditor's roles.

6.5.1.4 Accountants and Auditors' (AAD) View

The majority of participants in the AAD group argue that audits will remain relevant and BCT cannot eliminate the roles of auditors in a financial system. They believe that even with the adoption of BCT, auditors will still hold an important position in the financial system. They were of the view that there is no technology that is 100 % error-free, and independent third-party auditors will still be required to verify BCT enabled activities. The group justification for this view is that auditors' professional judgement on BCT transactions is irreplaceable because a third party need to check BCT.

AAD1 notes that someone needs to check the system, audit the system and that the system is configured correctly and behaving properly. S/He stresses that: “A system on its own cannot work without human intervention.” Similarly, AAD2 argues that there is the need to audit a blockchain because IT transactions are transferring through that ledger and if no one's auditing it, there is no guarantee that something didn't get manipulated on that blockchain. (M. Singer, 2019b) asserts that audit is necessary to ascertain that inputs in BCT are done correctly. AAD3 sees the elimination of auditors as something way out of proportion, “That was a little bit of overreaction to blockchain and people made statements like we're not going to need auditors, we're not going to need bankers.” S/He suggests that the relevance of auditors depends on how innovative and proactive they are because BCT will disrupt the audit profession.

Thinking slightly differently, AAD6 asks, what are the roles of auditors if BCT can lockdown transactions, and make transactions immutable with no need for reconciliations? S/He argues: “Well if auditors if what they do is audit transactions and the transactions are locked down, immutable or confirmed and there are no reconciliations, it's like well then what is an auditor's job? That is my layman's perspective on that.” BCT cannot ascertain the physical transfer of assets or occurrence of transactions in the real world (Schmitz & Leoni, 2019), so an audit will still be undertaken to check the genuineness of those transactions.

AAD6, however, agrees the role of auditors is still relevant but believes that BCT is likely going to reduce the audit fee because most audit time is spent on verification, reconciliation and sampling, and such tasks may no longer be necessary. AAD6 explains:

> It's interesting because the auditors are still going to be doing internal controls, and validation of the systems, processes themselves, but not so much the transactions. …The thing that I would ask some of these technical people that are doing the auditing is if you take an audit that says 1000 hours and you parse it into two parts. My perspective, but it's an uninformed perspective is that 80% of the work that goes into the audit itself is the auditing of the transactions, the sampling of transactions and then going back to source documents and so forth and maybe 20% is spent on the systems and processes. If that be the case, if the lion's share of the audit itself is the auditing of the transactions and not the system processes that mean that that 1000-hour audit could end up being a

> 200-hour audit. And if that be the case and this is what you have to confirm with others, then what that means is that the significance for the audit is very much just the time that is put into it. (AAD6)

Ittonen and Peni (2012) highlight the determination of audit fees as a factor of the budgeted hours of the individual member of the audit team and unit prices as well as risk assessment. There are some complexities regarding the fixing of audit fees in practice, particularly where the audit firms are also engaged in non-audit functions. Cao et al. (2018) note that BCT will disrupt conventional audit pricing and make audit a function of work done and not the size of an organisation. AAD6's observations become relevant where the hours spent on manual audit work are replaced with automated processes such as BCT. The implication of this will become feasible when BCT is fully adopted for financial reporting and accounting.

6.5.1.5 Accounting Regulatory Bodies' (ARB) View

All participants in the ARB group note that BCT does not affect the relevance of audits and the technology cannot replace the roles of auditors. The majority argue that BCT or distributed ledger cannot exercise professional judgement and scepticism which are critical elements in audit and the preparation of financial statements. The ARB group also noted that BCT is not the right solution for everything as claimed by some writers. ARB4 suggested that cryptocurrency blockchain is created as an open and transparent platform to attract a lot of people, but "BCT is not just the right solution for a lot of things". S/he notes that the BCT PoW concept is not relevant where there is trust in organisation(s) and a google distribution sheet could be used in place of the BCT ledger.

Maffei et al. (2021) assert that the BCT accounting system cannot replace the accountant's expertise in the preparation of financial statements because automation is not a substitute for the interpretation of accounting regulations and standards. The authors further argued that auditors' professional judgement and overall assurance are beyond what BCT's internal controls can guarantee (Maffei et al., 2021).

ARB3 notes that the relevance of auditors depends on their ability to understand the technology and ask relevant questions. S/He observes: "It is not the type of auditors you have today which has to come to do the verification, substantive and compliance testing, all that would be automated". Using ARB2's view as the representative position, s/he explains:

> In the audit space, it is the role of the accountant to be true to exert professional judgment and professional scepticism of the clients, and basically apply that to prepare the financial statements, and a blockchain by itself can't do that, especially not right now. We haven't reached a stage yet that blockchain development where it's a fully autonomous process. … The auditor is able to do an impairment test or a fair value evaluation, but blockchain itself is not. So, the auditor needs to put that information onto the blockchain. (ARB2)

A critic could ask if auditors have exercised professional judgement and scepticism in the audit of WireCard, Enron and the like. However, it is a regulatory requirement for auditors to exercise significant professional judgement and professional scepticism in the discharge of their duties, whether auditors observe these principles in practice is outside the scope of this study. However, ARB5 thinks it is difficult to know what impact BCT will have on audit until there is a use case. S/He argues that auditors may need to adapt but they still need to ascertain if BCT is working as expected. ARB5 clarifies:

> Look, it's really hard to know because we can all sort of look ahead guessing and predicting because there's been a lot of talk about auditors that you mightn't need an auditor, it's all real-time with blockchain and all the rest, but I just said until it's actually a use case, it's really hard to know maybe the role of the auditor will adapt. (ARB5)

Generally, the use cases will help to shed light on what roles the auditor will play. As previously highlighted, the study finds that there is yet no company that has fully adopted BCT for their financial reporting and accounting system.

6.5.1.6 Financial Analysts and Other Experts' (FAE) View

The FAE group support the view that auditors will not be eliminated by the BCT. They believe that the knowledge of accounting and auditing standards is still relevant and, even if machines are trusted to self-audit themselves, auditors are required to validate work done by the machines. FAE1 asserts: "Auditors are still needed to set the rules and ensure they are properly applied with random controls."

Similarly, FAE3 acknowledges that there will still be a need for people who understand the accounting and auditing standards to answer the process and control questions, but s/he believes that machines will be trusted to establish and test internal controls in the near future. FAE4 argues: “I'm not sure the blockchain is going to get rid of auditing, I think what we've seen with the pandemic is switching pressure to people to digitize and remote auditing is taking place.”

FAE2 states that BCT will not eliminate, but can help an entity to self-audit itself because validation of work done has to be undertaken by the persons external to an organisation.

> No, it won’t eliminate it [auditors]. It will redistribute the workload. So, it will make it easier for a company to self-audit or enable self-audit, but it will not be able to replace it. Because, at some point, the work has to be validated by humans and those humans cannot be within the organisation. They have to be outside the organisation. FAE2

The overall findings show that audit is still going to be relevant in a BCT environment and it is unlikely that technology will eliminate third-party auditors from financial transactions. However, the technology can reshape audit focus. This position contradicts the assumptions of scholars like Karajovic et al. (2019, p. 319): “blockchain’s evolution seems to have the potential to eliminate the accounting profession altogether”; and BCT has the potential to eliminate audit function and other accounting roles (Lazanis, 2015; Smith, 2018b). Further, the study’s finding is in line with the position of (Bible et al., 2017; Bonsón & Bednárová, 2019; Cangemi & Brennan, 2019; Maffei et al., 2021; Mahbod & Hinton, 2019) that technology cannot replace the audit of the financial statements.

However, it was pointed out that certain aspects of an audit would be unnecessary: reconciliations, paper work, sampling, testing and other repetitive manual audit tasks. The justifications for the auditor’s relevance by the participants include the high risks associated with BCT and the need for an independent auditor to ascertain if transactions in BCT are genuine and reliable. In addition, investors need assurance that entities that adopt BCT can withstand rigorous scrutiny and fulfil their regulatory requirements. It could be safe to say these justifications are rhetoric to support audit relevance by the majority of participants and the available literature. But, from the study’s lens and in practice, BCT has not been fully adopted for financial reporting and accounting systems at any commercial scale. Thus, it may be too early to ascertain the full extent of audit relevance in a BCT environment.

This is supported by Schmidt and Wagner (2019): “In reality, examples of successful blockchain applications are scarce (p.1).”

It should be noted that there are a few participants with the view that BCT is a labour reducing tool that can eliminate the roles of both auditors and bookkeepers because the technology is there to do the job. The participants’ perspectives could also be understood from the hype of related technologies in the past that have never lived up to their potential. It could also be because BCT is not the right solution for everything as proclaimed by its proponents. As succinctly put by some scholars (Alboaie et al., 2018; McLean & Deane-Johns, 2016) BCT is not a panacea irrespective of the hype around it and human intervention is required for the accuracy of its data management. Since the findings reveal that auditors will still be relevant and they are unlikely to be eliminated by BCT, what are they expected to audit in a BCT financial system?

6.5.2 Audit of BCT - Chains or Transactions

Some existing studies generally addressed the likely roles auditors will perform in a BCT environment without addressing the feature of BCT which is a block of chains and transactions. There are many unresolved critical issues: distributed databases using P2P storage, controls, security and system integration, regarding the potential digital transformation from BCT adoption in accounting. (Centobelli et al., 2021). Boillet (2017) highlights that auditors will need to examine and verify the existence of digital signatures and counterparties. However, some processes need to precede the verification of BCT digital signatures for auditors to check their existence. This study differs from previous studies in that it focuses on the specific task auditors are expected to perform. It also draws the views of the accounting and auditing professionals, blockchain start-ups and academics on whether it is chains, transactions, or both that auditors are expected to audit. The essence of seeking to understand what the BCT auditors will do in this study is to shift from the generic assertion that technology will self-audit itself by asking the practitioners whether it is chains or transactions, or both that require auditing.

Most participants are of the view that auditors need to audit both the BCT chains and transactions. In the case of blockchain for the smart contract, an audit will include the integrity of protocol, consensus mechanism and the chain itself.

Furthermore, BCT is unlikely to have any significant change on the principles and fundamentals of the materiality concept in auditing. However, participants also pointed out that this could depend on the nature of the audit because audit strategies vary in an IT environment. It was acknowledged that an IT is composed of multiple layers: application; interface; functionally, and security layers that may require scrutiny. This study has provided an answer to Karajovic et al. (2019, p. 322) poser: "Would auditors still be responsible for confirming the authenticity of transactions, or would their role change to audit the system itself?"

6.5.2.1 Audit Chain or transactions - Blockchain Start-ups and IT Experts' (BSIT) View

There is no consensus among the BSIT group as to what auditors are expected to audit in a BCT environment. Some participants said auditors are required to audit transactions only, while others believed that they are expected to audit both the chains and transactions. The technicality surrounding BCT made some participants suggest that financial auditors may not be adequately equipped to undertake an audit of BCT chains.

Auditors are mainly expected to audit transactions that go through BCT because auditing the chains may be outside their purview. This is also because there is little or no governance or regulatory guidance on BCT audits. Taking the perception of BSIT9 as a representative view:

> I think it's the transactions. Auditing the technology of the chain itself, I don't think is going to fall into the purview of auditors. There's a couple of things so I'm assuming we're talking about a financial auditor. They need to audit the integrity of the transactions and the new thing is you have to audit the custody; proof of existence, prove that the coins exist, and then proof of access. You have to prove that those coins can be accessed because just saying this is my account, the coins are there you can go look it up maybe on the blockchain explorers, but if you've lost the keys. The saying is not your coins, not your crypto, you have to also prove that you can access that account. There's some new stuff that comes in that wasn't there before when it's a traditional bank account. (BSIT9)

Furthermore, "I would argue that auditors will absolutely need to understand how to audit transactions data that comes from public or private blockchains" noted BSIT10. Additionally, BSIT11 suggests auditing the transactions will enable an auditor to ascertain the authenticity of transactions in a BCT system.

BSIT10 notes further that collaboration between auditors and technologists including legal professional are required in undertaking a complete audit of the BCT smart contract or other BCT applications because there are multiple developed hybrid blockchain solutions out there. Palm et al. (2018) state that some distributed ledger systems such as Swirlds, IOTA and R3 Corda do not store their transactions in chains of blocks but use graph-like ledgers which confirms BSIT10 view about the existence of many BCT solutions.

Contrarily, BSIT5 asserts: “Yeah, so I'd say it's a little bit of both chains and transactions”, but it all depends on whether it is a private or public blockchain that is being audited. BSIT5 assumed that auditors should undertake verification of transactions in a public blockchain because data produced could be said to be accurate, but in a private blockchain, auditors will need to examine the way data is being reported and the controls. Similarly, Crosley and Anderson (2018) consider that audits of the future will not be of transactions but of the blockchain itself because auditing transactions may be insufficient to address the need of stakeholders.

Where auditors are expected to check the level of compliance with internal and external regulations, and ensure that BCT complies with them and does what they are designed to do, then auditing the transactions only may not suffice. In practice, audit and assurance firms undertake IT audits; it is unlikely the adoption of BCT will result in any significant change to these established audit procedures.

Some participants who have undertaken audits of BCT-related operations shared their experiences. BSIT7 narrated how their firm audited BCT cryptocurrencies: “We have Application Programming Interface (API) into their bank accounts, and we pull those balances every 30 seconds. They just give us an API credential hook in there, then we can pull them up.” This shows that auditors obtained the necessary information from the BCT platform before undertaking the audit. BSIT3 explains the rationale behind this practice stating that “there is very little governance or authoritative guidance on how to audit things that come from blockchain technology.” This alluded to the fact that presently auditors merely offload client information on BCT and carry out an analytical process as there is yet no complete BCT-driven financial record and reporting system. This finding possibly contradicts the view of Pimentel et al. (2021) on the refusal of many auditors to audit BCT transactions due to a lack of technical knowledge.

As previously discussed, those organisations that are said to have adopted BCT for their processes only did so for a specific part of their operations. BSIT7 clarifies: "We have never audited a company that's using a blockchain for supply chain or anything like that, I only have audited digital asset companies." Currently, BCT is used for handling part of business operations, this is the situation with the likes of multinational companies such as Fonterra. BSIT6 pointed out that they have undertaken blockchain transactions that were purely an electronic bill of lading blockchain solution and not for payment.

Theoretically, since there is yet to be a complete BCT financial reporting and accounting system, the participants' perception about the need for auditors to audit BCT chains and transactions was from their experience of auditing existing similar technologies. It can be argued that the adoption of BCT on large scale will shape what auditors need to audit in the future.

6.5.2.2 Audit of both Chains and Transactions – Accountants and Auditors' (AAD) View

The majority of the participants in the AAD group thought the entire BCT architecture, both the chains and transactions need to be examined by auditors. They believe that for auditors to validate the integrity of the system, everything in BCT has to be audited.

Contrary to the view of the BSIT group, AAD1 notes that the examination of the security layer and all the associated controls in BCT falls within the purview of what auditors are expected to examine. This is because, in the IT system where BCT is located, auditors review the IT application, security and control layers. S/He explains:

> So, there is a lot in every IT system, we look at IT as a system, there are layers and layers. There is an application layer, and the auditor needs to be responsible for looking at the application layer. How is the application

> behaving? The interfaces, the functionalities, people need to look at how the users interface with the system? The security which I just spoke about. How is the security layer? What are the controls in place, the perimeters, or the intrusion system and all that? That is all within the purview of an auditor. (AAD1)

Similarly, AAD2 asserts that BCT cannot be audited in isolation, auditors must audit the entire ecosystem. S/He listed the areas auditors need to audit in BCT including the IT general controls on the ledger, the network and data centre, security development, access and password security and change management. AAD2 further emphasised that where transactions flowing through BCT or any IT system are not audited, the numbers cannot be used to “close the accounting books”. This may be because investors will not rely on unaudited financial records. AAD2 illustrates:

> The other thing that you have to understand is that when you audit a blockchain you can't just audit the blockchain you have to audit the whole ecosystem. For example, in the case of cryptocurrencies exchanges, banks and over the counter traders, they're all not blockchains. Exchanges just help you are on ramps and off ramps to blockchains, but they're still central that manage keys, they're still central database functions. The theory in auditing is that if you have transactions flowing through any system and you don't have an accreditation or auditing for IT general controls then you can't rely on any of the numbers that come through. So, if you have transactions that come via a blockchain. and that blockchain isn't audited by somebody and accredited, then you have no business using those numbers to close your books because you can't tell me that they didn't get manipulated while it was on the blockchain. (AAD2)

Auditing of BCT will not be limited to transactions through the technology only, it must include off-chain transactions. Auditors may need to satisfy themselves that the entire BCT ecosystem has been examined to place reliance on evidence generated from the system. Contrarily, ICAEW (2018) assert: “Any participant in the ledger can trace all previous transactions, allowing for increased transparency and the blockchain to ‘self-audit.” Where the technology can self-audit itself due to its inherent transparency, perhaps, an audit of the BCT ecosystem may not be necessary. Contrarily, Cangemi and Brennan (2019) explain that recording of transactions in a BCT is not a substitute for auditors undertaking routine financial statements audit.

Similarly, AAD5 notes that the materiality of transactions is still relevant in a BCT environment, saying that “If something is material, they will have to check the entire chain, they even have to contact suppliers as they do right now.” Going by established audit principles, auditors need to review both the chains and transactions as well as test for the materiality of transactions in a BCT environment.

AAD1 further states BCT will expand the scope of audit work because auditors may need to ensure the integrity of the system is maintained. This includes auditors following through with any observed security alarms or breaches from the IT system. The essence of this audit procedure is there are occasions when not all alarms are real security threats or breaches and for every such alarm there may be lessons to learn to prevent the reoccurrence of the same breach.

Karajovic et al. (2019) note that, unlike the traditional audit approach where auditors rely on a small sample size of transactions, the audit scope in a BCT will be exponentially increased because of the availability of the audit trail from many participants. AAD1 shared the same view with Karajovic et al concerning BCT leading to more work for auditors. Therefore, with BCT there is a possibility that auditors may need to perform more tasks to verify system integrity. Conversely, Fanning and Centers (2016) think that BCT will cause a significant reduction in dependence on auditors for testing financial transactions.

To understand further what the auditors are doing with clients that are use BCT for certain operations, the participants in the AAD group shared their experiences. It should be noted there is not much difference with the earlier procedures mentioned earlier in the BSIT group. AAD2 illustrated his experience of how they audit BCT which is similar to that of BSIT7:

> We take and offload the information from the blockchain and then we run analytics on it. Basically, we can audit the blockchain in a system of record that's secured by SOC. The other way, which is probably a better way is to use a smart contract, that's a node on the blockchain that continuously monitors every transaction to make sure it's a compliant transaction. (AAD2)

AAD2 went on to say that there is no smart contract exclusively for auditing, and the use of a smart contract for auditing is complex. Additionally, a smart contract for auditing is infeasible because currently there are only a few blockchains that allow smart contracts and those that do are simple smart contracts. AAD2 elucidates:

> The problem is that there are only a few blockchains that allow smart contracts right now and the ones that do there's kind of real simple smart contracts. If you want to have a smart contract that's a complete auditing program that's a pretty complex system in and of itself, and it would have the same frailties of any other smart contract because it would have to be audited to the code in it. (AAD2)

Similar to the view of AAD2 concerning the complexity of having a complete smart contract auditing software, Pereira et al. (2019) note that it is impracticable to create a smart contract that will foresee all uncertainties. Other than the ongoing experiments by the Big 4 firms and other software giants such as IBM, Microsoft and Samsung, none of the participants has come across a smart contract auditing program.

Hypothetically, where a smart contract is employed to audit BCT, the likely challenge would be who audits the smart contracts and the associated nodes to ensure they are doing what they have been designed to do. Swan (2015) suggested that there would be smart contract auditors as a result of BCT. Then, if this will be the case, it can be argued that it is important for auditors to examine both the chains and transactions.

However, AAD4 believes that the BCT system could look after itself, so the auditor should focus on transactions. Financial auditors should concentrate on ascertaining the integrity of the transactions because the technology can audit itself. AAD4 explains:

> I would look at transactions to use your judgment and understand that. Once you understand the business within those transactions are plausible and anything suspicious, I would look at it. For chains, the system automatically does that. Hopefully, the chains are looked after by that. (AAD4)

AAD4’s view is similar to the views of many participants in the BSIT group in that BCT has a self-auditing mechanism. Conversely, AAD2 was quick to point out the misconception among people about auditing BCT. S/He elucidates:

> Therein lies the problem that we just talked about everybody Ernst and Young, KPMG, PwC, all the small and large firms around the world and I teach audit at the MBA level, everyone's saying yeah we audit the blockchain, but most people really don't know how to do that because it's a difficult thing to audit, it's totally different from a central database, nobody in the case of public

> blockchains no one even owns it. And even if it's a private blockchain, if it's a Walmart blockchain that I mentioned to you before, do you just audit the Walmart node or do you audit all the other nodes the suppliers that are involved? What are the criteria and etc? (AAD2)

The assertion that BCT can self-audit itself is strong among some scholars and accounting bodies (Cao et al., 2017; ICAEW, 2018; Karajovic et al., 2019), but how this would be done in practice is yet unknown because there is no empirical evidence to support this view. However, Cangemi and Brennan (2019) suggest that there is an element of self-auditing mechanism in BCT, particularly regarding authentication, authorization, separation of duties and archiving when compared with the conventional system audit IT general controls. Despite these assumptions, incomplete or insufficient data on BCT networks makes it impossible to audit end-to-end transactions because the technology by design carries a limited amount of information in its database (Cangemi & Brennan, 2019). Similarly, Bashir (2018) states that BCT storage capacity is poor unlike the traditional database system because the technology is incapable of storing images or large blobs of data. Where information is distributed across nodes, end-to-end transaction audits may be infeasible. BCT cannot undertake a complete audit of itself, hence auditors may need to examine the technology.

AAD2 further stressed that BCT is much more secure than other processes and there is probably less to audit, but it will be difficult to convince anyone including auditing standards setters and regulators, that BCT is very secure, and that no one needs to audit it at all. S/he sums up, “There're plenty of things through smart contracts and transactions where blockchains have been hacked and there're plenty of examples of fraud that have gone on related to blockchains.”

Undoubtedly, negative publicity about BCT crypto-assets due to numerous hacks especially the DAO hack and other frauds related to blockchains will not help either. Scholars (Casino et al., 2019; Reid & Harrigan, 2011) were sceptical about BCT due to the DAO hack in 2016 and other vulnerabilities which were regarded as a potential way to harm the overall economy. For instance, Bourgi (2021) reported hackers stole cryptocurrency from about 6000 customers of Coinbase, a global cryptocurrency exchange firm bypassing the company’s multi-factor authentication procedure in October 2021. Similarly, (Wright, 2021) reported the stealing of about

US$600 million in Poly networks across three blockchains by hackers. Bartoletti et al. (2020) found that a smart contract on the Ethereum blockchain is used for Ponzi scheme to defraud innocent investors. Additionally, scandals and public perception (see Section 2.6.5) are other factors that could cause stakeholders to not support the idea that BCT does not require an audit by independent auditors.

6.5.2.3 Audit both Chains and Transactions - Audit and Assurance Firms' (AAF) View

There is no dissenting voice among the AAF group concerning what auditors will audit. All the participants claimed that auditors should audit both the chains and transactions as they do with the current IT system. In their view, auditors will examine the application and interpretation of financial standards, whether items are correctly classified, reported, disclosed, and valued and other issues that require professional judgement.

AAF3 highlights areas auditors will examine in a BCT environment to include the ownership, the right and obligation to an item including valuation, reported amount plus subsequent changes, and disclosure if it provides an appropriate overview to investors and stakeholders before inclusion in the financial statements. This view is supported by AAF5:

> Information stored in any BCT-based system, including an accounting system, is no different to auditing any traditional system. While there is an enhanced approach to encryption and synchronisation of distributed copies of the same data, ultimately the data refers to something that is owned or has some form of value. Evidence of ownership, evidence of value and evidence of authorisation to transact remain the same. (AAF5)

AAF8 suggests that when the BCT accounting system is implemented the auditor is expected to review the flow and have the IT specialists audit the IT controls. S/He elucidates:

> So, that's basically what the auditors will do, they will check the blockchain on the IT side, but also processes that follow, that have to be done, so that the transaction on the blockchain can follow. And then they will probably also take some sample transactions but way less than they do at the moment to see if the transaction is recorded critically on the blockchain, especially if they decide to go with private blockchains. (AAF4)

Liu et al. (2019) note the main focus of auditors in a BCT environment is not testing of transactions but testing all controls for accuracy of blockchain transactions. AAF4 argues that the auditor will examine both the chains and transactions because they need to check if the system and process are working correctly or not.

Another participant, AAF6 notes that it depends on the nature of the audit and what the auditors are testing for. It is equally important for auditors to understand the protocols governing BCT, as well as the associated risks and control governing it. S/He opines:

> Depending on the nature of what an auditor is looking at and what the testing for, maybe the actual transaction I would say at the very least that they need to understand the chain itself, the technology risks, and the control environment sitting over the top of it. I see the control environment being absolutely critical to this role. (AAF6)

The participants in the AAF group did not see much difference in auditing BCT from the way existing IT systems are audited. Irrespective of the potential associated with BCT, auditors will still undertake the review of both the transactions and the chains following existing IT audit procedures. This assertion may be correct considering that BCT is still evolving and there is yet no full BCT financial reporting and accounting system.

6.5.2.4 Both Chain and Transactions - Accounting Regulatory Bodies' (ARB) View

The majority of the participants in this group also believe that auditors will examine both the technology and the transactions that BCT produces to report their findings to stakeholders. ARB4 believes what auditors will do depends on the client's IT controls, but auditors will need to examine if those controls are working well and reconcile transactions. However, s/he acknowledged that the BCT use cases are few. S/He illustrates:

> It depends on the client IT controls, if the client uses a blockchain to store their data or the client transacts with another company, then the auditor needs to make sure that IT controls system is fully functioning. That is something that the auditor will have to audit. For example, if you think about smart contracts on a blockchain and the IF-THEN conditions that you encode onto those smart contracts. As an auditor, you need to understand if your client uses smart contracts on a blockchain, and how those smart contracts are coded and who

> codes them, and who might change the code of the smart contract? That's what's called IT controls. The auditor will have to do an audit or a review of IT controls, at the same time, the audit is also expected to reconcile the transactions. There are not that many use cases yet and the auditor will be supported by the triple-entry bookkeeping system that blockchain offers. In the process of reconciling transactions. The blockchain, actually, does reconcile the transaction almost in real-time through this edit layer to this sub-ledger. (ARB4)

Gay et al. (2018) explained that auditors can use generalised audit software (GAS) or in-house designed software to read and understand the format of the client's file and the storage to support audit testing. In 2019, IBM claimed to have patented two solutions to audit BCT networks that are capable of certifying the data integrity in BCT-based systems (Anujit, 2019). This patented audit solution is an example of a typical GAS package that may be used for auditing BCT in the future. Auditing of IT controls is indeed fundamental in any computerised auditing environment and BCT may not be an exception. The lack of many use cases has made it difficult to determine what auditors will audit in a BCT environment, and some participants also recognised this challenge.

Similarly, ARB4 was of the view that the technology and the associated programs need to be audited to ascertain if the program works as expected. This existing method of auditing IT systems will be applicable to BCT but it may be on real time-basis. S/He asserts:

> I would audit definitely the computer system, parties to the transactions and of course do a sample of the transactions, just to verify that the information is what it should be. That type of audit procedure would not be stopped, but it would be more real-time. (ARB4)

The position of the majority of the participants that auditors will need to audit both the chains and transactions could have been informed from their audit experience of existing IT systems as there is yet no full-scale adoption of BCT on a commercial scale. However, whether the auditor will audit the chains or transactions, auditors will need to have the requisite technical skills to audit BCT. Dai and Vasarhelyi (2017) note that the technical details involved in the audit of smart contracts are complex and will require auditors to possess the requisite skills and understanding of the technology.

6.6 Summary

This chapter presented the findings to the first five research questions using the technological and organisational contexts of the TOE framework (see **Figure 20)**. The technological context of the findings includes the potential influence on the double-entry accounting system, BCT-enabled triple-entry accounting system, audit firm as a node in a BCT environment, and the relevance of the audit. Similarly, the organisational context of the findings is related to organisations that have adopted BCT for financial reporting and accounting purposes.

Furthermore, it further addressed the probable disruption of the BCT in the double-entry accounting system, the suitability of the term 'triple entry accounting' and the possibility that the BCT facilitates triple entry, as well as the impact of the BCT on tax management. It further highlighted BCT disruption or enhancement to auditors' and accountants’ functions, identified specific areas the technology may impact, and also determined the extent of BCT's practical deployment for financial reporting and accounting systems. These themes relate to the technological context of the TOE framework (see **Figure 20)**.

Regarding the BCT disruption of the double-entry accounting system and facilitation of the triple-entry system, the study found different perspectives among the participants. It was found that BCT could disrupt double-entry accounting principles and enhance the debit and credit system by adding multi-party visibility to transactions. Additionally, it was found that BCT may not add value to the existing double-entry system or change the existing configuration. The limited experience with BCT could be the reason participants expressed diverse views on the likely disruption the technology could bring to the double-entry accounting system.

Before addressing the question of whether BCT will facilitate the proposed triple-entry accounting system, the majority of the participants regarded the ‘BCT triple-entry accounting system’ as jargon and confusing terminology which has no substance in the accounting system. Despite the divergent views on this terminology, the study found that BCT could enable the triple-entry accounting system by providing an algorithm as a third layer to the double-entry system. It was found that BCT could be used to administer company tax, GST, VAT and WHT, but not for income taxes because of computational complexities and multi-jurisdiction systems. However, the participants suggested that a BCT-based record and accounting system must be established for the technology to be useful for tax management.

The participants believed that BCT could disrupt manual accounting processes such as reconciliation, automation of transactions and bookkeeping systems, as well as facilitate real-time accounting, and inter-entity transactions, and reduce the cost of maintaining and sustaining accounting ledgers. Additionally, the study found that without the digitalisation of records, BCT or any other emerging technologies may have little or no impact on accounting processes. The study's findings revealed that areas that BCT is projected to disrupt in the traditional accounting functions have already been disrupted by existing technologies such as XERO, Peachtree, and SAGE.

Despite the contrasting views, the majority of the participants believed that BCT will have no significant disruption in the auditing profession beyond the likelihood of changing audit sampling, reconciliation, and confirmation processes. It was found that BCT could become a tool for the enhancement of audits. There is no empirical evidence from the participants to support the assertion that BCT has so far disrupted the auditing profession.

The practitioners and academics interviewed stated that, from their experience, no organisations have deployed BCT for financial reporting and accounting systems. This showed that despite the potential benefits or hype around BCT, the technology is yet to be adopted for financial reporting and accounting systems by any company known to the participants. This finding highlights the organisational context of the TOE theoretical framework.

Auditors are said to be relevant in a BCT environment but certain aspects of audit, such as reconciliations, sampling, testing, and other repetitive manual tasks would be unnecessary. According to the majority of participants, BCT will not eliminate auditors from financial systems. It was also found that auditors are expected to audit both the chains and transactions. This finding has provided an answer to some scholars' queries on whether auditors are to authenticate the transactions or audit the BCT system. For BCT smart contracts, the study found that audit will include the integrity of protocol, consensus mechanism and the chain. Additionally, BCT is unlikely to result in any significant changes to the principles and fundamentals of the materiality concept in auditing. **Table *4*** provides a summary of the findings of this chapter.

The next chapter discusses the findings on the effectiveness of the BCT fraud prevention and detection mechanism, the impact of GIGO, as well as the technical skillsets required by accountants and auditors in a BCT environment.

Table 4. *Summary of Findings - BCT Impact on Accounting and Auditing Practices & Relevance of Auditors in a BCT Environment*

Sub Research Question	**Participant Category**	**View**	**Major Findings**
RQ: What accounting practices will change in a BCT-based environment?			
What will BCT add to the double-entry accounting system?	BSIT	Significant disruption by eliminating the double-entry constructs, and enabling one interconnected and verifiable ledger account	*BCT will disrupt the double-entry accounting system * BCT, a new concept in accounting that enhances the double-entry system by adding multi-party visibility to transactions *BCT cannot change the configuration of the double-entry system
	AAF	A possible addition to the debit and credit system	
	AAD	Enhance integrity and transparency of the debit and credit system	
	ARB	* Add no value to the existing double-entry system * Facilitate one ledger and one account by changing the double-entry configuration	
How will it facilitate triple-entry accounting?	BSIT	*The term 'Triple-Entry Accounting' is the common terminology for BCT-enabled accounting ledger. * Adding a third entry to the debit and credit system	*The term BCT triple-entry accounting system is considered jargon and confusing terminology, a misfit in accounting practices. *BCT will facilitate a triple-entry accounting system by adding a third layer to the double-entry in real-time.
	ACA	* The term 'Triple-Entry Accounting' is confusing.	
	AAD	*The term 'Triple-Entry Accounting' is a misconception. * Creation of immutable transaction record.	
	AAF	*The term 'Triple-Entry Accounting' is not appropriate. *Enhance inter-entity collaboration and reconciliation of accounts	
	ARB	*The term 'Triple-Entry Accounting' is jargon. * BCT will add a third layer to the double-entry system	
	FAE	*BCT has the potential to enable a triple-entry accounting system	

RQ: What accounting practices will change in a BCT-based environment? (continued)			
What impact will the technology have on tax management?	BSIT	*Disruption of the tax administration by increasing tax revenue generation. *Enable citizens to exert control over public funds *Elimination of corporations as tax intermediaries	*BCT has the potential for collection of GST, VAT and WHT, but not income tax. *BCT could be a potential platform for tax evasion and fraud * BCT-based record and accounting system must be established for the technology to have any impact on tax management
	AAF	*Useful for GST, WHT or VAT collection *Automation of tax collection * BCT is uneconomic and expensive for tax administration *Too early to predict BCT influence on tax management	
	AAD	*Disruption of tax environment by facilitating online real-time tax system. *Ease of determining tax incidence to payers and tax authority.	
	ARB	*Transparency in tax administration. *No meaningful impact on tax management. *BCT could facilitate tax fraud	
	FAE	*Enhance integration and interaction of key stakeholders in tax administration	
RQ: What areas will BCT disrupt or enhance in the accounting and auditing practices?			
What areas in accountant's function will BCT enhance or disrupt?	BSIT	*Disruption of manual accounting work, reconciliation and bookkeeping. *Automation of everything that does not require human judgement in the accounting and auditing system	* BCT will disrupt manual accounting tasks and enhance real-time accounting, inter-entity transactions, reducing the cost of maintaining and sustaining accounting ledgers. *Eliminate traditional functions of accountants. *A tool for the accountants. * Traditional functions of accountants are already disrupted by the existing technologies and BCT may not be a disruptor of basic accounting functions.
	AAF	*BCT is not a disruptor of traditional accountant functions. *Modification to accountant's functions. *BCT may render accountants redundant	
	ACA	*Complementary roles to the functions of accountants	
	AAD	*Disruption of basic clerical accounting tasks. *A tool for accountants since the preparation of final accounts still require an understanding of regulations.	
	FAE	*Disrupt clearing, settlement and P2P payment. *Elimination of accountant's function. *Without digitalisation, BCT may not disrupt accountants' functions.	
What areas will BCT disrupt or enhance in auditor's functions?"	BSIT	*No major changes to the audit profession. * BCT will disrupt sampling, valuation, data recording and other repetitive work * BCT time-stamp and immutability of records enhance evidence-based transactions for audit. *Professional judgement cannot be replaced with BCT.	BCT will not disrupt auditing practices but will be a tool for its enhancement. *No evidence to support the likelihood of elimination of internal audit department roles where external auditor become a node in a BCT platform
	AAF	*Enhance sampling, data entry, control and testing. *Disruption is limited to change in audit approach which depends on what's permissible by accounting and auditing standard	
	AAD	*No significant disruption to the audit profession. *Useful for verification and consolidation of financial statements *BCT has inherent risks that auditors must look out for.	
	ACA	*Disruption of entire auditing processes *BCT is self-auditing technology, therefore, auditors will be disintermediated. *Auditor's professional judgements are regarded to be fraudulent	
	ARB	*Change in audit procedures. *Enhance real-time access to financial records. *External auditors as a node on the BCT network. *Internal audit department could be eliminated	

RQ: What are the organisations currently using BCT or have adopted BCT for financial accounting and reporting purposes?			
What are the organisations currently using BCT or have adopted BCT for financial accounting and reporting purposes?	BSIT	*Majority state that they have seen organisations that have deployed BCT for financial reporting and accounting systems *People may be unaware that BCT has been the underlying technology in their operations	No organisation is known that has adopted BCT for financial reporting and accounting systems
	ARB	*None beyond ongoing pilot tests by different organisations. *BCT is the least mentioned technology among the emerging technologies	
	AAF	*BCT has not been deployed for the financial reporting and accounting system.	
	AAD	*Beyond those trading in cryptocurrencies, no deployment for full accounting system	
	ACA	* BCT has not been adopted for financial reporting and accounting purposes.	
	FAE	*Have not seen where BCT is being adopted for financial reporting and accounting purposes	
RQ: How relevant are the auditors in a BCT financial system?			
What is the possibility of BCT eliminating third-party auditors?	BSIT	*Auditors remain relevant in a BCT environment. *Smart contracts will not replace auditors. *BCT cannot eliminate financial audits.	*Auditors are relevant in a BCT environment. *BCT cannot eliminate the roles of auditors from the financial system.
	AAF	*Audit function remains relevant in a high-risk BCT environment. *BCT cannot eliminate auditors' functions	
	ACA	*Roles of audit becomes less relevant if BCT is adopted for financial reporting. *BCT could disintermediate auditors' roles. *BCT will significantly affect the audit profession	
	AAD	*Auditors hold an important position in a financial system * BCT cannot eliminate the roles of auditors. *BCT could impact the computation of audit fees	
	ARB	*BCT has no negative effect on the relevance of auditors *Technology cannot replace the roles of auditors * BCT or distributed ledger cannot exercise professional judgement and scepticism which are critical elements in audit and the preparation of financial statements	
	FAE	*Auditors are still relevant *Auditors are required to validate work done by machines *Knowledge of accounting and auditing standards is still relevant	
What are auditors expected to audit in a BCT environment, the chains or transactions?	BSIT	*Audit of either transactions or chains *Financial auditors may not be adequately equipped to undertake an audit of BCT chains	*Auditors should audit both the BCT chains and transactions
	AAD	*Audit of the entire BCT ecosystem/architecture, both the chains and transactions *Auditors need to validate the integrity of the BCT system *Stakeholders are unlikely to accept smart contract will self-audit itself *Unaware of the existence of any smart contract auditing program	
	AAF	*Auditors are to audit both the chains and transactions as they do with the current IT system *Auditor is expected to review the transactions and the IT specialists to audit the IT controls	
	ARB	*Auditors will examine both the technology and the transactions	

Note. Source: Author

Chapter 7

Interview Findings: BCT Fraud Prevention and Detection and Technical Skillsets Required by Accountants and Auditors

7.1 Introduction

This Chapter addresses four research questions (six, seven, eight, and nine): "What mechanisms are in place in BCT for fraud prevention and detection?; What effect does garbage in, garbage out (GIGO) have on the effectiveness of BCT fraud prevention and detection mechanisms?; What are the technical skillsets required by accountants and auditors in a BCT environment?; and How relevant is understanding the BCT programming language?"

Fraud has been on the increase since the internet provided an opportunity for digital businesses and attention is always drawn to any technology that can prevent or detect fraud. This exploration of a BCT fraud system is important to understand whether the technology has an impenetrable mechanism for fraud prevention and detection or not, the types of anomalies that could be perpetrated in a BCT network and the effect of GIGO.

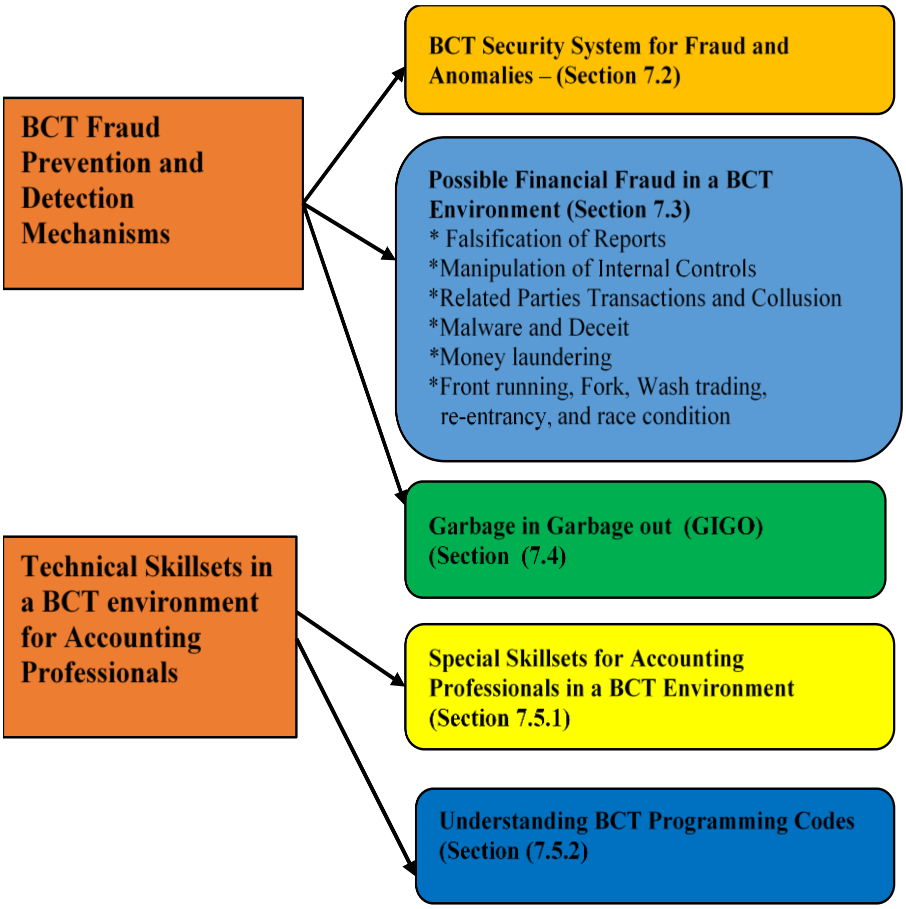
The first two sections examine how effective BCT is in the prevention and detection of fraud, and illustrate the types of fraud or anomalies that can occur in a BCT environment. This analysis goes beyond some existing studies (Meier & Stormer, 2018; Rechtman, 2017; Tapscott & Tapscott, 2017; Wang & Kogan, 2018) which assumed that the general features of BCT prevent fraudulent activities, to explore of identified frauds or anomalies that BCT cannot prevent or detect, and the overarching influence of the human element in fraudulent schemes.

The third section provides an insight into the impact of GIGO on the BCT fraud mechanism. Prior studies assumed that the general features of BCT provide a water-tight mechanism for fraud prevention and detection without considering the impact of GIGO. The section aims to understand if this computing logic has an effect or not on BCT security systems.

The fourth and fifth sections review the participants' perceptions concerning the technical skillsets required by accountants and auditors and if these professionals need to be familiar with programming language. This becomes important in light of the debate that accounting professionals require special skillsets and an understanding of BCT programming codes for the technology not to disrupt the profession and disintermediate their services. Implications that will emerge from this chapter could be helpful for the accounting, auditing and assurance firms, academics, investors, government, and policy makers on the extent of reliance to place on the BCT fraud prevention and detection system, and the skillsets required in a BCT environment.

The study's TOE framework (see ***Figure 12***, p.134) classified BCT fraud prevention and detection, and the skillsets required by the accounting professional under the technological context. They are directly or indirectly related to the attributes of BCT (see ***Figure 20***). **Figure 23** shows the key themes discussed in this chapter.

Figure 24. *Framework for the Analysis of Key Themes*



Note. Source: Author

7.2 BCT Fraud Prevention and Detection

BCT has been described as a disruptive technology with the potential to prevent and detect fraud because of its transparent and distributive ledger. Scholars (Meier & Stormer, 2018; Rechtman, 2017; Tapscott & Tapscott, 2017; Wang & Kogan, 2018) have asserted that BCT has inbuilt self-mechanisms to prevent and detect fraudulent transactions. This potential has made some writers assume that BCT will disrupt the accounting industry. In contrast, BCT does not have a 100% guarantee against fraud and anomalies because the technology security system could be breached by hackers (Oladejo & Jack, 2020). Different hacks of blockchain-driven cryptocurrencies and smart contracts have attested to the vulnerability of the BCT system. For instance, in the Digital Autonomous Organisation (DAO) hack of 2016, where hackers exploited a vulnerability in the smart contract built on top of the Ethereum blockchain. The DAO hack brought into doubt the transparency and immutability of blockchain (Andoni et al., 2019). However, Siegel (2016) notes that it is not Ethereum blockchain that was hacked it is the system attached to it.

Considering various arguments for and against the potential of BCT to prevent and detect fraud or anomalies, the study engaged with practitioners and academics to understand the effectiveness of BCT in the prevention and detection of fraud and anomalies. It further sought to understand what specific types of anomalies BCT cannot prevent or detect. These are discussed under the themes “BCT security system fort fraud and anomalies”, “possible financial fraud in a BCT environment”, and “GIGO” (See **Figure 24**).

In previous studies (Ahmed et al., 2016; Yufeng et al., 2004) on fraud prevention and detection analysis of e-commerce systems, it is difficult to ascertain the veracity of any technology’s fraud prevention and detection systems because there are no real-life data available for analysis. Similarly, most participants in this study acknowledged that their perceptions of BCT were based on the inherent features of the technology and hypothetical configuration of the technology’s potential to prevent and detect fraud. These participants further stated that the possible mass adoption of BCT will provide a better understanding of how reliable the technology’s inbuilt fraud prevention and detection mechanisms are.

The findings show that participants held diverse opinions or perceptions concerning the effectiveness of BCT fraud prevention and detection mechanisms. Most participants believe BCT has the potential to detect some fraud or anomalies, others think it can neither prevent nor detect fraudulent activities. This study also found that BCT is not suitable for complex operations since it would be integrated with other technologies that could expose the network's vulnerabilities to fraud. This would make tracking of fraud difficult in such complex domains. The participants also suggest that BCT cannot eliminate financial frauds because the pecuniary gain is the motive of hackers or criminals. This was also the position of Gee and Button (2019) that hackers are often motivated by financial gain. It was also found that the human element is the weakest link in a BCT system. This finding is similar to the assertion of (Alboaie et al., 2018) that the data accuracy in BCT depends on human management since transactions are validated by miners. The interviewed participants included front running[19], re-entrancy[20], race conditions[21], wash trading[22], money laundering, fork, and embedded malware as some of the examples of likely financial fraud that can occur in a BCT environment. It was further found that BCT cannot prevent or detect fraud arising from collusion, related party transactions, deceit and overriding of controls by management.

The findings further reveal that BCT mechanisms have no solution to the issue of GIGO in financial transactions. This finding supports the view of Powell et al. (2021) that blockchain cannot resolve the issue of GIGO in the food supply chain because "data on a blockchain may simply be immutable garbage (p.1)"

7.2.1 BCT Security System for Fraud and Anomalies – Blockchain Start-ups and IT Experts' (BSIT) View

The majority of participants in the BSIT group believes that BCT has more potential to detect fraud than to prevent fraud. The interviewed blockchain start-ups participants note that the effectiveness of the BCT fraud mechanisms depends on

[19] Front running is an illegal practice where investors or miners take an advantage of confidential information unknown to the public in making trading decision. For instance, when a miner approving transactions on a BCT network notice a large number of X shares are put on sale which may impact the price and the miner trade on it based on that privileged information, s/he is front running.

[20] Race condition attack happens when a computing system that's designed to handle tasks in a specific sequence is forced to perform two or more operations simultaneously

[21] Re-entrancy attack can occur through the creation of a function that makes an external call to another untrusted contract before it resolves any effects. One of the major dangers of calling external contracts is that they can take over the control flow, and make changes to your data that the calling function was not expecting. This class of bug can take many forms, and both of the major bugs that led to the DAO's collapse were bugs of this sort.

[22] Wash trading is when an investor set up fictitious transactions to show that genuine sales and purchases of cryptocurrencies have occurred so as to influence the market.

adhering to the established rules and protocols guiding transactions by all the nodes in the network, otherwise, it may be impossible for the technology to detect anomalies within the network. The BSIT's view indicates that irrespective of any instituted control measures in BCT, some hackers are working to breach the system. Fraudsters applied many methods to circumvent security control in an e-commerce environment (Abdallah et al., 2016). BSIT11 notes:

> I mean there're always [in] various ways to hack and control these things so you know security so long as you know additional security protocols and principles. You know you can prevent these things but a hardened hacker or someone incentivized enough to want to hit at the record because who knows why, but you know probably find the means to write security to get access to it. I guess it's another step, isn't it? (BSIT11)

However, BSIT1 acknowledges: "Although fraud can happen and it's very easy to identify and to fix almost instantly." Sharing the same sentiment, BSIT3 states: "I'm not sure if I can speak to that one specifically. I wouldn't say it's effective in preventing fraud, I think it's effective in detecting it." Abdallah et al. (2016) argued that the major challenge confronting the existing fraud detection system (FDS) is weak predictive accuracy and poor real-time detection. Based on Abdallah et al's argument and findings of this chapter, it could be inferred that BCT is likely to provide real-time detection of anomalies which the existing FDS is said to be lacking.

BSIT2 stated that BCT transparency also made it harder to commit fraud in the network because the timelines are visible to everyone. BSIT6 notes that BCT will prevent fraudulent activities because it will be difficult to perpetrate fraud in a BCT system, but went on to acknowledge hackers can game the system. Contrarily, Friedlmaier et al. (2018) assumed that the distributed nature of the BCT ledger makes it impenetrable to hackers. Similarly, Marvin (2017) also believes that records on the blockchain cannot be hacked or corrupted because there is no central database to hack. BSIT6 explains:

> It would be very difficult to commit fraud in the blockchain landscape because there's a whole point of blockchain is to prevent fraudulent activity. There're some smart people out there, and often they will find a way, but I guess one of the positives of blockchain is that control and security. (BSIT6)

BSIT5 further affirmed that BCT has a tamper-proof system and there is no way to commit fraud within the system but to ensure that transactions in a blockchain are not vulnerable the right controls and security should be instituted around other technology built on top of a blockchain. Likewise, Atlam et al. (2018) note that due to the robust security architecture in blockchain, there is no single point of failure. The importance of ensuring the right controls and security could is illustrated by the DAO hacks in 2016 and the hacking of over 6000 customers' accounts with Coinbase Exchange in 2021. These intrusions were possible because hackers breached the controls on other technologies connected to BCT (Karajovic et al., 2019; Marvin, 2017; Zohar, 2015). Real-time access, transparency, and the inability to forge transactions on BCT were reasons offered by participants to believe that the technology can easily identify anomalies. This is similar to the view of Friedlmaier et al. (2018) that features such as decentralization, consensus, and cryptography make BCT a tamper-proof ledger.

However, these beliefs that a blockchain security system cannot be tampered with have been called to question by a reported Coinbase Exchange hack in 2019. Brandom (2019) reported that the hackers had successfully rewritten BCT supposedly permanent ledgers of transactions in Ethereum blockchain, disrupted the Ethereum Classic and double spent both cash and coins. This successful attack suggests that the original assumption that BCT is 100% flawless and secure requires a rethink because BCT security features are penetrable.

Furthermore, sharing their company BCT operation, BSIT8 notes that the technology is not well suited to handle complex transactions in a real-world application except in a Bitcoin operation. This non-suitability for complex operations will make tracking of fraud difficult in a BCT since there will be other associated layers of technology connected to it that could be vulnerable to attack. BSIT8 explains:

> As soon as you start doing more complex things, blockchain technology is not at a place that can handle lots of complexity. It's not a place where, for example, it's on the web for users to access. So, when we are building our project we have a lot of different technology layers, there's a blockchain that's the base, but then we also have a Java layer. So, we have blockchain, Java and Angular. Angular to be the front end. Blockchain isn't taken care of all the layers, and it's not even taken care of all the information. There is some information that we don't want on the blockchain: like someone's social security number, some

> private information and that's not on a blockchain for a good reason. I believe in the real world, with the exception of a pure Bitcoin, blockchain has many other layers around it…When you track the fraud on the blockchain, are you checking for fraud on just the blockchain or the outside part of blockchain: Java or Angular? If it is just on the blockchain part, I don't know how to check for fraud for that. (BSIT8)

This hands-on experience by BSIT8 reveals that BCT is not a standalone system that is carved in stone and that the technology cannot handle complex transactions. This novel idea reveals that BCT is not suitable for complex operations and tracking of fraud could be somehow difficult thereby exposing the network's vulnerabilities to fraud via the associated systems. Since BCT cannot operate in an isolation as an underlying technology, some writers (Bashir, 2018; Karajovic et al., 2019; Marvin, 2017) have said that it is the vulnerability of other technologies attached to BCT that were exploited in the DAO and Coinbase hacks, thus, the concern of BSIT8 appears to be valid. It may be difficult to check for fraud in a BCT because of other technologies connected to it.

BSIT7 notes that the distributed nature of BCT gives every node a chance to confirm that a transaction adheres to the network rules or protocol before it is added to the chain. This process is the preventive mechanism to ensure that inaccurate data is not added. However, BSIT7 asserts: "Detection, theoretically, if everything got added that was accurate, there wouldn't be much detection because everything added was like the perfect preventative control. If only things that can be added are 100% accurate then you don't really have to detect any errors because everything else has to be prevented upfront." Prevention of fraud would be easier where all nodes comply with BCT rules and protocols. This view is similar to the remark by Marvin (2017) that BCT is hackable where the technology is not used for its intended purposes.

It can be construed that the BCT fraud prevention and detection mechanism can only function optimally where all parties or nodes comply with the established rules. Compliance with established rules governs the effectiveness of any IT system and since BCT is not an exception, it, therefore, means that there is not much difference between BCT and any traditional database system regarding fraud detection mechanism.

From the BSIT group's perspective, BCT can easily detect fraud or anomalies but cannot prevent fraud. This detection mechanism also works optimally where all nodes play by the rules. The human element has been described as the weakest link in any IT system. BCT or any underlying technology in an IT environment can work as programmed where there is no compromise by the human element because there is little or nothing technology can do to remedy this weakest link. Bănărescu (2015) identified both human and technical factors as important determinants of the effectiveness of any fraud prevention and detection mechanisms. The view of most of the BSIT group is based on their blockchain cryptocurrency operations and the general features of BCT because, as noted in the previous chapter, the technology has not yet been deployed for financial accounting and reporting systems (see Chapter 6, Section 6.4).

7.2.2 BCT Security System for Fraud and Anomalies – Audit and Assurance Firms' (AAF) View

The majority of the participants in the Big 4 firms state that BCT cannot prevent or detect fraudulent transactions or anomalies. The technology is said to have no mechanism to prevent, detect or understand fraudulent transactions. This view contradicts the position of Peters and Panayi (2016) that BCT has an inbuilt cryptographic security mechanism that can prevent anomalies/frauds and ensure data integrity. Most in the AAF group took the opposite view of the BSIT group. Technology in itself cannot prevent anomalies or fraud, this appeared to be the position of the AAF group, but a few participants still believe BCT can make the detection of fraud easier. AAF7 explains:

> The blockchain system itself has zero ability to prevent, see or understand fraud. It depends on which kind of blockchain you implement. If it's one that's an enterprise which is like Walmart's example that's not public, there's really no ability for fraud to be detected by the blockchain itself. You would just have to be using normal kind of analytics to look at transactions and see if there was potential for fraud…Blockchain itself as [a] technology has zero ability to detect fraud. It's just that when multiple people have the same piece of information, and one doesn't well there might be something wrong with that one but it's not the blockchain itself that notices that is the way I guess I would put it. (AAF7)

BCT is said to be incapable of preventing fraud on its own because the distributed ledger only enables participants to see transactions and possibly spot any anomalies arising therein, particularly in the Bitcoin blockchain. To detect fraud, there will be a need to employ other data analytic tools for fraud detection in a BCT environment. Arguably, there is insufficient information as to how this will work in practice because BCT is not yet deployed for full financial reporting and accounting purposes.

AAF5 notes that all BCT does is confirm that a transaction occurs, but it cannot prevent fraud. Fraud usually takes place with the recording of the actual cost or value of transactions and parties in any transaction could still commit fraud with the value of transactions or services in a BCT environment. S/He suggest: "All blockchain does is confirm that a transaction occurred, still, nothing stopping you from skimming on the top of it." AAF5 further explains:

> By the very nature, blockchain is entirely defraudable. It is simply that you have to make the cost of defrauding higher than the value of the outcome that you're going to get by providing rewards for people to effectively undertake a proof which uses naturally computing power or some other voting mechanism, which again is designed to correct costs in the system and ensure that you don't flood it with fraudulent votes by one bad actor. (AAF5)

The view of AAF5 is in line with the position of Schmitz and Leoni (2019), who observe that BCT cannot determine whether a transaction is fraudulent or not. Similarly, AAF2 asserts: "Blockchains are not going to prevent fraud, nor will they make detection much easier. There's this mistake people make, they say blockchain is secure. Technologies are never secure. It's the system that is secure, not the technology." S/He notes that a blockchain provides a write-only transaction and despite it being difficult to change the BCT transaction log, malicious actors can attack other parts of the system. Rückeshäuser (2017) also note that BCT cannot prevent fraudulent transactions. AAF2 states that security is an attribute of a system and not of the individual technologies that are used to make the solution. S/He highlights that despite the immutability of BCT transactions, many frauds in BCT and cryptocurrencies were not from changing the ledger. AAF2 sums up:

> It would be very dubious if someone claims that deploying a blockchain would solve your fraud problem. You might be able to do it in a way that helps because you can get better view of transaction histories, but then there's likely cheaper ways to do the same thing, and even then, it's only part of the overall solution…. Criminals are very creative, and you've got to remember that when you're talking about fraud and money laundering and stuff, you don't need

> higher returns to use it. Transaction "fees" for money laundering are around 30% of the money on the way through, and 30% is actually quite good. This means that criminals will do things like give someone 1000 bucks, and say go play the pokies for the night and bring back what's left. Even if they lose a third of it, they don't care. (AAF2)

From the available literature, frauds reported to have taken place in a BCT environment are not from changing of records or making the technology less transparent, they were from attacking other parts of the technology connected to the blockchain. In light of this, it could be argued that the BCT solution is unlikely to prevent fraudulent activities. It could also be said that because the data is recorded on BCT does not imply that the data is accurate or correct.

Contrarily, AAF6 thinks BCT can detect anomalies subject to how well the protocols are written, but where the design is flawed it will be difficult for the technology to determine whether items recorded are legally correct or valid. AAF4 specifically notes that fraud could be easily detected in a public blockchain, "I think with a public blockchain, it will be way easier to detect fraudulent blockchains. And even if a company does any fraud on a blockchain because it's immutable, it will be easier to track those transactions because you can't delete it." The immutability of transactions in a BCT is useful but it is insufficient in a well-conceived management fraud. Rückeshäuser (2017) pointed out that management can still perpetrate fraud by overriding controls in a BCT environment. Like the BSIT group, AAF4 and AAF6 also believe it is a lot easier to identify infractions in a BCT system.

Overall, the majority of the interviewees from the Big 4 accounting firms (AAF group) insist that BCT can neither prevent nor detect financial fraud.

7.2.3 BCT Security System for Fraud and Anomalies – Accountants and Auditors' (AAD) View

As mentioned in the introduction to this chapter, it is difficult to ascertain the effectiveness of fraud prevention and detection of any technology in practice. The AAD group (who were accounting professional from non-Big 4 firms) thought it is too early to determine the effectiveness of the BCT prevention and detection mechanism. The technology will be evaluated when there is a higher adoption of it. They further believed that BCT on its own cannot prevent fraud arising from collusion, related party transactions and wash trading. A common view amongst the

AAD group interviewees was that BCT has no answer to vulnerabilities due to interference from the human element. Ferris (2018) acknowledges that BCT is ineffective against collusion and financial statements fraud. However, the accounting firm, Deloitte reported that BCT will not only reduce the risk of errors and fraud but will also enhance efficiency and productivity (Deloitte, 2016b).

AAD1 states despite that a transaction recorded in a BCT is difficult or almost impossible to reverse, the technology in itself cannot prevent fraudulent transactions. S/He states: "No, Not on its own. There is no system that can single-handedly do anything without human involvement and human intervention. It is not going to be the first kind of fraud detection system." Pereira et al. (2019) claim that the risk of fraud in a BCT system is high since the technology is said to be trustless.

AAD1 went on to explain that there are many fraud detection systems in the market and all they could do based on their configuration is to trigger an alert if any anomalies are discovered. The system is not going to take any further action and that is where the human element gets involved. S/He suggests that when the breach happens, "Someone needs to check the system, audit the system and check that the system is configured correctly and behaving properly." Similarly, AAD5 also thinks the human element could override the fraud mechanism in a BCT, "I have always thought that no matter how secure you get a system it always depends on the people and the people are the weakest link normally." S/He further notes that the BCT distributed ledger could be its weakest point because sharing of information across nodes may open up the possibility to steal, misuse or tamper with such information. Contrarily, Deloitte (2016b) notes that in an insurance company where claims and customers' information including identity management are stored in a BCT, the technology will not only prevent fraud but reduce the incidence of fraud.

AAD6 pointed out that it is too early to determine the effectiveness of BCT fraud prevention and detection systems.

> It is still very much being sorted through and learned through and because there are no standards yet for it. It's very early yet and it's trial and error, we're still finding where the line in the sand is what can we rely on and what can we not rely on and then what are we going to do about the things that we can't rely

> on and how do we enhance the foundational capability that it has, so that the auditor walks away with what they need in order to test whatever they're attesting to. (AAD6)

AAD5 supports the argument of AAD6, “if there's a massive explosion of blockchain technology, only then we can evaluate the security features and I think it may be vulnerable once that happens.” The point made by AAD5 and AAD6 corresponds with the position of the Financial Stability Oversight Council (FSOC) 2016 report which observed that operational vulnerabilities of blockchain cannot be predicted with certainty until the technology is adopted on a large commercial scale (FSOC, 2016). A lot still needs to be learned before it will be safe to determine what BCT could prevent once it is deployed (beyond cryptocurrency operations) on a commercial scale.

However, AAD2 thinks that anyone who committed fraud on BCT could easily be identified. S/He narrates: “Well, I say this, that anybody who commits nefarious fraudulent transactions on a blockchain is an idiot. For this simple reason that what you're doing is documented forever on the blockchain.” AAD3 believes BCT can easily detect anomalies when compared with the existing traditional payment system but acknowledges that her/his claim depends on the users’ trust and full implementation of the technology.

> Well based on my knowledge, they're much more effective and they're much more timely in detecting those anomalies than traditional mediums of payment and audit processes. But again, until they're fully implemented, and people understand them and trust them there's always going to be questions and when there're questions then people start talking about security. (AAD3)

7.2.4 BCT Security System for Fraud and Anomalies – Academics’ (ACA) View

A variety of perspectives were expressed by the ACA group concerning the effectiveness of BCT in fraud prevention and detection. Some argued that BCT cannot detect all frauds, while others believe that the technology can stop fraudulent activities. Wang and Kogan (2018) note that BCT facilitates the identification of fraud in real-time, but the technology cannot eliminate financial fraud. The ACA group gave examples of deceit and malware embedded in a wallet as types of fraud that can happen in a BCT environment. They also believe that the human element has a greater impact on the effectiveness of BCT fraud mechanisms.

ACA1 believes that BCT may not be able to detect everything, and the technology should not be seen as a solution to everything. S/He notes that BCT cannot stop someone hacking the network and emphasis should be on the people that are using the technology. ACA1 states:

> Blockchain technology per se is not able to detect everything because I'm seen the technology has some history of records that actually is becoming more and more solid over time. But it's really important which people are using this technology, because every technology, I can see emerging technology has its own drawbacks…. Basically, I also see, obviously, some sort of hack for every technology doesn't matter which technology we're using, and I think the blockchain is no exception. So, we need to be careful about not just some sort of thinking about technology as a final solution for everything. (ACA1)"

Strengthening ACA1's view, ACA4 acknowledged that the Bitcoin system has a mechanism to detect anomalies to a limited degree and BCT immutability cannot totally stop the ledger from being changed but it makes it more difficult. ACA4 explains:

> To a degree the Bitcoin system has some of these functions built into the software code, so, it detects anomalies to a limited degree, but where deceit has been identified or attacks have occurred on chains, the protocol has built into sub-protocols that allow for change to be cancelled and checked those transactions reprocessed.… Unlike an accounting system where you would then have a ledger note, you don't get that on a Bitcoin. Clearly, there's a similarity between a general ledger which is, you're not supposed to be able to rewrite a general ledger or otherwise we end up with another Enron. So, we can change the ledger to that extent the blockchain is similar. It's immutable to a degree that you can change blockchain data, it's just hard. So, like I said at the beginning, there are certain ideas that are off-cuff and base on generally held attitudes. But then again, most people that are writing papers about blockchains have never really dug down deep inside the software to see how it actually works. So, and as I said there are a lot of software flaws. (ACA4)

The participants' view that transactions on the BCT ledger could be changed despite the claim that it is immutable contradict the position of some scholars (Pereira et al., 2019; Steinmetz, 2018) who asserted that records on BCT are permanent and unchangeable. No technology has 100% impenetrable fraud prevention and detection mechanisms including BCT (Banerjee et al., 2018; Oladejo & Jack, 2020). This contradiction could be, as suggested by ACA4, is that many writers do not understand the technicalities of BCT software. This finding is consistent with that of Centobelli et al. (2021) who assert that “accounting professionals and academic researchers are unaware about blockchain concepts and infrastructure.”

In contrast, ACA2 notes that decentralisation and distribution of data to many nodes will not only keep the data secure but will prevent hackers from attacking the network. Similarly, ACA3 believes that BCT fraud prevention and detection is effective because modification or manipulation of transactions is impossible unless a party controls the majority of computing power. Appelbaum and Smith (2018) claim that anomalies or alterations of the BCT ledger can easily be detected because the technology facilitates real-time verification and communication of information. However, ACA2 went on to acknowledge that fraudulent transactions are possible in a BCT because technology is a creation of man and chances are there for BCT to be broken, attacked, decrypted, and misused but not as easily as other existing technologies. ACA1 said: “We can reduce the amount of fraud, we can have some preventive actions by this technology, but at the end of the day it is really important, which people are using that, and how they are using that.” However, despite the benefits of decentralisation and distribution in BCT, the network has suffered from a barrage of attacks which has led to the loss of millions of dollars. The academic group also noted the effectiveness of the BCT security system depends on the human element.

ACA5 believes that the real reason people are interested in BCT, is that it will have an enormous impact on the degree of fraud with its inbuilt fraud mechanism that compels people to tell the truth, and prevent backdating or manipulation of data. Even if one claims that data is more secure in a BCT, the problem is that nobody knows how much fraud is out there and it is almost impossible to validate this claim, says ACA5. S/He elucidates:

> So, I think it's a purely theoretical argument that there's enormous opportunity to reduce fraud, in my opinion, but to validate this empirically is going to be a huge challenge. And I think it's probably going to rely on things like simulations where people deliberately commit fraud and we see how many we can catch with technology A and technology B. But these kinds of experiments are always somewhat artificial because, in the end, nothing's really at stake, you know that they're just games. So, like a lot of things in experimental economics, it's not clear that we can really rely upon them in real life, and it’ll keep academics busy though for a long time. It’s a debate that will not go away

> anytime soon. (ACA5)

It may be difficult in practice to determine how effective the fraud mechanisms in BCT are because there will not be any real live data to test it. As noted by ACA5, no one can accurately predict the amount of fraud. Succinctly, Cai and Zhu (2016) note "even if the fraudulent input is successfully identified, we may still not be able to access the truth and make the right decision (p.2)". It could also be argued that, like other software with an embedded fraud detection system, the effectiveness of the BCT fraud system will remain a theoretical conjecture based on its general features and not on real value.

7.2.5 BCT Security System against Fraud and Anomalies – Accounting Regulatory Bodies' (ARB) View

The accounting regulators' views are broadly divided into two: some think BCT cannot prevent fraud and others believe the technology has the potential to reduce or eliminate fraud. Participants from the ARB group believe that, besides the human capability to tinker with any technology, there are no use cases yet to prove the effectiveness of BCT fraud mechanisms.

ARB2 believes BCT does not prevent fraud because if a bad actor can convince the network that a transaction is legitimate and the nodes operating in that network validate the transaction that means a fraudulent transaction has entered the system. S/He notes that BCT can be a useful tool for the detection of infractions due to the technology's feature of transparency and immutability. ARB2 explains:

> What blockchain can do is, however, basically because it's immutable so all the transactions are attached to the blockchain. What blockchain might do is to be a bit of a mitigating tool because everyone knows that fraud will be made transparent on the blockchain and you can't make it go away. You can't just simply delete it…. I think blockchain does certainly not prevent fraud from happening in the first place. The fraudulent transaction can still make it onto the blockchain. (ARB2)

Likewise, ARB6 believes that BCT is very effective in dealing with inefficiency, but when it comes to dealing with wilful fraud, there is a need to have both human and technology mechanisms because people will always find a way to breach any system. S/He says it is incorrect to think that BCT prevent and detect all anomalies, particularly where human beings are involved. ARB6 asserts:

> I think what I would say, in that context is that it's very seductive, it's very alluring it's very tempting to think of blockchain and say it's going to solve the problem, all this crap that we deal with in our world where things get stolen, wrong records, people make mistakes, there's dishonesty, corruption, wrong information is used deliberately or accidentally, it will just solve all that is lovely to think that, but it's just not true. There are a couple of things. …Human beings are still in the picture, and they can still game the system, and there has to be a level of safeguards above that to deal with that problem. (ARB6)

ARB4 stresses: “People are ultimately usually the weakest link, and those kinds of roles will continue basically, no matter what kind of system you build, unfortunately.” This view aligned with Nickerson (2019), who notes that the chief factors that could affect BCT fraud prevention and detection mechanisms are human errors and technical factors. It could be deduced from the views of these accounting regulators that the reliability of BCT fraud mechanisms depends on the actors or nodes in that network because the technology can still be defrauded. The BCT fraud mechanism could be breached by individuals with a window of opportunity, pressure and justification (Nickerson, 2019). Therefore, it will require the combined efforts of humans and technology to tackle fraud in a BCT environment.

However, ARB5 believes that BCT will reduce or eliminate fraud because transactions cannot be modified, but acknowledges that there is no use case to prove this yet. S/He explains:

> I think blockchain can reduce or eliminate fraud. Like we've said earlier, once a transaction is on the blockchain, it's immutable, it can't be changed. So, someone can't go and like with a paper record, or even the way things are recorded at the moment, are more easily able to be manipulated. The fact that a blockchain transaction once it's on here, it's done and dusted immutable. So that's got to have massive benefits in terms of fraud prevention, but it's just about actually getting any use case. It has actually been used for that to be able to have happened. IARB5)

Similar to ARB5’s view, ARB3 believes the BCT fraud prevention and detection systems are effective because the technology will provide one version of a distributed ledger that is transparent and immutable for all participants. Using the same theoretical lens, Chopra et al. (2019) insisted that duplication or modification of previous records on BCT is infeasible mathematically and technologically because transactions are hashed and cryptographically secured. Contrary to the view of Chopra et al and others, the 2019 hack of the blockchain ledger, where a hacker not only stole over US$1 million of Ethereum Classic Coins but also rewrote the BCT ledger, proves that double-spending and modification of the BCT permanent ledger are possible (Brandom, 2019).

The view that records in BCT cannot be modified give rise to the assumption that the technology can prevent and detect fraud. However, this assumption may not be completely valid. BCT on its own may not be able to identify a genuine transaction from fraudulent or erroneous ones, and where the human element is compromised in the process, the immutable, transparent or cryptography security features in the technology may be vulnerable. However, it has been also argued that the BCT features may help regulators or auditors spot such anomalies because they cannot be erased. These are hypotheses that require empirical validation because there are no use cases to prove this feature. Currently, the BCT use cases are few outside the cryptocurrency operations and even with this, the technology cannot prevent or stop fraud as projected (Brandom, 2019; Nickerson, 2019). Different frauds have been reported concerning crypto operations: the DAO hack in 2016, the Coinbase attack in 2021 and a host of others. Bradbury (2016) notes that the DAO hack revealed that it is impossible to have complex applications with zero bugs or glitches.

7.2.6 BCT Security System for Fraud and Anomalies – Financial Analysts and Other Experts' (FAE) View

The FAE group considers that BCT will help with the detection of fraud or anomalies. A few of them believe that the technology is good but not flawless. These experts also hinted that the human element can undermine the effectiveness of BCT fraud systems.

FAE2 believes that BCT can help prevent fraudulent transactions but the technology is much stronger in the detection of anomalies, “I think their main thing is the detection side, the prevention is not as thick because humans will always find a way around the system.” S/He further believes the BCT fraud detection mechanism could help internal audit teams, lawyers and those in assurance roles that investigate fraud, to either prove a case or to build a case. FAE2 acknowledges that it is possible to find a common element in fraudulent behaviour that is being enabled or disabled by blockchain, but s/he thinks because BCT is its infancy, predicting such patterns and establishing how widespread such anomalies are, may be difficult. FAE3 clarifies:

> The big one is the fact that everyone can see every transaction on the nodes. The distributed decision-making process, shared database, difficulty in changing something in the accounting system and that a set of default triggers are going through in the blockchain and they're being watched by multiple entities it is very difficult. Unless everyone on it or at least more than half, and even if it's more than half I think it can be very tricky to try to change it so that the other nodes wouldn't be able to tell something happened. That fear is in the place where if you had that system you might have been able to prevent frauds like Bernie Madoff or whatever. (FAE3)

However, FAE 5 observes that the BCT fraud mechanisms are good but not flawless because there has been fraud committed in blockchain cryptocurrency. FAE4 does not think the immutability of BCT is enough to validate the genuineness of transactions on the network and records on BCT can be changed. S/He also doubts whether the assertion by many people that BCT is relatively secure today will be valid in the near future particularly as computing power and AI gain momentum. The record on BCT can be changed and this has been proved by the hacking of Ethereum Classic coins and subsequently re-writing of the so-called blockchain permanent ledger by hackers. FAE4 notes:

> The blockchain is sort of "guaranteeing" the information once it's into the blockchain, but it doesn't guarantee that its authentic information going in. So yes, you may have to have guardians at either end and trusted sources that you use to make sure that that's going in. Of course, once the data is in there, yes, it is. It's not immutable, it can be changed, but it can only be changed by creating a new record and the record is kept up to that change. (FAE4)

The arguments are the same among the participants for or against the effectiveness of BCT in the prevention and detection of fraud or anomalies. The BCT enthusiasts claim that BCT's features such as a shared database, transparency, cryptographic and immutable records will make the identification of fraud or anomalies much easier. They also acknowledged that this also depends on the actors on the BTC network because the technology could be breached through collusion or acquisition of more than 51% of the computing power. Some BCT critics argue that despite these BCT general features, frauds are still being perpetrated in blockchain cryptocurrency operations. The Squid Game fraud involving US$3.38 million

(£2.48m) in crypto currencies was exposed (BBC, 2021). The majority of the participants believe that BCT in itself can neither prevent nor detect fraud or anomalies on its own. It will take the combination of human and technology efforts to reduce, prevent or detect anomalies in a BCT environment. It was noted that tracking fraud may be cumbersome because BCT cannot operate in isolation and the technology is not well suited to complex operations. The next section discusses some types of financial fraud that BCT is not capable of preventing or detecting.

7.3 Possible Fraudulent Transactions in a BCT Environment

Fraud is a global problem that affects organisations, governments, and people alike. Mass digitalisation has led to an exponential increase in fraud across various fields in 2020 totalling over US$14.8 billion (Arkose Lab, 2021). This was partly caused by the mass lockdown prompted by the COVID-19 pandemic. Montesdeoca et al. (2019) note before the major accounting scandals that rocked the likes of Enron and WorldCom, the world was seeking honest business information. BCT is envisaged as a platform to facilitate transparent business information for all stakeholders, thereby stemming the tide of fraud that is causing huge losses to the world economy. This assertion has caused BCT to attract huge investment and research interest from many organisations, governments, and regulators, including the Big 4 accounting firms (see Chapter 3, Section 3.5). However, the study's previous section (Section 7, Section 7.2) has established that BCT cannot prevent or detect all types of fraud.

Participants were asked to highlight the likely anomalies or fraud that could take place in a BCT environment. The interviewees highlighted several possible anomalies and fraud that BCT security architecture is unlikely to prevent or detect. The major financial fraud identified include falsification of reports, manipulation of internal controls, wash trading, related party transactions, collusion, malware, deceit, and money laundering.

It is important to note, that despite the views of the participants being classified into sub-themes, the group's views regarding possible fraudulent transactions in a BCT environment overlapped. For example, falsification of the report could be due to the manipulation of internal controls. Additionally, not all the interviewees were able to provide an opinion on this issue as some considered it too technical. Consequently, some groups' views were merged to aid analysis and discussion. The identified financial frauds are discussed in the following subsections.

7.3.1 Falsification of Reports – Blockchain Start-ups and IT Experts' (BSIT) View

The BSIT group suggested that where BCT is used to store financial information, all types of fraud going on in the traditional databases could happen. They include falsification of reports, hacking, stealing of people's keys with a keylogger and transaction manipulation as possible fraudulent activities that could be committed on BCT.

BSIT1 believes that there is transparency in utilising the BCT public ledger for storing financial information because customers or any interested parties could see that the transactions occur. Cai and Zhu (2016) note that BCT can guarantee the accuracy of stored information with its P2P network and cryptography algorithms. However, some participants argued that fraud can still be perpetrated in a BCT despite transactions meeting the rules. BSIT9 notes that BCT cannot determine whether transactions are fraudulent or not in as much as such transactions do not invalidate any rules or protocols on the network. BSIT9 explains:

> Blockchains are arbiters of trust. So, anything you put in there can be incorrect. …They have rules but assuming that the transaction meets those rules, it doesn't know whether it's fraud or not so you can easily conduct fraud on a blockchain system as long as it's not a fraud that's tried to invalidate those rules in which the system is designed. (BSIT9)

BSIT9 supported this argument with examples of fraud arising from ICO scams, hacking, and stealing keys with a keylogger, but s/he noted that BCT is at its infancy and there is an ongoing improvement. S/He suggests: "Right now, it's immature and the blockchain ecosystem is rife with scandals, vagabonds, and fraudsters. But, things are changing, it's a lot better than it was two or three years ago and it'll continue to change." Similarly, BSIT1 states that developers can manipulate transactions and software in a BCT system.

Similarly, BSIT8 observed that their firm is using Proof of Authority as a BCT protocol that involves a human element. S/He notes that if someone steals someone's password or private keys and then authorises a transaction for an organisation, there is nothing much BCT can do about that. The technology does not know the difference between a genuine owner of private keys and a hacker. BSIT8 notes that most organisations will likely use Blockchain as a Service (BaaS) because of the huge cost and technical complexity involved in building and maintaining an in-house blockchain. S/He strongly believes that the effectiveness of BCT fraud prevention and detection using BaaS depends on the human factor. BSIT8 believes that where a BaaS firm has bad actors with the intent of defrauding the users, BCT cannot prevent or stop that, as that is not a technology issue but a human problem. Notwithstanding the complexity of any fraud prevention system, it is the human factor that determines the success or failure of such a system (Bănărescu, 2015). BSIT8 clarifies:

> …Blockchain as a Service company had a bad actor in it, and they created an update that had a backdoor in it. Theoretically, our company needs to check for that, but it's a little bit like your iPhone, how many people who get an update on their iPhone check the code to make sure it’s working properly. What do we do, we just go update straight because we trust Apple is looking out for our best interest to be secure. It is possible to have a blockchain that only a company were to control, but quite honestly, I don't see that being efficient to roll out. It would just be too expensive right now. … I think it would happen and the most damage would happen in a Blockchain as a Service. It's not blockchain, it's not the technology of blockchain, but someone could create an update that would put a bait. It's a human problem. (BSIT8)

7.3.2 Manipulation of Internal Controls – Audit and Assurance Firms’ (AAF) ‘View

The AAF group mentioned that manipulation of BCT control systems may be difficult, but the adoption of the technology will not provide a bulletproof system because it is still possible to commit fraud. AAF2 could be taken as the representative view:

> I don’t think manipulating the actual blockchain system, of course, we are not, but there will always be ways to do it. I don't think you're going to get a bulletproof system with the adoption of blockchain…. No, you're not going to eliminate the risk of fraud with blockchain. (AAF2)

This view was echoed by BSIT11 who believed there could be the possibility of transaction manipulation in a BCT environment. Swan (2015b) pointed out that BCT cryptography is penetrable by hackers. However, Rakshit et al. (2022) hold a contrary view. The author suggest that BCT can mitigate the occurrence of fraudulent transactions because blockchain ledgers are shared and immutable

(Rakshit et al., 2022). The recent hacking report (see Brandom, 2019) revealed that the blockchain security mechanism cannot stop hackers from accessing the BCT ledger and tampering with the immutable BCT transactions.

AAF6 expressed the same concern as some participants in the BSIT group by emphasising the role of the human element in the BCT control environment. S/He explains:

> The technology will record and detect stuff depending on the protocols that are written, so it comes down to how well those protocols are written…. If you have the right protocols in the right place, I think from a fraud perspective, internal and external control environment and we got to look at the control environment versus the business detective controls. If anything happens you can screw up your controls, take the human element out of it to some extent, but from a technical perspective, you can add another layer. If these transactions flag the loan limits you can pick them up straight away rather than down the track, so it means you can identify things a lot faster. (AAF6)

AAF6 suggested that, on a technical level, a protective layer could be added to BCT, but the human element remains the major threat that can undermine any controls in a BCT environment. Peters and Panayi (2016) expressed concern about the BCT irreversibility of transaction structure and suggest the need for protocols in the financial procedures to mitigate against human errors by the programmers and hackers exploiting vulnerabilities in the financial code.

7.3.3 Related Party Transaction and Collusion – Accountants and Auditors' (AAD) and Accounting Regulatory Bodies' (ARB) Views

The participants also recognise that with collusion BCT fraud prevention and detection mechanisms could be circumvented. AAD6 also notes that the immutability of transactions in a BCT cannot provide sufficient evidence of a transaction, particularly in a related parties transaction, "So, just because transactions are locked down and immutable, doesn't mean that they are evidenced like related parties, or that someone really exists or something really exists." M. Xu et al. (2019) consider that despite the BCT encryption system hacking of data is still possible. However, Friedlmaier et al. (2018) believe that the BCT database is less vulnerable to hacking, because hackers will need to manipulate the entire distributed architectural system.

AAD4 thinks it is difficult for one person to erase a transaction in a BCT unless it is done in collusion with others. Despite the position of some participants that it is hard to commit fraud in a BCT environment, AAD2 suggested that frauds have been committed in BCT and smart contract many times. S/He clarifies:

> "There's plenty of things through smart contracts and transactions where blockchains have been hacked and there're plenty of examples of fraud that have gone on related to blockchains…. If someone is able to manipulate smart contracts, not just through re-entrancy and race conditions, but through other vectors. There is a lot of opportunity for fraud and then of course there are opportunities in the ecosystem for fraud where you know by getting your private key off of an exchange, I can take or steal your money from you on the blockchain and you can't and no one can do anything about it. (AAD2)

A common view among the participants in the AAD group was that BCT cannot prevent financial fraud. BCT can make a ledger tamper-proof but financial fraud can still take place because it involves many other elements beyond what a machine can cater for, such as collusion and related party transactions. Schmitz and Leoni (2019) believe that BCT has a limited capacity to detect fraud, but contrarily, BCT has inbuilt algorithm security that can reject any malicious attempt to defraud the network system (Swan, 2015b). The AAD group identified front-running, wash trading, re-entrancy, and race conditions as other common fraud in a BCT environment.

In support of the position of accountants and auditors, the ARB group also believed that the BCT network cannot stop fraud arising from the collusion of actors in the technology network. ARB3 suggests that fraud is possible in a BCT system through collusion, "I would think that the only time that you could really commit fraud is all the parties in the transaction are all colluding at the same time." Blockchain cannot detect fraud from collusion (Nickerson, 2019).

7.3.4 Malware and Deceit – Academics' (ACA) View

ACA4 notes that Ethereum proof of stake opens the potential floodgates for fraud and deceitful practices and transactions are being retracted because of this. S/He further states that people are constantly trying to find ways to create fraudulent transactions on cryptos as they are with any other financial system. S/He cited examples of hacking into New Zealand Cryptopia and Binance. ACA4 sees malware embedded into wallets as a threat.

> There're many examples of cryptos being hacked, or coins being stolen or fraudulent transactions going through or double-spending. There're lots and lots of examples. I think one of the biggest threats is in wallets, coin wallets and Malware that's also embedded in wallets." (ACA4)

The effectiveness of BCT fraud prevention and detection is said to depend on the human element in the technology ecosystem. It is also said that types of fraud that could take place in a BCT environment include re-entrancy, race conditions, malware embedded in wallets, fork, front running, and wash trading, amongst others. The participants believe that BCT cannot prevent or detect fraud arising from collusion, deceit, and related party transactions. This view is corroborated by Bradbury (2015), who believes BCT cannot detect deceit and Yeoh (2017), who maintain that blockchain cannot prevent fraud executed by collusion orchestrated by the majority of nodes in the network.

The issue is that neither the enthusiasts nor the sceptics have seen BCT used for a complete financial reporting and accounting system. The participants' epistemological claim is based on interactions with blockchain-enabled supply chain, transport documentation and crypto operations as well as the general features of BCT. As AICPA (2020) state: "Because blockchain is a relatively new technology, service auditors may have limited experience with how blockchain works (p.3)." To further understand the efficacy of the BCT fraud prevention and detection system, the participants were asked about the impact of GIGO on the technology.

7.4 Impact of Garbage In Garbage Out (GIGO) on BCT Fraud Prevention and Detection Mechanism

GIGO is a popular acronym that denotes that bad input will lead to bad output. Some writers (Swan, 2015b; Zhao et al., 2016) have postulated that as part of the likely disruption associated with BCT is the technology's capacity to significantly reduce, eliminate, prevent and detect fraud because transactions are transparent, distributed among participants and cryptographically secured as well as immutable. BCT is promoted as a one-stop solution to everything that will disrupt accountants' and auditors' functions. Some BCT critics held a contrary view that the technology itself cannot prevent fraud. Frederik (2020) suggests that BCT as a database is not an independent system that neither guarantees the accuracy of data nor can stop unauthorised transactions, where entries are garbage in, the technology will garbage it out. Similarly, Cai and Zhu (2016) suggest that despite the immutability and permanence of records on BCT, there is no assurance that information stored on it is correct or reliable. The study engaged with the participants to understand their views on the implication of GIGO on BCT fraud prevention mechanisms.

The findings from most of the practitioners and academics in this study show that the BCT fraud mechanism has no solution for the effect of GIGO. This view is corroborated by some scholars (Ferris, 2018), who believe that BCT cannot stop fraud arising from garbage information into the network and Frederik (2020), who asserts that BCT is like any other technology and blockchain will garbage out information based on garbage in data. A few of the participants still insist that GIGO cannot occur in a BCT because the technology will not allow garbage entries into it. The views of the interviewed practitioners and academics are analysed according to their groupings.

7.4.1 Blockchain Start-ups and IT Experts' (BSIT) View

The BSIT group consider that GIGO has the same implications for BCT as any other IT system. The majority of the blockchain start-ups believed once the entries are faulty, the output will be faulty in a BCT network. This view is similar to Nickerson (2019), who claims that "if you have the authority to input bad data, then the blockchain will validate the bad data (p.32)." However, a few of the participants thought there is no room for garbage entries into BCT because the technology is capable of preventing that.

BSIT8 notes that a blockchain is a system similar to any other system where the transaction data that comes out of the system is only good as the data that goes into it. Similarly, BSIT3 believes that BCT is affected by GIGO and highlights that the focus should be on the prevention of the garbage in a BCT. S/He further observes that the existing approach relies on garbage out for the identification of fraud. BSIT2 elucidates:

> I think garbage in, garbage out that's true in today's systems as well. One of the things I look at when I think about blockchain is in this context, in particular, is the immutability and then the immediacy of transactions especially if we think about like monetary fraud. If I move money, and I

> incorrectly pay a fraudster, it's not like our existing ACH [23] wire system where I have like a day effectively to stop it, it's moved and within the next few seconds, it could be moved again and again and again and again. By the time I've detected it later, that's gone. So, from a timing standpoint, I look at that and I say when you commit you better make sure that you're ready to commit that transaction and that it's passed all validations. (BSIT2)

BSIT2 compared the implication of GIGO from the perspective of a cryptocurrency operation and the existing centralised banking system if a customer makes a wrong entry, there is a time lag to recall such the entry. However, this is unlikely in a BCT crypto-driven system. No wonder, BSIT2 concluded that it is important to exercise restraint before entering into a blockchain. The need to focus on the prevention of garbage entry as suggested by BSIT3 is also important because the immutability of transactions in a BCT could make it difficult to correct genuine accounting entry.

However, BSIT7 and BSIT10 think GIGO is not possible in a public blockchain because such entries will not be validated on the network, but there is a greater risk for when using a private blockchain. They asserted that the BCT governance model will need to be compromised for GIGO to take place. BSIT7 and BSIT10 explain:

> The only way garbage gets in, is if those like miners or stakers, those people governing the network allow it. If it's like a centralised private blockchain, the person that controls that private chain allows that to happen, they allow the garbage to get in. In a decentralized network, it's a lot harder for garbage to get in because there are more players in the network, you'd have to corrupt at least 50% of them or two-thirds of them to get the garbage in. It’s kind of what we were talking about earlier that the preventative nature of the blockchain makes it really valuable. (BSIT7)

> …Garbage in transactions would get rejected and not be approved and validated by a large global public blockchain like Bitcoin. That becomes a bit more complicated when we look at things like private blockchains. We're back to the governance model, who decides what data can go in, or how have you evolved the blockchain and written in code to confirm that the data going in is appropriate and acceptable to the network? So, garbage in, garbage out does exist certainly, but I think private blockchains are at greater risk for garbage in, garbage out. (BSIT10)

BSIT7 further emphasises the importance of the governance of the chain and

[23] Automated clearing house (ACH) is an electronic payments and automated money transfers system between participating financial institutions without using paper checks, wire transfers, credit card networks, or cash.

assumes that if the user or the assurance providers on the network do not let garbage in, there should be no garbage out. S/he notes, “I think it becomes very important to understand how things are added to the chain and how does the network make sure that the people governing the network are altruistic, good and not adding garbage. Basically, it really boils down to governance and how things are added.”

It is much easier to think that GIGO is not possible in a BCT particularly with cryptocurrency operation because the network knows what is in an individual’s wallet. However, unlike crypto operation that could be said to be a linear system, in complex non-linear business systems where transactions are generated by multiple persons or departments, how the BCT network will deal with such multiple entries or garbage transactions are not considered by BSIT7 and BSIT 10 in their views. In such businesses, there are no wallets or fixed amounts attached to nodes or participants, transactions are generated from zero and multiple sources. It may be hard to determine what is garbage in such non-linear business operations by any IT system including BCT.

Nonetheless, the governance of the BCT network is indeed important which goes back to the earlier findings of the influence of the human element concerning the efficacy of the BCT fraud prevention and detection mechanisms. Therefore, it could be argued that GIGO is still possible in a BCT transaction because everything depends on the governance of the network that is under the influence of humans. Nickerson (2019) argues that GIGO is possible in BCT because the technology depends on the human element for data sources and authorisation, that if compromised the entire system can easily be breached.

7.4.2 Audit and Assurance Firms’ (AAF) View

The AAF group consider that BCT is a recording database system and the technology has no mechanism for stopping GIGO. It is unlikely for BCT to get to a situation where it is going to solve the problem of GIGO. This is considered unachievable by the participants from the Big 4 Firms. AAF5 and AAF7 elucidate:

> This absolutely goes to the challenge of data quality. Data quality has been a problem since the start of record-keeping and yet, all that we're doing is we're increasing our ability to increase the volume of garbage that we can process. Blockchain doesn't solve that, it is just a record-keeping application. It increases the places that you've potentially got the code. Having said that, it

> does give you the ability to securely and manage as you spot the data quality issue, to correct the issue, to recognise and reverse the issue in there. I think it shares the same database problems that the rest of us have in almost every data application we tackle. (AAF5)

> The blockchain will record literally anything you tell it to so if you put garbage on it that's all you're going to get out of it. It's no different than any other technology system from that point of view, I'm talking about enterprise blockchains. …. If you've got your processes wrong or you have a smart contract that's written wrong, you're going to have wrong information on the blockchain. There's a 100% probability of garbage in, garbage out if you don't understand the business problem of what you were trying to solve with the technology. (AAF7)

Despite the views that BCT is unlikely to resolve the GIGO conundrum, AAF5 notes that BCT could support the easy identification of errors in data quality. Similarly, AAF7 acknowledges that "You can't get garbage in, garbage out on a public blockchain like Bitcoin." This is also the view of some participants in the BSIT group. The only time the interviewed participants believed garbage-in could occur in a public blockchain is through collusion or when a node control about 51 % of the computing power in a network. So far, there have not been any reported cases of a 51% attack in cryptocurrency operations. It could be difficult to enter incorrect data in Bitcoin because it involves straightforward currency transactions.

AAF4 also thinks BCT will not solve the issue of GIGO and illustrates her/her position with the recent fraud in Germany.

> Did you hear about the Wire Card scandal in Germany? If such a company would create a blockchain system and they say we have every transaction here on the blockchain. If you create one which is garbage in the first place, there will be garbage in the system or it will be shitty system. And so, you still need the auditors to check the blockchain system if it's programmed correctly because the blockchain won't change the issue of garbage in, garbage out. Again, if you do transactions on a public blockchain, I really like public blockchain, then, it will be way easier because you can track every transaction, it will be probably at least easier to find frauds or to detect frauds. (AAF4)

However, AAF1 believes there is a limited chance of GIGO occurring where transactions are between external parties in a BCT. S/He claims:

> ...If you're transacting on the blockchain with someone external to the

> organization, I feel like there's a low risk of garbage in, garbage out, because you've got another party looking, and the other party, from classical economics mantra, this other party you are the buyer and seller, there should be robust negotiation and the terms should be agreed, and had a high level of scrutiny. But if you are talking solely about an internal, within an organization capacity, then I think you're going to have less of that robustness and a higher chance of garbage in, garbage out. (AAF1)

It is possible to prevent garbage entries as claimed by AAF1 in transactions with external parties in a BCT, but this participant appears not to consider that BCT cannot prevent collusion either between internal or external users. This is supported by Malik et al. (2019) that BCT cannot stop the generation and recording of garbage data by the supply chain entities. The position of most participants in the AAF group is that BCT has no mechanism to stop the impact of GIGO.

7.4.3 Accountants and Auditors' (AAD) View

Similar to the position of the AAF group, the AAD group state that the impact of GIGO on BCT is the same as any other existing technology, the technology is not immune from the effect of input determining the output.

AAD5 notes: "I think the garbage in, garbage out, definitely does have an impact just like any other system, blockchain is not immune to it." S/He states that bad transactions can still be recorded into BCT, and fraud can occur for reasons other than just a transaction being recorded accurately. AAD2 illustrates:

> That's a great question and the same effect it has on any other system. I can have a great blockchain and when I told you about lettuce if I am growing lettuce in New Zealand, and shipping it to Walmart or somewhere in Australia or wherever and I say that this lettuce came from Australia and not from New Zealand. The provenance of that lettuce is garbage in, garbage out. It's not right, so clearly not yet. It's the same problem as with any other system, it's only as good as the data that gets put in. (AAD2)

Contrarily, AAD3 claims that there is no room for garbage in entries into BCT because the technology is capable of preventing or detecting them. S/He narrates, "Theoretically, you don't have garbage going in and garbage coming out like you do with the other systems, because those get kicked out in the block before it gets certified. So, we correct that upfront, whereas right now there's no way to correct that in most systems." This proposition by AAD3 might be based on the general features of BCT especially the current setting in a Bitcoin blockchain where miners will not validate any entry that does not meet the network criteria. This theoretical exposition may not generally be applicable in complex business operations with many actors and entities.

7.4.4 Academics' (ACA) View

The view most academics is if incorrect information goes into BCT, the technology will produce incorrect output like any other system. ACA1 sees BCT as a container whose output depends mainly on whatever record is sent inside by the users. This corroborates the view of Frederik (2020) that "The same rules apply for blockchain as for any database: if people put garbage into it, what comes out is also garbage." ACA3 explains:

> When your actual system is garbage, you're going to see the garbage and you are going to exchange garbage data, it is as good as the data that gets into it. Let's say in the financial industry, and you add false data to the blockchain, blockchain is just a technology. You could enable, for example, smart contracts that raise red flags, exclude certain conditions if that specific data gets in. Let's say I report my income as $10,000 while it is a million dollars, the blockchain wouldn't distinguish it, doesn't have to know me because it deals with a certain system and that other system it's kind of connected to as getting that garbage data then it's ended up processing garbage data advertently. (ACA3)

ACA4 thinks that the verification process in a Bitcoin blockchain and other cryptocurrencies should prevent garbage entry into the system because they are designed at a software level to prevent imbalances and bad data from entering their operations. S/He acknowledges that it is still possible to enter erroneous data into a transaction. ACA1 suggests the need to leverage overlapping functions of other technologies such as data analytics and AI to prevent incorrect data in a BCT system. The suggestion by ACA1 may be a possible way to strengthen BCT since all these technologies are still evolving.

7.4.5 Accounting Regulatory Bodies' (ARB) View

All the accounting regulators maintain that BCT has no solution for GIGO and many of them claimed that this view also supported their earlier position that the technology cannot prevent fraud or anomalies. ARB2 reckons:

> Garbage in, garbage out means whatever you feed into the blockchain if it's bad data, you get bad data out, so, the fraud is then on the blockchain which

> means that blockchain does not inherently prevent fraud from happening. If you manage as a bad actor or a fraudulent actor to get a fraudulent transaction onto the blockchain, then they succeeded it's on the blockchain and it can't be removed, eliminated, or changed. I think this garbage in, garbage out perfectly describes how blockchain is not able to fully prevent fraud. (ARB2)

Similarly, ARB6 believes GIGO is applicable in a BCT and further compares the hype of BCT with the adoption of plastic materials as a metal substitute in the 1950s.

> One is there's an issue of garbage in garbage out, so, what you put into the blockchain leaves forever in effect. It's basically like kind of a data form, potentially, if we get this wrong it could be like the data equivalent of plastics in our ocean. When plastics first came in the 1950s everybody thought is beautiful, it's wonderful and it's cheap and it's flexible and you can use them for different things from making a chair to making a spoon. What fantastic material! And now today we're realizing that it's toxic waste all over the place. (ARB6)

Analogously, ARB6 thinks that a few years down the line the world could have created big data/information on BCT without knowing how to archive or dispose of it, thereby opening a window for the malicious use of such unarchived data. The concern here is the incorrect data in BCT is expected to be there forever and what happens to such data in the future. ARB5 was concerned about how errors in a BCT accounting system will be corrected because anything incorrect on a blockchain is permanent. S/He notes: "Once you put something on a blockchain it is permanent, I think garbage in garbage out that's a very real concern because if you put an error into the system and you want to correct it, how you're going to deal with that on a blockchain, I'm not sure how that works." ARB3 concern appears genuine because it is yet unclear how genuine errors will be rectified in a BCT system due to the immutability of records. Biswas and Gupta (2019) think the inability to correct mistakes in a BCT system will be a challenge to users. The envisaged challenge is that it is difficult, if not impossible to edit bad transactions that include mistakes, fraud, and any kind of abuse in a public blockchain because no one person is managing it. It is a double edge sword that has advantages and disadvantages.

The overall view of the ARB group showed that BCT cannot solve the GIGO conundrum and further expressed concern about how to deal with the correction of errors or mistakes. Arguably, whatever is inaccurate in a BCT system becomes cryptically frozen and stuck in the record. This assertion requires evidence since

BCT is yet to be fully employed as financial reporting and accounting system.

7.4.6 Financial Analysts and Other Experts' (FAE) View

The views expressed by the participants in the FAE group are the same as that of other participants. FAE1 argues: "In BCT you have garbage in, garbage forever". So, the value of BTC is not that data is true by virtue of being stored in the chain. The value is that the entity that introduced fraudulent data can be immediately identified." This is an example of Bitcoin operation in practice.

Similarly, FAE2 also believes that data entered into BCT is permanently on the network. S/he submits:

> Well, the thing is once it's in, it's in there forever, it can be taken out. That's the whole point. And so, it's just like any other decision problem with garbage in, garbage out. It's no different. It simply means that there is [sic] errata, there is bad data in the system, and it would be on the people or the actors of the system to identify, isolate and clean that up. If fraudulent pieces of information are deliberately introduced into the blockchain, it still goes to the fact that someone has had to prove that it was fraudulently done and that suggests to me that the technology, in this case, is neutral. (FAE2)

It must be noted that the participants believe that the large-scale deployment/ adoption of BCT will provide a better understanding of how reliable the technology's inbuilt fraud prevention and detection mechanism are. It is important to point out that the perceptions of many of the interviewees are influenced by Bitcoin blockchain and other cryptocurrency operations and the general features of BCT because the technology has not yet been deployed for financial reporting and accounting systems.

In brief, the blockchain start-ups interviewed in this study believe that the detection of frauds or anomalies is easier than fraud prevention in a BCT environment. They suggested that the overall effectiveness of the BCT fraud mechanisms depends on the strict observance of protocols underlying the network by nodes or participants. Furthermore, it was revealed that BCT is not suitable for a complex operation thereby making tracking fraud somehow difficult and further exposing the network's vulnerabilities to fraud. The practitioners from the Big 4 firms (AAF group) who participated in this study believe that the BCT mechanism can neither prevent nor detect fraud or anomalies. Similarly, professional accountants from non-Big 4 firms (AAD group) consider that BCT cannot prevent fraud.

The academics, on one hand, argue that BCT cannot detect all frauds, on the other hand, they also believe that the technology can stop some fraudulent activities. Like the ACA group, in the ARB group, some interviewees believe that the technology cannot prevent fraud while some consider it has the potential to reduce or eliminate fraud. The accounting regulators note that the assumption by many participants about the effectiveness of the BCT fraud security system cannot be proved empirically since there are no BCT use cases to support them. In the view of the FAE group, BCT can facilitate the detection of fraud or anomalies, but the technology is not flawless.

The participants believe that the human element will be the weakest link in a BCT security architecture and possibly a critical factor undermining the effectiveness of BCT fraud systems. The participants identified front-running, wash trading, re-entrancy, race conditions, fork, embedded malware as well as money laundering as possible types of fraud in a BCT environment. Additionally, despite the features of BCT, the technology cannot prevent fraud arising from collusion, related party transactions, deceit, overriding of controls by management and falsification of reports.

Academics, those from blockchain start-ups, IT, accounting, audit and assurance, and other experts believe that the BCT fraud mechanism has no solution for the effect of GIGO. They argue that GIGO is still possible in a BCT transaction because the human element controls the governance of the network, and the technology will validate garbage data from an authorised person. However, a few of the participants still claim that GIGO cannot happen in a BCT because the technology will not allow garbage entries into it. **Table 5** is an overview of the key findings in line with the participants' groupings.

The next section explores whether the accounting professionals need special skillsets in a BCT environment.

Table 5. Summary of Findings - BCT Fraud Prevention and Detection and GIGO

Sub Questions	Category	View	Major Findings
Research Question: What mechanisms are in place in BCT for fraud prevention and detection?			
How effective are BCT security systems in preventing and detecting anomalies or fraudulent transactions?	BSIT	*BCT can detect fraud, but cannot prevent fraud *Hackers can game the system. *BCT security may be vulnerable to other technologies built atop it. *BCT is not suited for real-world complex transactions. *Human element is the weakest link	*BCT cannot prevent or detect financial fraud. *The effectiveness of BCT fraud prevention and detection mechanisms is as good as the human element that is involved. *Large-scale deployment can provide a better
	AAF	*BCT has no mechanism to prevent, detect or understand fraudulent transactions *Detection of fraud in a BCT may require the use of other data analytic FDS. *BCT cannot differentiate between a fraudulent or correct transaction. *Immutability of the BCT ledger is not sufficient because fraud taking place in cryptocurrencies was not from tinkling with the ledger.	
	AAD	*Evaluation of the BCT security system depends on its mass adoption *Human involvement is key in the effectiveness of BCT fraud prevention and detection systems. *BCT cannot prevent fraudulent transactions	
	ACA	*BCT cannot detect all types of fraud *BCT ledger can be modified * BCT is a creation of man, emphasis should be on the human element because it is hackable *Contradictory views are due to a lack of understanding about the technicalities of BCT software *Technology cannot prevent or detect fraud where an individual or group has over 50% of BCT computing *Prediction of fraud in real-life is difficult	

Sub Questions	Category	View	Major Findings
	ARB	*No use cases to prove BCT fraud prevention and detection mechanisms. *BCT cannot prevent fraud *Detections of anomalies and infractions *Human involvement can hinder fraud prevention and detection because people are the weakest link in any technology. *Provide one version of an immutable ledger	
	FAE	*Detection of fraud *Human element can undermine the effectiveness of BCT fraud systems	
What types of fraud or anomalies can take place in a BCT environment?	BSIT	*Falsification of reports *Stealing of cryptography keys with a keylogger *Money laundering	BCT cannot prevent fraud arising from the falsification of reports, manipulation of internal controls, collusion, related party transaction and malware
	AAF	*Manipulation of internal controls by top management	
	AAD	*Collusion *Related party transactions *Wash trading *Font-running *Re-entrancy *Race conditions	
	ARB	*Collusion	
	ACA	*Deceit *Malware embedded in a wallet	
What impact does garbage in, garbage out (GIGO) have on the effectiveness of BCT fraud prevention mechanisms?	BSIT	*Faulty entries lead to faulty output in a BCT network *No room for garbage entries into BCT * GIGO is not possible in public blockchain because it will not be validated	*BCT fraud mechanism has no solution for the effect of garbage in, garbage out
	AAF	*Technology has no mechanism for stopping GIGO *No GIGO in a Bitcoin blockchain	
	AAD	*BCT is not immune from the impact of GIGO. *Garbage data get kicked out before it gets certified	
	ACA	*If wrong information goes into BCT, the technology will produce the wrong output like any other system. *BCT may prevent bad data from getting in.	
	ARB	*BCT has no solution to GIGO	
	FAE	*Effect of GIGO on BCT is the same with any other IT infrastructure	

Note. Source: Author

7.5 Technical Skillsets Required by Accountants and Auditors in a BCT Environment

The previous chapter (Chapter 6, Section 6.5.2) established that auditors are required to audit both the transactions and the chains, and to undertake these roles, auditors need a changed skillset (Kogan et al., 2017; Stern & Reinstein, 2021). Beyond crunching numbers, accounting professionals, particularly auditors, are expected to have specialised skills and technical abilities to remain relevant. Many scholars (Accounting Today, 2020, August 23; AICPA, 2020; Andiola et al., 2020; Antipova, 2018; Apostolou et al., 2017; Appelbaum & Smith, 2018; Botes, 2005; Pan & Seow, 2016; Pimentel et al., 2021; Sarkar et al., 2021; Tanaka & Sithole, 2015) have argued that in the digital age accountants and auditors must keep abreast of technology innovations that could impact their functions. The debate on the technical skills required by accounting professionals is unending, particularly IT skills that are needed to keep up with the exponential increase in technological innovation. Consequently, this study seeks to understand from the practitioners' and academics' points of view, "What are the technical skillsets required by accountants and auditors in a BCT environment?" and How relevant is the understanding of BCT programming language for these professionals?"

Considering the diverse views of scholars, practitioners, and accounting professional bodies on the array of skill sets required by professional accountants, this study attempts to understand if accountants and auditors required a specialised skill set to work in a BCT environment and the relevance of understanding BCT programming language. The participants' views are discussed under the themes: special skillsets and programming language (see Figure 23).

7.5.1 Special Skillsets for Accounting Professionals in a BCT Environment

As mentioned in the literature review (Section 3.7), prior studies have noted the importance of special skillsets for accountants and auditors in an emerging technology environment such as BCT. Kogan et al. (2017) note that IT knowledge is essential for all accountants and they further acknowledge that accountants and auditors are lagging in innovations driven by new technologies such as AI and BCT. Gillon (2017) emphasizes the need for more technical skills for accounting professionals, and Sarkar et al. (2021) and Andiola et al. (2020) highlight the need for accounting students to develop technology and Big Data analytic skills. La Torre et al. (2019) underscore the importance of acquiring new skill sets in a Big Data environment and the need for organisations to adapt to working in a digital ecosystem. Digabriele (2008) lists the skills for forensic accountants to include analytical, deductive analysis and unstructured problem solving among others. Appelbaum and Smith (2018) infer that the understanding, utilisation, and implementation of BCT is essential for professional accountants irrespective of the industry: academia, private or public practice. Additionally, Stern and Reinstein (2021) suggested the need to add blockchain to accounting curricula and to teach it as a separate course due to the increase in the technology’s popularity in the business environment.

The findings of this study show that the majority of the participants emphasised that accountants and auditors do not need any special technical skills to use the BCT system beyond the IT skills acquired from their professional training and degrees because the technology will be embedded into the existing system. The general understanding of the BCT ecosystem is said to suffice for accounting professionals as the technology end-users. The finding further reveals that practitioners and academia agreed that accountants and auditors need some IT knowledge to remain relevant in a BCT environment, however, accounting practitioners do not need to become IT specialists. The study has not only provided an answer to one of the research objectives of this thesis relating to the technical skillsets required by accountants and auditors but also responded to one of the future research areas suggested by Schmitz and Leoni (2019) that, “…future research may explore the level of technological understanding and skill sets needed by accountants and auditors to provide accounting and auditing services to clients using BT (p.339).”

7.5.1.1 Blockchain Start-ups and IT Experts’ (BSIT) View

Most participants in the BSIT group argued that accountants and auditors may not require any major technical skillsets to function in a BCT environment. They believed that the use of BCT for accounting professionals requires a basic understanding of the general features of the technology. They need to have a basic understanding of public and private key cryptography, an understanding of how hashes, hashing, and databases work.

BSIT10 notes: “I would argue that they shouldn't look to have too many technical skillsets to get involved in blockchain because there will be providers that offer them toolsets to do that." S/He was of the view that accounting professionals will have the chance to plug into different platforms that could assist them to examine BCT on behalf of their clients. Similarly, BSIT8 suggests that the emphasis should be on understanding governance around BCT, its protocols and related vocabulary. S/He thinks:

> I don't know at this stage if there's any point for them learning how to build a blockchain or to understand what a hash is, but I do think some basic things are super important like governance around blockchain. Is it Proof of Stake, or Proof of Work, or Proof of Authority? What is a node? How many nodes are there? Are they all the same type of node? I definitely think that every CPA needs to start learning some basic vocabulary more than just a word cryptocurrency. (BSIT8)

BSIT10 further considers that all accounting firms should have IT staff with requisite technical competence in the audit team. S/he explains:

> I think the core value becomes understanding what the solution to the technology offers and being able to explain that to their clients from technology skills particularly with some of the offerings like IBM, Amazon's and Microsoft. If you've got a member of your staff who understands basic coding or basic access to data sets, that'll be fine, they don't need to be coders and they don't need to be deep technologists. (BSIT10)

BSIT10's view is in line with the AICPA guidelines that a service auditor should use a specialist with appropriate skills to perform the engagement according to professional standards where the engagement team lacks appropriate competence, capabilities and knowledge of BCT (AICPA, 2020). The current practice among top audit and assurance firms is to assemble an audit team with different professional competencies according to the client's requirements. Thus, if this applies to auditing BCT, then there may not be any need for professional accountants to understand the technicalities of BCT.

BSIT2 believes that some basic IT knowledge is covered in AIS, and this is sufficient for accountants and auditors to use in a BCT environment. S/He clarifies: "It's essentially what's already covered in the accounting information systems courses because we're learning how to look at data entities, learning normalization, and learning data structures, but not necessarily having to do the actual data structure or programming yourself." Simply put, accountants should learn how information or data is passed across and between systems, but not necessarily the ability to hash codes. Further explanation was provided by BSIT9 on the reasons accountants and auditors do not need any technical knowledge in a BCT environment:

> It's like a basic level of basic education that you need to understand the nature of this new system. Just like when the cloud was introduced, people needed to understand the nature of a cloud-based system. There's a basic understanding that you'll need in working with companies who've chosen to either use blockchain systems as part of their operations or to hold purchases, transact in digital assets. (BSIT9)

However, BSIT3 thinks understanding computer logic would be beneficial to auditors. S/He is of the view that such knowledge will aid the auditors to understand the nitty-gritty of BCT. BSIT3 explains:

> I think they are going to require some understanding of computer logic, they will still be required to understand the regulatory guidelines and in their jurisdiction, but definitely, they're going to need to understand more in computing, even I will go as far as saying even some programming…. And I think things like that would help auditors and CPAs to understand blockchain as well. (BSIT3)

Understanding the logic behind the BCT system could help auditors to comprehend the logic, but most participants in the BSIT group do not see the need for accountants and auditors to get such technical knowledge. A critic may argue that this position by the majority of BSIT participants could be a 'protectionism approach' and a way to ward off professional accountants from taking over their jobs as CPAs with computer programming skills can combine accounting and IT roles.

Nonetheless, a participant shared an experience when asked if they had any special technical skillsets or training to use [xxx][24] blockchain solution before using the technology to handle their global transport documentation. BSIT6 replies:

> Yes, we did. We did it all online, very easy. We trained, I think we had probably one session for an hour, and to train us on how to use a blockchain

[24] Delete to protect the participant's anonymity.

> because it's very simplistic, very easy to use. BSIT6

Going by the experience of BSIT6, it could be argued that accountants and auditors may not need any technical skillsets to use BCT.

7.5.1.2 Accounting Regulatory Bodies' (ARB) View

The majority in the ARB group believe that accountants and auditors may not require any special skillsets to use the technology. ARB4 simply says: "We don't expect that all accountants or auditors are going to be computer programmers or going to be technology experts." S/He thinks understanding the basic features and general terms of BCT is enough for accounting professionals. ARB4 explains:

> I think for the average accountant it's more about understanding the key features. …Understanding the general system, but not really getting into a lot of technical detail because that's not where I think accountants are the best people to be talking about those issues. (ARB4)

Similarly, ARB5 thinks that in terms of technology, accountants need to have an awareness of it, they need to be able to work with data and that's the same for blockchain. S/He mentions:

> They need to have a basic awareness of the skills that go with whatever the emerging technology is, an ability to be able to use or work with data and to actually use the application. In the case of analytics that might be Power BI or Tableau or whatever and because we don't have any blockchain technologies as such I can't name any that they need to be able to use, but where they should emerge, they'd be able to use it. (ARB5)

Currently, no technology is associated with BCT for financial reporting and accounting purposes. Perhaps, as the technology evolves, accounting professionals will become aware and embrace it. In the 2020 blockchain symposium, AICPA acknowledges the importance of integrating more technology skills for prospective CPAs and reskilling old members on emerging technologies. Considering such AICPA initiatives and how the accounting professionals have engaged with other emerging technologies, they may engage with BCT when the technology is fully adopted.

Contrarily, a participant pointed out that understanding BCT at the basic level may not suffice for auditing purposes because auditors may need to know more to provide professional advice on the IT controls and workings of the technology.

ARB2 asserts: "They certainly need to have that high level of understanding of how blockchain works because auditors will find clients who are using blockchain for their transaction purposes, and they won't get away with not understanding how blockchain works." Thus, auditors are expected to understand how transactions are produced in a BCT system. Smith (2018b) reinforced this view by emphasizing that accounting practitioners should have technical expertise and knowledge for implementing BCT-based solutions.

7.5.1.3 Audit and Assurance Firms' (AAF) View

The prevailing thought among the participants in the AAF group is that beyond basic IT skills, accountants and auditors do not need any technical skills to work in a BCT environment. Professional accountants need to understand how to work through the system, examine the source records, how records got into the blockchain and the rules guiding the coded items, says AAF1. S/He asserts: "…while working through the system. So, I think accountants or auditors need to know the rules for what was coded and how things were input. They need to understand what they're looking at in the transaction."

Similarly, AAF4 acknowledge that auditors need a robust IT skill that will enable them to see to the correct working of any programmable system but not to become programmers. S/He went on to say that they do not need to know how to program BCT or set it up, but they should be able to review the workings of coding in the technology.

> I think they don't need to understand how to correctly program everything on the blockchain, but auditors should at least know, for example, if you create a website or build a website, you can learn HTML, CSS, Java or whatever, and you can move the website or take the code if it looks like that you want to use it, and then just apply it. I think this will be true for the auditors as well. They don't need to understand how to program a blockchain and how to truly set up a blockchain system, but if they see it, they need to understand how it works and that's the IT skill they need. They need to understand, and they need to be able to at least change certain attributes to check if it still working. (AAF4)

Tan and Low (2019) note that the BCT application is not meant as a data transformation solution for accounting information because the technology is more of a database engine. If this assertion is true, accounting professionals will only interact with BCT at the user interface level. Thus, they may not need any technical skills to do that. However, accountants and auditors need to understand how algorithms work and their domain as well as increase their digital literacy, according to AAF2. S/He clarifies:

> … you will be relying more and more on things that are defined algorithmically. So, understanding what that means, the minute you defined an algorithm, you have to throw away information because it uses a narrow set of parameters. So, understanding how algorithms work, will become more important. But other than that, probably not. There're probably not many new skills, not that we can predict or that we need to quantify. … They need to be more digitally literate, and unafraid of computers, but beyond that, as long as they can navigate a computer, they'll be fine. The practice will change, and they'll learn, but there's no defined skill that you need to give them. (AAF2)

Similarly, AAF6 thinks accountants and auditors need to upskill their technical skills to carry out BCT audits. S/He expresses doubt as to how auditors will undertake the audit of technology if they lack basic knowledge of it. S/He suggests the possibility of using an IT specialist as a member of the engagement team. AAF3 lends credence to the use of experts or the industry specialist for auditing general IT controlling (GITC) environment in a BCT. S/He affirms that there it is a standard practice among all the leading audit and assurance firms to consult in-house experts or specialists in auditing GITC. AAF6 describes:

> Fundamentally from an audit and accounting perspective, how can you audit something and record something if you don't understand the very nature of what you're doing? There's going to be an IT or some sort of technical technological element that accountants and auditors need to upskill on. The audit profession, more so, there's an inherent component, to sign off on an IT audit at least you still need to understand your control environment. That's going to become an even more complex understanding of how the blockchain works even rudimentary or having an IT or a specialist and it's going to be core. I see specialists involved in auditing, this will be the way and I think it's going be a fundamental skill set. (AAF6)

There is a high chance that audit and assurance firms will place reliance on in-house IT specialists for auditing BCT. Pimentel et al. (2021) consider the engagement of experts to provide necessary technical support to auditors as one of the available options to audit BCT. Thus, the accounting professionals may be satisfied with their analytical and basic computing skills in auditing BCT since this approach has been working. However, what will be left unanswered is how will professional accountants audit or certify the controls of an IT system such as BCT without adequate technical knowledge.

7.5.1.4 Academics' (ACA) View

In the academic's view, most consider that accountants and auditors may not require any high-level technical skillsets to use BCT, while a few of them believe these professionals require more than basic IT skills to function optimally in emerging technology environments such as BCT.

There were some suggestions that what accountants require is an understanding of the basic knowledge of BCT which includes the composition of transactions, processing layer and data structure because the technology will be integrated with the existing system. They felt, possibly, end-users of BCT which could include accountants may not require any special training to use it. ACA2 states that "…they [*accountants*] are not to know the top level of technical skills. Maybe the basic level, the way how to know transactions or understand the processing layer, the data structure, Merkle tree or what is the data structure and the very important encryption and security." Elaborating further, ACA3 explains:

> They don't need technical skills to deal with blockchain. That's what I have learned on [sic] that when you want to have a skillset and training, you do not train the end-users, because blockchain is going to be integrated with the existing system that they are using. So, using blockchain shouldn't be a problem for them. And they shouldn't be interacting with blockchain directly. Nobody's interacting with blockchain directly because they are end-users. The technical people are going to build a blockchain and integrate it with the existing system, so it is the back end. For auditors, they are interacting with their regular normal system. So probably, they would out of legality need to learn about the existence of blockchain on the system. They would learn whether blockchain would bring the value, what it's going to do or not, but directly, they are not interacting directly with the blockchain. (ACA3)

Auditors need to understand the internal working mechanism of their clients' systems including adopted technologies for their operations to prevent material misrepresentations (Brazina & Ugras, 2018). In practice, even if auditors will be interacting with BCT as a user interface, it may be important to have a good understanding of the logic and components behind any IT infrastructure deployed by clients before audit engagement. ACA4 notes that the skillsets required are a function of auditor's roles. S/He justifies:

> If all they [auditors] want to see is reports, outputs from a system, no skill [is] needed. If, however, they're auditing at a governance level, for example, that undertaken an ISO audit, they probably will need some technical competence because the governance of blockchains, suddenly becomes very technical. They will need to understand what they're actually looking at in terms of inputs processes and outputs to determine whether or not the system is being used as fit for purpose or safe. If they are undertaking an audit of feasibility, again they probably going to need technical competence. The type of audit will determine the level of need, I would think anyway. (ACA4)

The argument by ACA4 could be described as a working template for the skillsets that auditors need in any IT system environment because the skillsets will depend on the nature of audit assignments. It could also be argued that is important for professional accountants to obtain technical IT competence to look beyond transactions and numbers in a BCT environment. However, ACA6 argues that knowledge in programming or a computer degree for accountants and auditors are not important in using BCT, but the acquisition of such knowledge may confer a greater advantage on those that have such additional qualifications over others that do not.

A few of the participants in the ACA group still believed that professional accountants require a technical knowledge of BCT. ACA7 claims: "Auditors and accountants will need a pretty high level of computer and technical knowledge for creating the blockchain in every transaction stage initially." Another participant, ACA1 also suggests that accountants and auditors need an element of software engineering skills. S/He explains:

> If you take a look at blockchain technology as one of the arms of the fourth Industrial Revolution. People that are most involved in business and finance areas like accountants or auditors, all of those guys need to have some understanding about the IT infrastructures, data, some sort of software engineering kind of stuff. (ACA1)

Despite most in the ACA group believing that accountants and auditors do not require any high-level technical skillsets for BCT operation, a few still felt that accounting professionals should have an element of software engineering skills.

7.5.1.5 Accountants and Auditors' (AAD) View

The majority of the participants in the AAD group suggests that accounting professionals need to have skillsets to understand distributed ledger technology (DLT), encryption and the whole of the BCT ecosystem. They further believe that accountants and auditors need to re-train to function efficiently where BCT is adopted for operation. Their position is hinged on the need to have requisite IT skillsets that include an element of computer programming to understand the logic behind transactions, input and output in a BCT environment. Swan (2015b) highlighted the skill sets required in a BCT environment to include programming, cryptography, and distributed protocols to understand and work efficiently with the technology.

AAD5 explains: "I think accountants will need a little more IT knowledge and some fundamentals of programming would be important and how the language is configured will be important." S/He went further to state that undertaking an audit of a BCT may require an element of programming, thus for auditors to find transaction's trail and examine transactions will require them to up their IT skills. AAD5 affirms: "I think accountants and auditors need to upskill and learn a lot more about it [BCT] than they do now. They don't need to be an IT specialist, but a cross-functional knowledge will be helpful."

AAD1 suggested that the current set of professional accountants are attuned to embracing emerging technology because they want to remain relevant and survive the possible changes that BCT will bring.

> The point is that many accountants that receive their training in the last 10 to 15 years are more attuned to accepting technology change. I believe that a lot of the new generation of accountants, most of them are probably investing in training themselves on blockchain already even before their organisations roll out the technology. So, the short answer to that question is, yes definitely that there would be a need for auditing and accounting professionals to be up to date on this technology to be able to survive. (AAD1)

To understand the BCT ecosystem and those involved in it, what are the inputs and outputs that come in and out of a blockchain, it is important for accountants and auditors to up their IT skills. It may be necessary to understand the basic tenets of consensus mechanism, protocol code and smart contracts. It could be argued that some accounting professionals are already investigating BCT.

7.5.1.6 Financial Analysts and Other Experts' (FAE) View

The view of participants in the FAE group is similar to most interviewees in that accountants and auditors do not need any specialised technical skills to function in a BCT environment.

FAE1 notes that "Nothing different from their current skillset, BTC apps are transparent to the user." This was corroborated by FAE5 who liken the technical skills required to use BCT with the use of PDF files. S/He is of the view that the BCT-based accounting and audit solution will be in a user-friendly format that hardly requires any technical reskilling. FAE5 elaborates:

> I wouldn't have thought so any more than they need technical skills to read PDFs. We have garbage in garbage out, but also WYSIWYG [What You See Is What You Get]? Yeah, so whatever sort of skills in blockchain-based accounting and audit solution or whatever that's going to look like. What your client is going to be having on their screen is going to be designed to be a very user-friendly format of saying, yes, this is fine or no, there's a problem here. So, I wouldn't have thought it was going to require much technical reskilling. (FAE5)

Like AAD1, FAE2 argues that the same skills used by forensic accountants and auditors are enough in a BCT environment because some accountants and auditors already specialise in the retrieval of digital information.

> Yeah, but they're the same skills as forensic auditors and forensic accountants, currently use anyway. It's just a different platform built-in, we already have accountants and auditors who specialise in the retrieval of digital information. Yes, there will be new skill sets, but they won't be greatly dissimilar. We are not asking them, for instance, to learn how to paint art, they're just using your existing skills on a new set of roles and platforms. Many of them in fact will be very familiar with the concepts of distributed ledger technology. (FAE2)

In sum, from the analysis of the participants' perceptions, most believe that accountants and auditors do not require any high-level technical skills to use the BCT-enabled accounting system or any DLT.

The next section describes the participants' perceptions of whether accountants and auditors need to understand the BCT programming language.

7.5.2 Understanding BCT Programming Language

Global professional accounting bodies, practitioners and scholars have expressed different opinions on whether understanding BCT programming language and technicalities are critical skills for accounting professionals or not. Bible et al. (2017, p. 12) assert: “A CPA auditor may need a new skill set, including understanding technical programming language and the functions of a blockchain. The view of Appelbaum and Smith (2018) aligned with the CPA and AICPA’s position. by suggesting that it will be an excellent skill for CPAs to understand how to set up different BCT networks and platforms. Similarly, Brender et al. (2019) claim that IS auditors must understand BCT and its underlying codes. However, ICAEW (2018) acknowledge that BCT will change the spectrum of skills of the accounting industry but accountants are not required “to be engineers with detailed knowledge of how blockchain work” (p.11).

The findings from practitioners and academics in this study indicated that accountants and auditors do not require an understanding of the BCT programming language. This finding contested the assertion of Bible et al. (2017); Brender et al. (2019), but aligned with the position of ICAEW. The overall majority of the participants affirmed that understanding BCT programming language is desirable but not important for accounting professionals, while a few of the participants held contrary views. It was also found that many of the participants emphasised BCT requires hybridisation of talent, thus accounting professionals could collaborate with other technical experts in harnessing BCT potentials because the technology involves multidisciplinary fields and unique skills. This view was almost similar to that of Centobelli et al. (2021) who believe that to realise effective BCT transformation of any business including accounting there is the need to be collaboration between blockchain developers, academics and accounting professionals The views of the participants were analysed under their groupings in the following subsections.

7.5.2.1 Blockchain Start-ups and IT Experts’ (BSIT) View

The perception of most in the BSIT group is that accountants and auditors do not require BCT programming language to effectively use the technology. This view is similar to their earlier discussed position that accounting professionals require no technical skillsets in a BCT environment (see Section 7.5.1.1).

BSIT10 insists that accounting professionals need not learn to code for blockchain, but they should equip themselves with the knowledge to explain to their clients what BCT can do. Similarly, BSIT2 note that understanding BCT programming is not relevant to accountants in the same way that comprehending the underlying database and technologies behind Oracle or SAP is not required by them. S/He illustrates: "…An accountant doesn't necessarily need to understand the database and programming under Oracle or SAP or any of these other ones, they technically shouldn't need to understand the underlying programming codes in the blockchain system." Another participant, BSIT5 notes that a baseline understanding of how the software works and the data are adequate, and accountants and auditors do not have to go deep into programming languages. BSIT10 suggests:

> I do not advise my accounting friends to learn how to code on the Bitcoin blockchain or the Ethereum blockchain because that's not a core value unless they want to learn computer code. I think the core value becomes understanding what the solutions to the technology offer and being able to explain that to their clients from technology skills particularly with some of the offerings like IBM, Amazon's and Microsoft. If you've got a member of your staff who understands basic coding or basic access to data sets, that'll be fine, they don't need to be coders and they don't need to be deep technologists. (BSIT10)

Brender et al. (2019) insist that auditor must expand their technical skillsets to include coding and cryptography and understand BCT features to undertake proper certification of the technology's process. To explain BCT to clients, accounting professionals may require an in-depth knowledge of how the technology works and its components. Perhaps, this was not factored in the perceptions of some participants who asserted that accountants and auditors just need baseline knowledge.

However, BSIT3 suggests: "… definitely they're going to need to understand more in computing, even I will go as far as saying even some programming." S/He believes that besides the need for auditors to have a basic understanding of programming language, they should partner with experts with a deep understanding of BCT. Learning coding could help auditors and CPA to understand BCT better, BSIT3 adds. Auditors need to have a full grasp of the technologies adopted by their clients (Brazina & Ugras, 2018).

BSIT7 shared their firm's experience in handling BCT and gave reasons why auditors need to add BCT programming language to their skills. S/He believes that programming language skill is a prerequisite for auditors in BCT smart contract environment. Though BSIT9 acknowledges that auditors should not become super savvy in programming languages, they should have a framework for understanding the risks around smart contracts, custody, and keys. BSIT7 illustrates:

> My firm, in particular, we're looking at that because there are some potential services that we can provide that overlap with knowing blockchain programming languages. For instance, our company is looking at getting into a smart contract audit. Right now, smart contract audits are done by specialised technology, that's smart contract firms. In an old-world we'll call it that's what accountants and auditors would do, they would provide assurance, that was our role. In order to make sure that we are still relevant in this digital age, what kind of audit and accounting services can we provide? One of those would be a smart contract audit, and to do that you need to know the languages, how the languages work to do all that stuff. That's one reason why it's relevant [BCT programming language]. If you're a consultant in the future and your client wants to use a smart contract you need to try or figure out how to do it. (BSIT7)

BSIT3 further said that it is important for auditors to collaborate with technology and business experts because no one expects auditors to be a jack of all trades. BSIT3 notes:

> I think that is something that is important, it is about the collaboration between an accountant, a technology expert, and a business expert; it's going to take a lot of different unique skills. I don't think auditors can be expected to be experts in everything and all of those particular skills. (BSIT3)

Collaboration with technical experts and other professionals could assist not only accountants and auditors but also other professionals to harness the benefits of BCT because BCT as a cross-disciplinary field requires unique skills. Boomer (2017) suggests that the accounting profession needs collaborative effort with other experts to position itself to benefit from emerging disruptive technology such as BCT.

BSIT1 likens the use of BCT to using a browser, Google search engine or the internet and s/he states that there is no technical skill involved. S/He explains:

> ...it's similar to using a browser so you should as an auditor know how to find a blockchain explorer and scroll a public ledger, and find a transaction, identify what is this transaction and be able to read the transaction output, essentially. It's no more technical than using a browser and learning how to use Google

> search engine…If you think [about] how technical do you have to be to access the internet in the 90s, you might think I need to be super technical to be able to use it. But, you don't need to know how to be a developer, understand how the protocol works and how the transactions are secure, you don't need to know any of that. (BSIT1)

In summary, the BSIT group do not consider the BCT programming language an important skillset for accountants and auditors. They suggest collaboration among professionals from different fields is a requirement because auditors and accountants cannot learn everything.

7.5.2.2 Accounting Regulatory Bodies' (ARB) View

The ARB group is still of the view that BCT programming language is desirable but not an essential skill set for accounting professionals. Most believes that a good understanding of how BCT work is good enough for accountants and auditors.

ARB2 thought that auditors do not need to learn blockchain coding and construction unless they are providing advisory roles or IT consultancy services to clients, but acknowledges the need for auditors to understand how the transaction made it onto the blockchain. S/He went on to say that since the audit team in medium and larger firms is composed of IT experts and data scientists, it is part of these experts' roles to decipher and acquire BCT technical knowledge to support their audit team. S/He explains:

> In medium-sized and larger firms, especially the "Big 4" firms, the audit teams consist of auditors and data scientists. I think it's more up to the data scientists and the IT experts to figure out and acquire that blockchain technical knowledge, and for the auditor only to understand how a blockchain works. (ARB2)

The easy way out is to claim that professional accountants especially auditors do not require technical knowledge of BCT because there are technical experts in the audit engagement team. It is a reasonable thing to have a robust audit team, but it could be argued that professional accountants should understand BCT beyond its general features. This understanding will assist them in collaborating with other experts.

ARB6 believes more value could be added where accountants learn programming languages, but it is not a must for them. S/He is of the view that understanding programming languages could come in handy, especially in the application of smart contracts, yet the way to go is for collaboration with other experts by the accounting professionals in that area.

> The area which is probably the most interesting I suspect will be smart contracts, so that's the place where you need to do a certain amount of programming and where you can try to add value with programming, and there's no harm in going down that path, but I wouldn't say that's a must have and you can't engage with blockchain without that as an accountant. I think as an accountant what you want to be dealing with is being very clear about what is the process, inefficiency, or the business use case that you're trying to solve with blockchain and working with programmers and IT people. (ARB6)

A client could request auditors to provide financial valuation and regulatory guidance concerning the relevancy of blockchain and its possible adoption for business. Arguably, if auditors do not understand programming languages how will they undertake or certify transactions from such programming codes. Bible et al. (2017) suggested that auditors require collaboration with other experts to undertake the audit of BCT technicalities and inherent risks. However, ARB6 affirms that examination of the smart contract’s functionalities should be left to technical staff because accounting professionals do not require such skills. S/He illustrates:

> To understand how that needs to be reflected within the smart contract and coding, and also being able to have a view of how to assure the smart contract. How are you going to know if the smart contract is doing what it is supposed to do and what you want to do, and how are you going to know if the smart contract will not over time lose relevancy? I think to answer those kinds of questions is probably, in the first instance, more useful than just being able to do the programming because that is a very specific area of expertise and those who are genuine technophiles should do it. I certainly wouldn't say that if you can't program you can't engage with blockchain, I think for accounting and finance professionals that's not the case. (ARB6)

ARB5 recalled the conversation s/he had with a colleague regarding the impact of evolving technologies and the associated skills for the accounting professionals:

> I was speaking to one of our members, he's an auditor, audit partner for KPMG, he heads up the rollout of analytics across KPMG Australasia in terms of audit and he commented that it will be the same for blockchain technology. He doesn't need his auditors to be analytics experts. They'll pick things up as they go and he needs them to have those basic skills, those human skills in the deep accounting skills as well, but they most definitely don't need to become IT-

> specialists. I think I've heard a lot of talk about emerging technologies in terms of the hybridisation of talent that is where you'll have your deep accounting skills. (ARB5)

However, ARB3 insists that it is important for not only accountants and auditors but other professionals to understand programming languages. S/He argued that without understanding the cryptography formula behind BCT, IT specialists can easily manipulate the system. ARB3 further recommends the need to make programming language compulsory for undergraduate accounting students: "… it is essential that auditors and accountants understand the language of the technology so that they can verify what is in the program, the smart contract. … it should be compulsory at university that audit students are trained in a programming language." This view is in tandem with the position of scholars who suggested blockchain courses for accounting and business students (Stern & Reinstein, 2021), the integration of technology and data analytics skills into the accounting curriculum (Andiola et al., 2020). ARB3 further amplifies:

> Cryptography is the mathematical formula that prevents fraud, it could be manipulated that's why it's very important that auditors in the future really need to learn how to program and understand cryptography, the whole end-to-end of blockchain technology to ensure they are working especially the smart contracts. … no matter what profession you are especially accountants, auditors and lawyers, it is compulsory to learn how to program. They should be able to speak with the techies and speak the language because if you cannot what's going to happen, the techies are the ones that are going to commit the fraud. (ARB3)

The ability to communicate and use technical language will possibly enhance the collaboration between the accounting professionals and other experts in a BCT environment or any IT environment. The idea of accountants learning a programming language is not convincing to many of the participants, while a few see it as a necessary skill. To bridge the knowledge gap of members ICAEW claimed that they have proactively included blockchain in ICAEW's ACA qualification curriculum (ICAEW, 2018).

ARB3 added that it is risky leaving everything to IT experts such an expert may use the opportunity to manipulate the system: "If you get a techie that is already a crook and the parties to the transaction don't know that this guy programmed his computer to cook the books, then we are all in trouble." S/He illustrates:

> I give you an example, I used to be the Technical Director [xxxx][25]. At that time there was a massive failure of a life insurance company. We did a review as to how this life insurance failed. We realised that in life insurance the most important number is calculated by an actuary. The actuary calculates the liability of the insurance company in the years to come, it's an actuarial valuation. We found out that the actuary was a crook and through collusion, certain management was involved in cooking the books. They created an artificial position of vulnerabilities of a company. We went to the auditors to ascertain what went wrong. The auditors said we don’t audit the actuarial liability because that's an actuary work, we don't have the expertise. Then we realised that you don’t need to be an actuary to be an auditor. Thereafter, the audit profession changed to say, if you are an auditor of an insurance company you will employ your actuary that will go on to audit the actuarial liabilities. But for you to say because you don’t have an actuary you have to rely on the actuary valuation of the company that is unacceptable. The same will apply to computers. (ARB3)

The ARB3 experience further confirmed the position of some participants that in practice audit teams usually use specialists for certain auditing areas. The AICPA guide recommends reliance on specialists for auditing BCT where the auditor has limited knowledge of the technology (AICPA, 2020). It could be argued that where this practice continues, accountants and auditors may not require an understanding of the BCT programming language. Collaboration with other experts may be more important than learning a programming language.

7.5.2.3 Audit and Assurance Firms’ (AAF) View

All the participants in the AAF group believed that accountants do not require an understanding of the BCT programming language. They asserted that the audit team have an array of experts in the team to provide technical support where needed.

AAF1 argues that it may not be necessary for accountants to understand BCT

AAF1 argues that it may not be necessary for accountants to understand BCT programming language, but where the audit team needs to sign off a BCT system review, auditors or any member of the audit team need to understand the programming codes behind the system. S/He asserts: “No, I don't think it is for an accountant. It’s possible for an auditor if there is a level of risk or if the auditor needs to sign off on the system.” AAF8 notes that programming language is

[25] Delete to protect the participant’s anonymity

important for IT audit, but for financial statements audit, it is not relevant, “They don't need to know the BCT programming if they are not issuers of an IT assurance report or IT audit report.” AAF7 believes that having a developer in the audit team with an understanding of the BCT data processing system suffices because the important thing is to understand the logic behind the system output. S/He illustrates:

> There are various blockchain programming languages, but how they interact with other IT systems that we use is important. A lot of them use Java, for example, so that's way more common, sometimes there may be a layer with Python. It's not always knowing how to read the blockchain, but understanding how that information comes through to the final system that you're dealing with. That's why originally, I was trying to hire someone more of a programmer, but I have people on my team who have a basic programming knowledge like Java, Python and everything like that and it seems to be enough. I don't think that people need to have blockchain programming language knowledge, but they need to understand what smart contracts are. (AAF8)

It could be deduced from AAF7’s argument that the knowledge acquired from using an existing programming language is the same as using BCT, hence the IT programmers in the audit team will still perform that role. The participant acknowledges the need for auditors to understand a smart contract. If smart contracts are made up of written codes, it can be argued that professional accountants may need to learn elements of computer programming to understand the logic behind them. However, AAF2 states that having a special skill such as smart contract coding is not as important compared to understanding the overall logic. S/He explains:

> So, there’s more and more evidence saying that experience in the domains is more important than particular skills in a wide range of areas. Knowing the principles behind accounting, knowing how the sectors you work in operate, their assumptions, the dynamics of them is more important than being able to write a smart contract. (AAF2)

AAF2 was of the view that accountants and auditors will not interact directly with the programming languages. They are possibly going to interact at the user interface which is mediated by the machine. This argument may not hold where an audit involves a review of an IT system because auditors have to undertake an audit through the system. Nonetheless, AAF3 provides insight into the approach adopted in practice by the audit and assurance firms concerning the special audit of client operations. S/He affirmed that in addition to an auditor with a basic understanding of BCT, a specialist will be among the audit team. AAF3 explains:

> … a basic understanding would be helpful but I don't think we get to a deep understanding of it and it's probably going to be outsourced to specialists. If you are going to audit blockchain, you need a basic understanding but before we can even take a step further than that and across your team, you might need an understanding. I think you're going to need a specialist involved to audit. We provide assurance set in [XYZ][26] Australia on this and there is certainly a specialist team that considers blockchain out of Australia. So already, you're seeing teams in Australia that focus on blockchain and can provide assurance around things like the algorithm aspect of blockchain.(AAF3)

The majority here assume that auditors should understand BCT from a process perspective and not from a technical perspective. The BCT technicalities or interpretation of coding should be left to specialists in the audit team. It is unlikely this approach will change in a foreseeable future; thus, accountants and auditors will concentrate on their core competence of generating and examining records of transactions.

7.5.2.4 Academics' (ACA) View

The ACA group was also of the view that accountants and auditors are not expected to be computer programmers, so they may not need to understand detailed BCT programming language.

ACA3 considers accounting professionals need not learn a programming language and compares this to asking doctors and health professionals to learn BCT as users. S/He claims such an approach will not only hinder BCT adoption but also lead to a waste of resources. ACA3 illustrates:

> For accountants and auditors, I don't think they need to learn and know about blockchain programming…. it's like we are saying for the doctors, and nurses, let's teach you blockchain programming language because we are implementing it onto our system, which makes it difficult. You will spend millions of dollars teaching, training and providing all of that stuff which
>
> would make blockchain also very difficult to adopt. (ACA3)

Similarly, this view is supported by ACA6. S/He claims: "Most auditors do not need to know about programming, do they? No. So, I don't think blockchain is

[26] Delete to protect the participant's anonymity.

necessarily any different…. I do all my research now on blockchain and I can't program."

Researching BCT may not be the same as undertaking an audit in a BCT-enabled accounting system where auditors are expected to certify that a system input and output can be relied upon. It can be argued that auditing a BCT system is more than researching a BCT, thus auditors may require knowledge of the entire operating system of a client.

In contrast to ACA3's view, ACA5 states: "If the physician knows something about computer science, so, I would say it's the same for the auditor that to be conversant with the people writing the code, you would be well served by having a background in this yourself." ACA5 believes that accountants are not expected to write code, but suggest the need for auditors to understand programming to aid their conversation and collaboration with the technical staff. S/He narrates:

> I hope the actual software can be delegated to experts that no one's going to ask accountants to write code. But, we've had a guest speaker who's repeated advice to many of my students over the years. He said you should take as many programming classes as you can stand, not because you're going to be programming yourself, but because you're going to be asking programmers to solve problems for you. So, I think if I'm an auditor I'm not going to be writing code but I'll be talking to people and asking them to write code for me. And so, I'm going to need to be conversant in their language to know what they're talking about, what they're saying. And so, the more familiarity, the better. (ACA5)

This view is similar to that of ARB3, as it emphasises the importance for accounting professionals to understand some programming terminologies to ensure effective collaboration with other experts. However, in practice, accountants learning computer programming may be rare. Most participants in the ACA group considered that accountants and auditors do not need to understand the BCT programming language.

7.5.2.5 Accountants and Auditors' (AAD) View

The arguments of the participants in the AAD group are similar to the position of previously discussed groups, they do not see the need for accountants and auditors to understand the BCT programming language. Some of the participants acknowledged the importance of accounting professionals having such knowledge, but they were quick to point out how audit firms have been dealing with the audit of related IT systems. AAD4 shared her/his experience to support this view:

> They don't need to know; accountants and auditors don’t need to know. I have done some work on the IT side of things where I might not know things, but I can do checks to see some things that are not correct. (AAD4)

The experience of AAD4 is the usual practice in the accounting industry, you can audit the system relying on the expertise of other members of the audit team. Professional accountants may just undertake the necessary accounting checks, verifications, and validations. Another participant, AAD2 believes there is no need for auditors to learn programming to audit BCT or validate smart contracts, the IT auditor in the audit team will look after the code. S/He supported the argument of AAD1 that the current generation of accountants is IT conversant. AAD2 explains:

> Yeah, I mean, to the extent that you want to validate that smart contracts and they're usually written in solidity or JavaScript or sometimes in Python. I mean somebody in the auditing group ought to be able to look at code and make sure things are right in the code. I want to say this too, I don't think that every auditor needs to retool in order to audit blockchain, you could have a group that just looks at code, your IT auditors. For example, it's not that complicated that I don't think at least, and I teach auditors that audit blockchain. If you have most of the people of your generation are already technically savvy enough to figure it out. (AAD2)

Where it is true that the BCT programming codes are similar to other programming languages such as Java, Python and Solidity, it may not be as difficult to understand as projected. BCT is seen as a complex technology that requires a new set of technical competence and knowledge. Consequently, the idea that the programming codes behind BCT are similar to popular programming languages indicates that existing IT auditors can still undertake an audit in a BCT environment.

However, AAD5 felt that accountants and auditors need IT knowledge, some fundamentals of programming and the configuration of the language are important. AAD5 explains:

> In a blockchain environment, if someone's auditing a blockchain system I would imagine they're using some sort of program to audit the transactions because finding the trail of the transaction would require a lot of information

> processing. I think that auditors will need to learn some programming languages to process all that big data, all the data that there is. I would imagine auditors would be needing more skills to audit that. (AAD5)

This view supports the need for auditors to understand computer programs to undertake an audit in a BCT environment and for the processing of the associated big data. It could be argued that such knowledge is not necessary where other technical specialists in the audit team can readily provide such support when needed. Thus, auditors should concentrate on accounting and financial related matters.

Similarly, AAD1 agreed that accountants and auditors do not need to become computer programmers, but it is unwise to leave everything to software engineers because there are some technicalities in accounting that the IT experts may not be conversant with. S/He suggests collaboration between accountants and IT experts. This view corroborates the view of ARB3 who claims BCT cannot be left to the technical specialists alone. AAD1 explained:

> ...You cannot leave a system to the software engineer or computer programmer because he does not understand the rationale for how certain things should be programmed into the system, he does not understand the accounting rules, he is not an expert in IFRS or whatever the accounting principles that your organisation is using, he does not understand what are the risks in certain areas of the organisations that you as accountants or auditors are trying to mitigate. There has to be a collaboration. This is a mistake that accountants and auditors made when technology was first introduced. They thought they have to leave everything for the IT guys, but the IT guys don't care, they just want to see that the system is up and running, they are satisfied. Their job is to make sure that the system is running and not to monitor the controls. (AAD1)

AAD1 went on to say that it is possible to have a system that is either giving the right output or producing nonsense. This could happen when accountants and auditors are not involved in the process, or they don't understand what the system is saying because they have assumed that it is a job for the IT experts. One can argue that despite the need for auditors to collaborate with other professionals, there is still the need to understand the basic logic behind any IT system. ARB3 referred to this as "understanding and speaking the language of techies".

From the accounting and auditing perspective, accounting professionals must understand the risks associated with the implementation of any system and how to mitigate the same. Dai and Vasarhelyi (2017) observed that audit of smart contracts require technical competence and auditors should have the requisite skills and an understanding of BCT. For effective collaboration, accounting professionals must understand the logic behind BCT processes.

7.5.2.6 Financial Analysts and Other Experts' (FAE) View

All but one of the participants in the FAE group consider that an understanding of BCT programming language by accountants and auditors is not that important. The FAE group believe the important thing for accounting professionals is the ability to explain the components of BCT to their clients. Some participants were of the view that many users do not understand the underlying technology behind the internet or email or their IT system. Thus, knowing the technicalities behind BCT programming is of little use to accountants and auditors.

The view of FAE3 could be taken as the representative view of those who think accounting professionals do not need to understand BCT programming codes. S/He explains:

> No, they need to have a good enough understanding of how it works to be able to kind of describe to anyone who's asking about it what it does. It's kind of like using the internet or sending emails we all do it and the vast majority of us can't describe what's going on. A little closer to home, we use online banking, our money is available and we trust it even though we can't do the coding. If someone put coding on it in front of us we'd have no idea what we were looking at. (FAE3)

However, FAE2 thinks BCT programming language is important for auditors, particularly for digital forensic audit assignments. S/He considers that without proper training in BCT, auditors may not be able to undertake such tasks. FAE explains:

> I think you're talking about the capability that auditors have in order to deliver any sort of digital brand forensic audit work. They won't be able to meaningfully speak about the distributed ledger side of things unless they've been specifically trained to use it. So, it's a basic competency but once you have that competency, you're good. (FAE2)

Basic competency in BCT codes is desirable, but FAE2 failed to consider that a forensic team is composed of different experts who are assigned different tasks

(Botes & Saadeh, 2018). It could be argued that auditors or forensic accountants could leverage the expertise of other team members to undertake any digital forensic audit work without learning BCT codes.

It is arguable how a basic understanding of a BCT will be enough for CPAs that are expected to examine the output and controls within the BCT system including the smart contracts built on it. For accountants, one may agree that knowledge of a programming language is not necessary because they would be interacting with the BCT user interface. This is confirmed by some participants who are currently using BCT to handle some aspects of their operations. Participants' justifications include professional accountants already using a whole bunch of software and platforms, and BCT could be an addition to their toolbox for auditing and accounting work. In addition, the audit team is said to have a specialist who should be conversant with BCT coding, smart contracts, and the like.

However, understanding BCT programming codes could be said to be required knowledge where auditors are expected to certify BCT, associated transactions and the underlying technology. But practitioners and academics in this study believe that auditors do not require an understanding of the BCT programming language. Some of them claim that they have undertaken research in BCT but they do not understand any computer programming. Additionally, the current practice by some audit firms with clients using BCT for crypto transactions was to pull out necessary information from clients' BCT platforms to the existing GAS to audit them. One could say an easy way-out approach adopted in audit and assurance firms is to have IT specialists in the audit engagement team. It appears that accounting professionals prefer to leave the technical aspects of their jobs to technical specialists.

Some participants believe that it is unwise to leave everything to software engineers because there are some accounting technicalities that the IT experts may not be conversant with. It is considered important for accounting professionals to understand the logic behind BCT because IT experts have little or no knowledge of the fundamentals of accounting and audit procedures. Leaving everything to technical specialists is regarded as risky because a rogue IT expert may use the opportunity to manipulate the system and perpetrate fraud. Thus, where accounting professionals know software programming, it would be easier to work with other experts.

Overall, the findings of this study showed that it is not important for accountants and auditors to learn blockchain codes or become programmers, cryptographers, or database experts. What these professionals require is a basic understanding of the technology's impact on their profession and their clients. This finding contests the claim of Bible et al. (2017) that CPAs require an understanding of BCT programming language to undertake the audit of the technology. Moreover, the finding reveals that accountants and auditors are expected to collaborate with IT and other experts to facilitate the use of BCT.

Auditors may be required to perform BCT software testing. The importance of software testing in audits cannot be over-emphasized. It provides stakeholders with quality assurance about the entire system and information generated, enables businesses to appreciate and understand the risks of BCT implementation, and assists in the prevention of fraud in complex ERP systems. Testing often involves evaluation and verification that will allow auditors to determine whether BCT software or applications are working properly or not. Software testing will require an understanding of the programming codes behind the technology. It could be argued that for auditors to place reliance on BCT software and the associated transactions, an understanding of the programming codes will be useful to them.

7.6 Summary

The findings in this chapter were situated within the technological context of the TOE framework (see ***Figure 20*)** and are directly or indirectly related to the attributes of blockchain as a technology. Existing literature has asserted that BCT will disrupt the accounting and auditing professions when deployed because the technology has an inbuilt fraud prevention and detection mechanisms. Similarly, some studies have argued that accounting professionals need special technical skills and an understanding of the BCT programming language to work in a BCT environment. In light of these claims, the chapter explores the effectiveness of BCT security systems in preventing and detecting anomalies or fraudulent transactions, the possible types of fraud or anomalies that could occur in a BCT system and the impact of GIGO on the technology. It further considers whether accountants and auditors require special technical skillsets to use BCT and an understanding of BCT programming codes. It is important to bear in mind that the participants' perception of BCT security architecture is influenced by Bitcoin blockchain's general features in their overall assessment of its effectiveness in fraud prevention and detection, as the technology is not fully adopted for financial reporting and accounting systems. Despite diverse opinions held by the participants concerning BCT security architecture against fraud, this study found that BCT cannot prevent fraudulent transactions but has the potential to detect some anomalies. The study further found that BCT is unsuitable for complex transactions and could be vulnerable to fraud from other technologies connected to it. Most participants believe BCT cannot prevent or detect financial fraud and cannot change the impact of GIGO. In addition, findings indicate the effectiveness of BCT fraud prevention and detection mechanisms is as good as the human element that is involved. The human element is considered the weakest link in a BCT security architecture and a critical factor that could undermine the effectiveness of BCT fraud systems.

Accounting professionals are expected to keep pace with the exponential increase in technological innovations and should have special skill sets beyond crunching numbers in a BCT environment. Participants think that accountants and auditors do not need any special technical skills to use the BCT system beyond the IT skills acquired from their professional training and degrees because the technology will be embedded into the existing system. The general understanding of the BCT ecosystem is said to suffice for accounting professionals as the technology end-users, thus, the practitioners and academics in this study noted that the accounting practitioners do not need to become IT specialists. It was also found that accountants and auditors need not learn BCT programming language or become cryptographers or database experts. Most participants regarded learning a BCT programming language as unimportant for accountants and auditors. They mentioned that basic knowledge of how BCT works and a framework for understanding the risks around smart contracts, custody of keys and basic concepts are adequate. Additionally, participants suggested that accountants and auditors could collaborate with IT and other experts to facilitate the use of BCT.

Table 6 provides an overview of the participants' perceptions and a summary of findings on the special skillsets required by the professional accountants and the need to learn the BCT programming language.

Table 6. *Summary of Findings – Technical Skillsets and Understanding of BCT Programming Language*

Category	View	Major Findings
Research Question: What are the technical skillsets required by accountants and auditors in a BCT environment?		
BSIT	*Use of BCT for accounting professionals requires a basic understanding of the general features of the technology: public and private key cryptography, an understanding of hashes, hashing * Some basic IT knowledge covered in AIS is sufficient for the accountants and auditors in a BCT environment *Accounting firms require IT staff with requisite technical competence in the audit team	*Accountants and auditors do not need any high-level special technical skills to use the BCT system beyond the IT skills acquired from their professional training and degrees because the technology will be embedded into the existing system
ARB	* Accountants and auditors may not require any special skillsets to use BCT *Auditors may require more than basic knowledge of BCT to give professional advice on its IT controls and workings.	
AAF	* They do not need any technical skills to work in a BCT environment *They need to upskill their technical skills to carry out BCT audits *Audit and assurance firms will place reliance on in-house IT specialists for auditing BCT	
ACA	*Accountants and auditors do not require any high-level technical skillsets for BCT operation *The skillsets required depends on the nature of audit assignments. *Auditors and accountants will need a pretty high level of computer and technical knowledge	
AAD	*Accounting professionals should have skillsets to understand distributed ledger technology, encryption and the whole of the BCT ecosystem	
FAE	*Nothing different from their current skillset, BTC apps are transparent to the users *Same skills used by forensic accountants and auditors are enough in a BCT environment because some accountants and auditors already specialise in the retrieval of digital information	
Sub-Question: How relevant is the understanding of BCT programming language and whether auditors should become IT specialists before using BCT		
BSIT	*Do not require BCT programming language *Accounting professionals need not learn to code for blockchain. *Programming language skill is a prerequisite for auditors in BCT smart contract environment *Collaboration among professionals from different fields is a requirement	
ARB	*BCT programming language is a desirable skill but not an essential skill set for accounting professionals *Auditors do not need to learn coding and construction of blockchain except in the provision of advisory roles or IT consultancy services to clients *IT experts could manipulate BCT where accounting professionals do not understand the programming codes *Using the technical language of techies will enhance the collaboration between accounting professionals and other experts in a BCT environment	

Sub-Question: How relevant is the understanding of BCT programming language and whether auditors should become IT specialists before using BCT		
AAF	*Accountants do not require an understanding of the BCT programming language *Audit team have an array of experts in the team to provide technical support where needed *Accounting professionals may be end-users with no direct interaction with the BCT programming languages * BCT technicalities or interpretation of coding should be left with the techies or specialists in the audit team	*Accountants and auditors do not require an understanding of the BCT programming language *Accounting professionals require collaboration with other technical experts to harness BCT potential because it is a multidisciplinary field
ACA	*Accounting professionals should not learn a programming language *Auditors should understand programming to aid their conversation and collaboration with the techies	
AAD	* Audit BCT system relying on the expertise of other members of the audit team *Auditors should not learn programming to audit BCT or validate smart contracts, the IT auditor in the audit team will look after the code *Auditors do not need to become computer programmers	
FAE	*Understanding the technicalities behind BCT programming is of little use to the accountants and auditors *For digital forensic audit assignments, BCT programming language is important for auditors	

Note. Source: Author

The next chapter discusses the findings on the incentives, barriers, and unintended consequences of adopting BCT, and whether the impact of COVID-19 has accelerated the adoption of the technology.

Chapter 8

Interview Findings: Incentives, Barriers, Unintended Consequences of BCT Adoption and Impact of COVID-19

8.1 Introduction

This chapter addresses research questions ten and eleven: "What are the incentives, barriers, and unintended consequences of adopting BCT as FinTech solution? and "How has COVID-19 enhanced the adoption of BCT?" The chapter discusses incentives, barriers, unintended consequences as a FinTech, and the impact of COVID-19 on the adoption of BCT using TOE contexts. The three contexts of innovation decisions are elements that influence a firm's decisions to adopt and implement any technological innovations (Low et al., 2011; Tornatzky & Fleischer, 1990). The TOE framework (see **Figure *13***, p.134) was used to understand and evaluate factors that practitioners and academics consider important for the likely adoption, non-adoption, and unintended consequences of adopting the technology, as well as whether COVID-19 has enhanced the adoption of BCT or not.

These research questions were aimed at understanding what make academics, commentators and practitioners in blockchain, finance, accounting, auditing and other professions excited or sceptical about adopting BCT, considering the technology is seen as a disruptive innovation to accounting and auditing work (Bible et al., 2017; Hughes et al., 2019; Hyvärinen et al., 2017; ICAEW, 2018). Saadatmand and Daim (2019) acknowledge that is hard to know in advance how disruptive any technology will be, nonetheless, they suggest the need for research to advance techniques and methods for determining potentially disruptive innovations. This study explores the perception of participants about the unintended consequences of adopting BCT as a FinTech and it also helps to under their views regarding BCT disruption of the accounting and auditing fields.

The evaluation techniques used in many previous studies do not include input of multiple stakeholders from different geographical locations about their willingness to adopt BCT. Bai and Sarkis (2020) suggest the need to evaluate and account for the views of different stakeholders on factors that encourages or discourages the adoption of BCT instead of relying on a single traditional technology evaluation method. To address this research gap, this study engages with multiple practitioners, experts, and academics from 13 countries to examine their perceptions about factors that spur the adoption or non-adoption of BCT as well as the unintended consequences of using it as a FinTech.

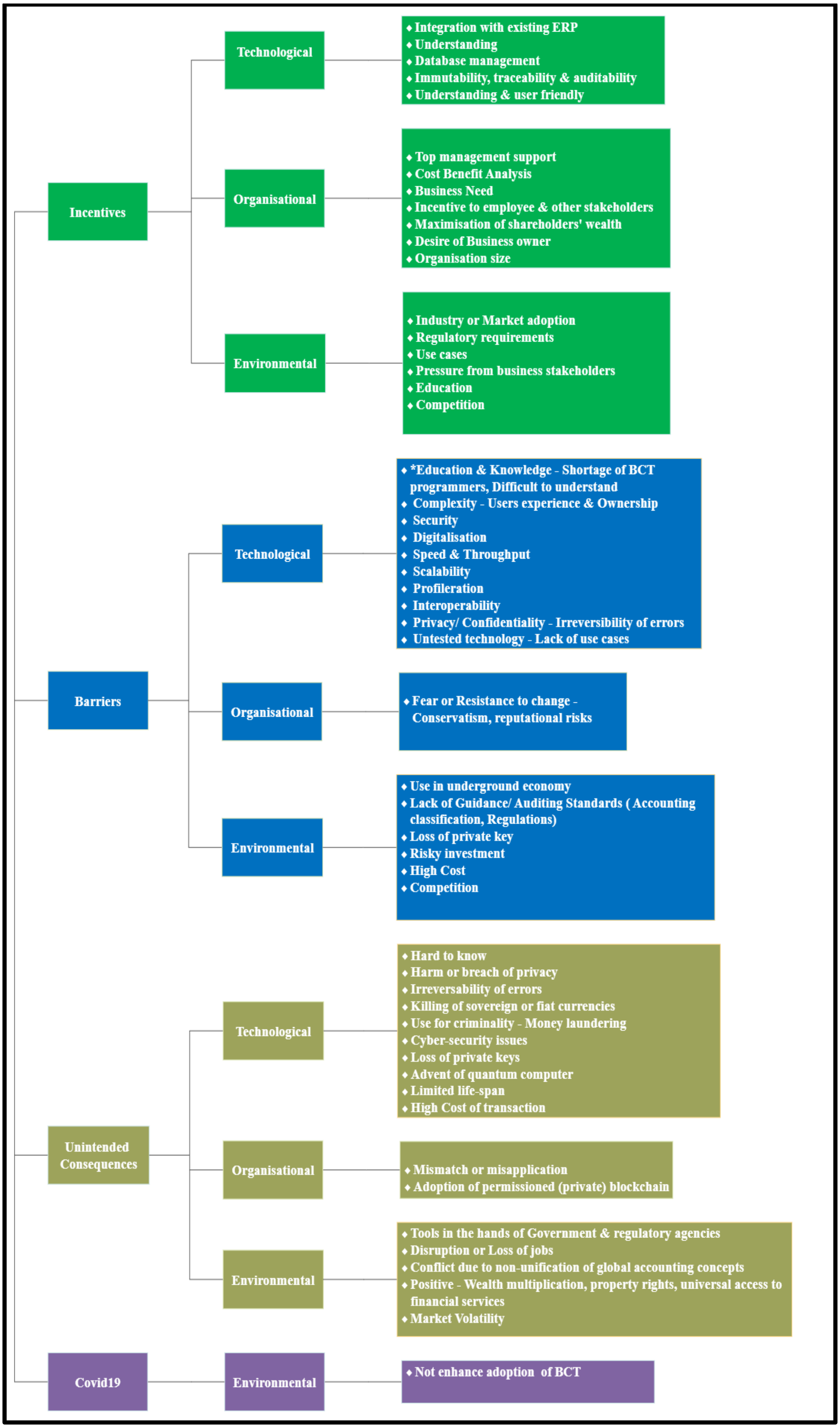
The participants in this study mentioned numerous factors that they considered as incentives, barriers, and possible unintended consequences for the adoption of BCT including the possible influence of COVID-19. These factors were classified under three main themes: Technological context, Organisational context and External Environmental context. **Figure 25** displays the main themes and subthemes that emerged from the study's NVivo thematic analysis. It should be noted that the presentation of findings in this chapter combined and discussed more than one participant's group under the identified themes to co-construct their perceptions and give meanings to their views. In addition, not all the participants were able to give opinions on all the aspects of questions posed to them by the researcher. This approach is adopted because it made the presentation of the participants' perceptions more concise and comparable to achieve the research philosophical assumption of co-construction and interpretation.

8.2 Incentives, Barriers, Unintended Consequences, and COVID-19 for the Adoption of BCT

The findings from the previous chapters show that BCT will neither disrupt auditing nor eliminate the roles of auditors, but the technology will enhance some accountants' and auditors' functions. Despite all the potential benefits that BCT is projected to bring to financial reporting and accounting systems, this study found that there are no organisations that have deployed blockchain in this way. Beyond cryptocurrency operation and some haphazard applications in supply chain management, the germane question is, "What could be the barriers preventing the mass adoption of BCT as a FinTech?"

As discussed in Chapter 2 (see Section 2.6), some of the highlighted technical barriers to BCT adoption include proliferation, lack of portability, interoperability, and standardisation of the technology. Lack of uniform standards and regulations

Figure 25. Themes and Subthemes from NVivo Thematic Analysis



Note. Source: Author

in a BCT operation are seen as obstacles to its adoption (Williams, 2019; Yu et al., 2018). Further, some scholars (Banerjee et al., 2018; Gaggioli et al., 2019) believe that privacy and confidentiality of data could hinder the adoption of BCT for accounting systems. It has been argued that some of these barriers are gradually being reduced as BCT technology continues its evolutionary trend (Bashir, 2018; Guo & Liang, 2016; Sanka & Cheung, 2021). However, it is unlikely to provide solutions to some of these identified barriers (scalability, decentralisation, security and trust) without a trade-off (Sanka & Cheung, 2021).

The literature review in this study identified concerns about the technical barriers that inhibit the adoption of BCT, but there is a lack of understanding from the point of view of practitioners on the incentives, barriers, and unintended consequences of adopting disruptive BCT technology. However, Chang et al. (2019) emphasise the need to examine both technical and non-technical barriers to the implementation of BCT applications. Additionally, some authors (Abd-alrazaq et al., 2021; Abd El-Aziz et al., 2021; Chamola et al., 2020; Mbunge et al., 2021) have suggested that COVID-19 will accelerate the general adoption of many technologies, including BCT, but there is no empirical evidence to support this statement. This study has further attempted to answer the research challenge by Schmidt and Wagner (2019) that researchers should explore, "How do technological, organisational and environmental factors influence blockchain adoption? (p.10)"

Furthermore, there is insufficient literature on barriers to the adoption of BCT in the accounting and auditing fields, and the existing literature pays little or no attention to the unintended consequences of the adoption of BCT. This study not only fills this gap by exploring the incentives and barriers to BCT adoption from the perceptions of practitioners and academics, but also considers the unintended consequences of adopting the technology without delving into many technical details. Exploring the impact of COVID-19 on the adoption of BCT further distinguishes this study from existing studies.

8.3 Incentives for BCT adoption of BCT

The majority of the participants include ease of integration with the existing technologies, immutability, traceability, auditability, business need, maximisation of shareholders' wealth, industry or market influence, regulation, cost-benefit and top management support as likely incentives for adopting BCT in their organisations. The most highlighted incentives are discussed under the main themes: Technological, Organisational and Environmental contexts as follows.

8.3.1 Technological Context

A firm’s decision to adopt a new technology does not only depends on the technological context of the industry in which an organisation operates but also on how well the new technology matches with the existing firm’s infrastructure (Tornatzky & Fleischer, 1990). According to the participants, the most highlighted technological context factors are BCT integration with the existing systems and ease of using them. The perceived benefits of using BCT may not be realisable where the technology is not compatible with the existing infrastructure, or the technology is not users’ friendly.

Additionally, other incentives within the technological context that participants believe could aid them in adopting BCT are immutability, traceability and auditability of records which guarantee that records on BCT are reliable and trustworthy. With a secure BCT ledger, Dai and Vasarhelyi (2017) claim that the technology can enhance information auditability

8.3.1.1 Integration with other technologies - Blockchain Start-ups and IT Experts’ (BSIT) View

Integration of BCT with existing technologies is considered an important factor by the participants when deciding whether to adopt the technology or not. Some studies have proposed how BCT could be integrated into existing accounting IT systems for accounting and auditing purposes. For instance, scholars have demonstrated how blockchain could be integrated into the audit logs (Ahmad et al., 2019), general Access Control systems (Di Francesco Maesa et al., 2019), AI (Angelis & Ribeiro da Silva, 2019), and possibly enable a triple-entry accounting system (Cai, 2021; Faccia & Mosteanu, 2019). The views of the participants are highlighted in the following sub-sections.

The BSIT group members suggest that ease of integration with the existing system, immutability of records, scalability and audit trail are the top incentives they considered for adopting BCT. They argued that BCT can be easily adopted if the technology can be easily integrated with other technologies irrespective of whether the enterprises involved are small, medium, or large organisations. BSIT6 observes that BCT needs to be scalable, and the integration should be good and useful for everybody in the supply chain, not just for the exporters but for the customers as well. Their view is captured by BSIT10:

> The attributes of immutability, auditability, traceability, and the attributes of public-private key encryption to manage the security of transactional data, those are all attributes that make sense for the accounting professional to engage with and understand blockchain technology. (BSIT10)

However, BSIT11 expresses concern about where integration of BCT with the old system is not compatible, and what will happen to the human and capital investments made on the existing ERP. Orji et al. (2020) note that compatibility with the available infrastructures and accounting applications are factors that will affect the choice of BCT. Integrating BCT with other technologies is deemed very important to many of the BSIT participants.

8.3.1.2 Integration with other technologies - Accounting Regulatory Bodies' (ARB) and Accountants and Auditors' (AAD) Views

The accounting regulators interviewed believed the incentive to adopt BCT lies in the technology's ability to fit into the existing legacy system. ARB5 stresses the need for organisations to consider all other legacy systems before adopting newer technologies by ensuring they fit together and align with the business strategy. Lin et al. (2018) emphasise the need to exercise caution while integrating BCT with the existing systems due to the incompatibility of some systems. This sentiment is further echoed by (Prewett et al., 2020) that integration of BCT into the existing legacy system is complex and could be a hurdle to its adoption.

Integrating existing technology with a new one is often difficult and cumbersome in practice, but this fear is allayed by some participants in the AAD group. AAD2 suggest that BCT can be integrated with artificial intelligence, machine learning, neural learning, existing central databases, robotic process automation (RPS), the Internet of Things (IoT) and any of the emerging technologies. However, some of these proposed integrations are theoretical expositions that need practical demonstrations. Some of the proposed BCT applications with other technologies are conceptually based, for instance, BCT based IoT security for datasets (Banerjee et al., 2018). Dai and Vasarhelyi (2017) suggested that the security features of piloted Ripple10 and Litecoin11 were unsuitable for accounting applications. Contrarily, Cai (2021) reported that BCT-based accounting applications such as Luca^{TM}, zkLedger and Pacio have demonstrated potential to enable triple-entry accounting and required little or no change to the existing accounting systems. Undoubtedly, any innovation that cannot be easily integrated with other technologies may be difficult to adopt.

The participants from the BSIT, ARB, and AAD groups considered the ease of integrating BCT with other technologies as an important incentive for its adoption.

8.3.1.3 Ease of Understanding and User-Friendly – Accountants and Auditors' (AAD) and Financial Analysts and Other Experts' (FAE) Views

The FAE and AAD groups consider ease of understanding and user-friendliness as other important factors for the adoption of BCT within the technological context. The participants mentioned that the BCT concept needs to be simplified for people to understand and focus on real problems the technology can solve instead of solving imaginary issues.

FAE5 thinks ease of use is a major attribute that needs to be considered for the adoption of BCT. AAD6 explains:

> It's going to have to be user-friendly, right now it isn't. It's very complicated and people don't understand it. It reminds me of the early days of any technology. In the early days of the internet, you fill in the blank where the user interface is difficult. Understanding of the technology is difficult and that is going to need to be overcome in order for it to go mainstream. (AAD6)

BCT is an offshoot of a familiar and existing technology (Cai, 2021) and the Bitcoin application combined with known technology (see further details in Chapter 2, Section 2.2). Where this statement holds sway, the technology should not be difficult to understand and apply for the users. Crucial to the adoption of BCT is requisite knowledge and skills by the organisation's employees and management (Clohessy & Acton, 2019). The user's experience with Bitcoin and other cryptocurrencies shows that BCT is a complex system to understand. This probably causes some participants to think that ease of use and understanding are attributes that could encourage them to adopt BCT in their organisation.

8.3.2 Organisational Context

The organisational context is the most significant factor in an organisation's IT innovation adoption (Clohessy & Acton, 2019). It encompasses internal related issues which include the firm's structure, size, management structure, resources, and communication (Kouhizadeh et al., 2021; Oliveira et al., 2014). An organisation's structures and processes could limit or enhance the adoption and implementation of new technology (Tornatzky & Fleischer, 1990). Most of the participants suggest the business need, cost-benefit evaluation and top management support as important incentives for the adoption of BCT. Other factors mentioned are incentives to employees and other stakeholders, maximisation of shareholders' wealth, business owner desire for innovation and organisation size.

8.3.2.1 Business Need - Blockchain Start-ups and IT Experts' (BSIT) View

The majority of the participants in the BSIT and AAF groups believed that the business needs and problems to be solved by BCT are necessary incentives for the adoption of the technology. They note that an organisation may be willing to deploy new technology that could improve the process and solve existing problems.

BSIT10 thought the attributes for the adoption in any organisation are driven by the problem to be solved. S/He illustrates, "If an organization has multiple reconciliation challenges, multiple dispersed datasets and multiple different types of clients, basically being able to streamline those processes using blockchain technology." BSIT9 provides further justification for why the business need is the ultimate:

> I think you got to start with the business problem. We spend a lot of time in our innovation unit looking for problem spaces, where is the problem that's big enough to solve rather than saying here's the technology let's go looking for a problem. You always want to come at it from here's a problem that's worth solving and here are the characteristics of the problem. You line those characteristics up against the technologies that are available today and in the near future. To solve those problems, and sometimes blockchain will rise to the top because of its unique characteristics sometimes it won't. I like to think that it demands a problem big enough and one that's suitable for your company

> to attack. That's how we think about it and then we fit the technology to the problem. (BSIT9)

With any emerging technology including BCT, there is a need for an organisation to have a problem to be solved as opposed to just adopting the technology for the sake of it. This sentiment was echoed by scholars like (Carson et al., 2018) that companies should identify the critical areas that BCT applications can improve because there is no need to adopt a technology with no tangible adding value to an organisation.

8.3.2.2 Business Need - Audit and Assurance Firms' (AAF) View

Most of the accounting practitioners in this study share a similar view to that of the BSIT group in that they believe that the business need is an incentive for an organisation to adopt BCT. AAF8 believes that technology is to solve an organisational pain point and there may not be an incentive to adopt BCT where there is no significant improvement to the business needs. AAF7 elaborates:

> You should only adopt blockchain if it actually solves a business problem. Lots of people think it sounds sexy and they want to use it, but there's frankly no business case for them to be using it. It's really just not trying to fit technology into a problem. The technology is always secondary to what your business problem is which you need to understand that first and then you select the technology that will help address it. Again, it's no different than any other business problem. Blockchain is just one of the many ways that you can solve it. (AAF7)

This means that BCT is simply a technology like any other that need to support a business architecture and strategy. Given it is a high-risk and immature technology, it needs to be aligned with the risk appetite of the organisation. Despite BCT's novelty, users need to understand what problems the technology can solve (Iansiti & Lakhani, 2017).

In summary, the study's findings on business needs and problems to be solved as incentives for BCT adoption could be considered a new addition to the list of factors practitioners considered as drivers of BCT adoption. This is because this factor has not been mentioned in the previous study by Clohessy and Acton (2019) who investigated organisational factors that influence BCT adoption.

8.3.2.3 Cost-Benefit Analysis - Accountants and Auditors' (AAD) and Audit and Assurance Firms' (AAF) Views

Previous studies (Ding et al., 2007; Ho & Ko, 2008; Leung & Tse, 2001; Museli & Navimipour, 2018) have emphasised that cost-saving or reduction is an important

consideration for IT adoption in any organisation. The majority of the practitioners from the accounting and auditing industry considered that the cost-benefit evaluation of the innovation to an organisation is an important incentive for them to consider adopting BCT. These views are highlighted as follows.

AAD1 is of the view that if there is no business need there is no justification to invest in BCT. S/He points out, "Nobody just wakes up and throws $1 million at an investment that is not going to bring anything, efficiency, and cost reduction." Similarly, AAD4 thinks it is important to examine the cost-benefit analysis because innovation that ushers in cost reduction stands a good chance of being adopted. AAF3 explains:

> Yes, there might be some cost-benefit if you were to adopt it in terms of you may achieve some savings in the organization. In many of the types of transactions that you're entering into and across your business you might have the ability to reduce costs on your business in many folds. (AAF3)

Organisations need to understand and evaluate the cost-benefit of adopting BCT among other incentives because where the cost outweighs the perceived benefits, this becomes a disincentive to the adoption of any technology. Cost reduction or saving is among the perceived benefits of BCT adoption (Iansiti & Lakhani, 2017; Ullah et al., 2020). Contrarily, Biswas and Gupta (2019) note that high sustainability costs as a barrier to BCT adoption. However, for small accounting firms, there is probably no reason to invest in the technology by buying hardware or building BCT, but for larger firms, the "Big 4" and the top global accounting firms, it might make economic sense to make those investments. For instance, organisations do not need to build a computer for themselves as they are available in different configurations and sizes on the shelf. Similarly, many businesses are unlikely to build their BCT applications themselves, there is a high chance that they will adopt blockchain as a service as a cost reduction strategy. These findings underscored the importance accounting professionals placed on the issue of cost in adopting any technology.

8.3.2.4 Top Management Support – Academics' (ACA) and Accountants and Auditors' (AAD) Views

Some scholars (Choi et al., 2020; Clohessy & Acton, 2019; Kouhizadeh et al., 2021) have identified top management support as a critical factor for the adoption of BCT. The commitment of the organisation's top hierarchy can make or mar the adoption and implementation of BCT (Kouhizadeh et al., 2021). The views of the participants from the ACA and AAD groups aligned with previous studies on the importance of getting organisations' top managers to support in technology adoption.

Most of the participants in the ACA and AAD groups in this study believe that top management support is a great incentive for BCT adoption. ACA7 considers that top management support is important for adopting new technology such as BCT. AAD1 elaborates:

> There has to be support, what I called from the top of the house, senior management support. The senior management has to be aware of this technology because they are to be signing off, if there is any smart guy somewhere in the middle who understands what value that this technology can produce and it goes all the way make a presentation to convince everyone. If the top guys are not in the picture or they are not aware of what is going on, what value they can get, it is going to be a hard sell. Getting people at the senior management level to understand the value of a digital revolution of this nature and what it can deliver for the organisation, I think that is the second most important factor. (AAD1)

It is indeed an incentive for the adoption of BCT where the top management of an organisation show their commitment and favourable disposition towards the technology as highlighted by the academics and professional accountants in this study. However, it could be argued that BCT could still be adopted without the support of a firm's top management where it is a regulatory requirement or pushed by the industry. Nonetheless, top management support will be a good incentive for the adoption of any innovation.

8.3.3 External Environmental Context

The external environmental context which includes competition and infrastructure support can influence the adoption of any innovation (Museli & Navimipour, 2018;

Tornatzky & Fleischer, 1990). As the external environment influences the adoption of innovation by organisations, an organisation can also shape the adoption of innovation in a particular industry (Tornatzky & Fleischer, 1990). The major incentives cited by the study's participants in the environmental context include industry or market adoption, regulatory requirement, use cases, pressure from business stakeholders, education and competition.

8.3.3.1 Industry or Market Adoption - Blockchain Start-ups and IT Experts' (BSIT) View

Some participants noted that the potential disruption of BCT to the accounting and auditing professions occur when the technology is widely adopted by industry. They believe that the accountants and auditors will have no choice when BCT applications become the underlying technology for most businesses.

The BSIT group felt that where there is market or industry adoption, it would naturally become an incentive for many sceptics to consider adopting BCT applications. BSIT10 succinctly captures their view:

> I would argue also, over time the accounting profession is going to be pulled into the dialogue where you see more and more organizations using and benefiting from the attributes of blockchain, that means the accounting and auditing professionals will also benefit from those same attributes. The accounting professional would be pulled into deeper blockchain engagement, and even crypto asset engagements simply because their clients will be doing so. Likewise, their clients will be using blockchain that means they need to be plugged into how the blockchain impacts them and their clients. (BSIT10)

Technology favoured by clients will influence the services of accountants and auditors, thus this justifies BSIT10's position that the accounting profession will embrace BCT whenever the market and their clients do so. It could be argued that the market dynamic could dictate and influence the technology in use.

8.3.3.2 Industry or Market Adoption - Accountants and Auditors' (AAD) & Accounting Regulatory Bodies' (ARB) Views

In the view of the AAD and ARB groups, what is happening in the wider environment could be an incentive for the adoption of BCT. The industry in which an organisation operates has a great influence on the technology deployed for operations. AAD5 and ARB3 elucidate:

> I think first of all I would like to see how popular blockchain is in my environment. If something my suppliers and customers are okay with, is something which is required by the regulator, is it something that competitors are using or not? Imagine my company being the only adopter of blockchain and making our transactions public to a certain extent and my competitors are not doing that, they may have the added advantage. So, I think that adoption of it is an important question that whether it's being adopted by my environment. That's the first consideration that I would like to take before deciding whether to adopt blockchain or not. (AAD5)

> So, the most important thing is that there must be more than one party…. But when you have an industry that has a dependency on other parties and you get information and record information that goes to someone else, that's why supply chain and trade finance are so perfect. Anything that relates to a consortium of people working in an industry, this is ideal. (ARB3)

The suggestion of ARB3 that BCT requires the involvement of multi-parties to harness its benefits for industry use is apt. Industry or market adoption is an incentive for stakeholders in that particular industry to consider the deployment of BCT for their operation. For instance, Maersk has implemented a BCT supply chain platform in which they expected their suppliers or customers (Angelis & Ribeiro da Silva, 2019; Berg et al., 2019). Furthermore, the Australian Securities Exchange is reported to have launched a BCT platform for managing its transactions (Carson et al., 2018). These examples supported the view of the participants that industry adoption could be a catalyst for BCT adoption.

8.3.3.3 Use Cases – Blockchain Start-ups and IT Experts' (BSIT) and Accounting Regulatory Bodies' (ARB) Views

Some of the participants from BSIT and ARB groups believe that an increase in use cases will be an incentive to adopt BCT. The more the use cases, the higher the chance that BCT will be adopted by different players in the economy. The views of BSIT10 and ARB5 could be taken as the representative of the groups:

> I think the attributes for the adoption in any organization is driven by, and I will use this phrase, a lot of the use cases and the problem to be solved. If an organization has multiple reconciliation challenges, multiple dispersed

> datasets, and multiple different types of clients, basically being able to streamline those processes leveraging blockchain technology. (BSIT10)

> First of all, I guess there needs to be a use case for them to adopt. With any emerging technology, there needs to be a problem that has to be solved as opposed to just adopting the technology for the sake of it. There's no point in just going, Oh, blockchain is cool, let's have a distributed ledger technology here, but you don't have a use case for it or something that you want it to solve. (ARB5)

Some scholars (Choi et al., 2020) have noted that the limited number of BCT use cases is a barrier to its adoption. The potential BCT use cases must be viable to motivate organisations to adopt the adoption (Clohessy & Acton, 2019) and the realisation of the technology value depends on deployment at the scale of commercially feasible solutions (Carson et al., 2018). Therefore, examples of successful use cases could be an incentive to adopt BCT. The next section examines barriers to the adoption of BCT.

8.4 Barriers to BCT Adoption

A plethora of obstacles has been cited by the existing literature that may prevent the adoption of BCT including complexity, lack of use case, privacy and confidentiality, and scalability (Bag et al., 2021; Biswas & Gupta, 2019; Chang et al., 2019; Choi et al., 2020; Iansiti & Lakhani, 2017). As a result, some scholars argue that BCT is not suitable for accounting and financial services (Coyne & McMickle, 2017; Oh & Shong, 2017) and this may have limited the adoption of the technology (Karuppiah et al., 2021). Some studies have suggested that these obstacles are not permanent barriers and better solutions are emerging as BCT matures (Bashir, 2018; Biswas & Gupta, 2019; Karuppiah et al., 2021). However, Pirrong (2019) insists that BCT must overcome some of these barriers before it can enjoy any large scale adoption and bring significant change to the business landscape.

The barriers identified in this study that prevent the adoption of BCT include lack of education and knowledge, lack of use cases, irreversibility of errors, complexity, fear or resistance to change, use in the underground economy, absence of regulatory guidance and accounting standards and risky investment, amongst others (see **Figure 25**, p.342). Some of the barriers most highlighted by the participants are discussed under the main themes.

8.4.1 Technological Context

Within the technological context, most participants, both practitioners and academics, believed lack of education and knowledge of BCT, lack of use cases, and the irreversibility of errors are the main barriers to its adoption. Other barriers highlighted are privacy and confidentiality, complexity, speed and throughput, proliferation, and interoperability of BCT as obstacles to adoption.

8.4.1.1 Poor Education and Lack of Knowledge - Blockchain Start-ups and IT Experts' (BSIT) View

Most participants in the BSIT group think poor education and lack of sufficient knowledge about BCT are major barriers to its mass adoption. Vovchenko et al. (2017) identified a dearth of staff with digital competencies as among the major obstacles facing the introduction of new technologies. The participants noted that apart from the shortage of BCT programmers, a poor understanding of how the technology work in practice is regarded as a major obstacle. This is not far from the position of Choi et al. (2020) who state that the cost of recruiting or training staff to use BCT is expensive. BSIT6 sees understanding as an obstacle to adoption by pointing out the frustration encountered in getting some of their biggest partners to use BCT.

> It's getting people to understand. Helping people understand because we've been trying to promote an electronic bill of lading in China, but it's been very difficult because people don't understand blockchain technology. There're so many competing solutions out there at the moment. You've got so many people all competing for the same blockchain solutions. (BSIT6)

Refusal to use BCT by some firms has been traced to a lack of education and knowledge about the technology. BSIT9 asserts, "I think the big challenge is educating policymakers, executives, even line management as to why working in the blockchain or working with the blockchain technologies now doesn't impose an unnecessary risk." S/He reckons that this is because BCT came out of Bitcoin which is associated with the Silk Road and money laundering.

BSIT10 elaborates on the reasons why knowledge and education are major obstacles to BCT adoption. S/He explains:

> Well, I think the biggest obstacle still is knowledge and education. My wife's an accountant so I've been talking to her for a long time. I've been talking to the accounting industry since 2015 about blockchain. Certainly, the industry needs adjustment to know much more. AICPA publishes courses now on a blockchain, but there are thousands of small firms around the world in the accounting industry who just don't know about it and don't understand it. I think education continues to be a challenge because also the technology is evolving very rapidly as well. I was looking at one of the courses with AICPA from two years ago and some of the reports in the course are already out of date. Those always have to be updated I think education is one of the key challenges. (BSIT10)

8.4.1.2 Poor Education and Lack of Knowledge - Audit and Assurance Firms (AAF) and Accountants and Auditors' (AAD) Views

From the accounting practitioners' perspective, the AAF and AAD groups, identified poor education and lack of knowledge about BCT practical applications as major barriers to its adoption.

The AAD group believed that barriers to BCT adoption remain in the realm of lack of education and understanding. AAD3 notes, "I think it's more of an education and understanding. There's a lot of misinformation out there or lack of understanding of what the blockchain really is and how it works." Similarly, AAD2 suggested other hindrances to BCT adoption to include lack of knowledge and the lack of training but acknowledged that despite these challenges BCT adoption is on the increase.

Echoing the same sentiments as the AAD group, AAF6 is of the view that the barrier is education because many people in the accounting and auditing industry are unwilling to understand BCT and how it works. S/He posits, "Education or lack of it. I think the prescriptive nature of our profession especially accounting and financial accounting, so to speak, makes it hard to be open to anything new or evolutionary." AAF6 further states that the unwillingness to open up to embrace evolving innovation as BCT is due to the conservative nature of the accounting profession. Singer (2018) observed that the accounting industry is sceptical about embracing BCT due to its association with Bitcoin. The AAF6 view contradicts the position of (Carlin, 2019) that accountants have always been keen on embracing innovations. It also negates the huge investment and ongoing experiments that the likes of Big 4 firms and other top accounting and assurances firms have made in BCT applications (See Chapter 3, Section 3.5).

AAF1 agrees that knowledge and education are obstacles, but the key thing is to strengthen trust in the BCT ecosystem. S/He explains, “I think knowledge, education, understanding of what it is, what it does or doesn't do. I think clear communication and building trust in the system so that proof of concepts needs to be done really well.” AAF4 summarises his/her experience:

> Most important, I would say that the people don't understand it. Everybody heard of Bitcoin, some people heard of Ethereum maybe, but not a lot of people really get what blockchain technology is? When I first told my parents for example that I work for a company which is building blockchain applications. I think they still don't understand what they're offering to them. And this is also the case for most companies, they don't get the benefits of blockchain technology they don't even understand what blockchain is. They heard the word, but they didn't really read about it to understand so I would say the knowledge barrier is the biggest. AAF4

The finding on lack of knowledge and poor education is similar to the findings by Bhaskar et al. (2021); Karuppiah et al. (2021) who identified lack of knowledge as a challenge to the adoption of BCT.

8.4.1.3 Untested Technology- Financial Analysts and Other Experts’ (FAE) View

As highlighted in the previous findings in this study, no organisations have deployed BCT for financial reporting and accounting purposes (see Chapter 6, Section 6.4). The lack of use cases has been highlighted by most of the participants from FAE, ARB, AAF and AAD groups. They considered BCT as untested technology outside cryptocurrency operations, some piecemeal applications in the logistic business and ongoing exploration by different sectors. The finding agrees with studies by (Clohessy & Acton, 2019) which insist lack of use cases is a major factor against the adoption of BCT. The participants’ perceptions of the lack of BCT use cases are highlighted as follows.

The FAE group noted that BCT is untested technology, and the lack of use cases is an obstacle to the adoption of the technology. The perception of these experts could be represented by the view of FAE2:

> We don't have enough use cases at this stage. I did see one recently about using blockchain and electricity in Poland, and quite interesting. But there is a lot of truth to the idea that we can achieve many things without blockchain. So, one of the barriers, as people in 2016, 2017 and 2018 periods that were saying blockchain can solve many things, but nothing came from it outside of FinTech and some works on the logistics, so the use cases are actually quite small. We're still waiting for them to build up. (FAE2)

8.4.1.4 Untested Technology - Audit and Assurance Firms (AAF) & Accountants and Auditors' (AAD) Views

Similarly, the interviewees from the Big 4 firms and non-Big 4 firms, the AAF and AAD groups, also believed that the untested nature of BCT could be a barrier to its adoption. They suggested that where there are many use cases, it would be easier for clients and companies to adopt it. Some of their views were captured as follows:

> The barrier for auditing firms is that there are not enough companies using blockchain for them to have a vested interest in learning about it because if they learn about it, they can't do anything with the learning. (AAD6)

> The biggest barrier is we were yet to find an application where it is the most compelling solution. (AAF5)

8.4.1.5 Untested Technology - Accounting Regulatory Bodies' (ARB) View

Lending credence to the issue of describing BCT as untested technology were participants from the accounting regulatory bodies. The ARB group argued that there are not yet many clients who are using BCT, so auditors and accountants might have not seen the need to embrace the technology. They stated further that big institutions or organisations have not yet implemented blockchain.

ARB2 observes that use cases from the likes of central banks, the United Nations, and other big clients such as BHP Billiton and Westpac could compel accounting professionals to dig deep into the technology. However, the ARB group believe the lack of use cases is a barrier to BCT adoption.

Despite the claim that BCT is untested technology with little or no use cases, governments and multi-national corporations have invested huge capital in the exploration of BCT. Lohmer and Lasch (2020) suggest that some new business models based on BCT are emerging. Perhaps, with time, the outcomes of these explorations will enhance BCT use cases in many industries and lead to higher adoption.

ARB5 thought adoption is beyond the investment hype and demonstrable use cases are required to validate BCT adoption. S/He explains:

> There was a lot of hype at the beginning of the blockchain revolution if you like three or four years ago, and all sorts of different Consortiums, groups and investigations involved, and then nothing ever came out the other end, it's just sort of died off. There is a need to be not just ongoing investment in research into actually making it a thing and to these use cases. Once we start to hear of these use cases, I think it will snowball them, to really pick up again. (ARB5)

Research has shown that there are many ongoing BCT experiments across different fields (Guo & Liang, 2016; Kshetri, 2018; Sanka & Cheung, 2021), which suggest that slowly it is likely more use cases will come through. Contrarily, Kouhizadeh et al. (2021) note that the BCT use cases are very limited because most of the pilot schemes hardly proceed to implementation. However, most of the study's participants think the lack of the BCT uses cases could impede its adoption.

8.4.2 Organisational Context

Within the organisation context, the majority of the participants in this study identified fear or resistance to change as the greatest barrier to the adoption of BCT by many organisations. This finding is novel because several existing studies (Bag et al., 2021; Biswas & Gupta, 2019; Karuppiah et al., 2021; Lohmer & Lasch, 2020; Mathivathanan et al., 2021) on barriers to BCT adoption did not mention this critical obstacle (fear of change) in any innovation adoption. Some of them identified lack of management support as a barrier, but they omitted one important factor that could make management avoid disruptive innovation as BCT, which is the fear of getting disintermediated (that is reducing the management intermediary roles).

Nisbet and Collins (1978) identified resistance to change by people as one of the most challenging obstacles to the successful implementation of innovations. Irrespective of the novelty innovation stands to bring to an organisation, fear of change could make people sabotage or unwilling to support it. Similarly, employees in most organisations often resist the introduction of disruptive technologies. (Vial, 2019). Oreg (2003) further suggested that some individuals could resist changes that are beneficial to them for reluctance's sake.

8.4.2.1 Fear or Resistance to Change - Academics' (ACA) View

Leveraging their experience, most of the participants from academia, professional accountants and practitioners from audit and assurance firms noted that resistance to change would be a hindrance to the adoption of BCT. Their positions are explained in the following subsections.

The ACA group believed that many people preferred the continuation of the old order in their work places, so they could be averse to adopting BCT which could likely disrupt their operations. ACA6 noted that:

> One of the biggest sorts of problems with the adoption of blockchain is that people like the way they do things. So, if you got a blockchain system say for supply chains, will everyone need to be using it? And so, people don't want to use it, they want to be in control and that's part of where we get a whole lot of problems because when you've got different systems, you have to look for reconciliation between all the different organisations. (ACA6)

Another participant, ACA5 asserts:

> In industry, there's great fear of the decentralized system which is really owing to privacy reasons, more than anything else. And so, you have this new model called the enterprise blockchain and many of the big IT companies are selling this now as a service, sometimes it's even called Blockchain as a Service (BaaS) (ACA5).

BaaS is regarded as standardised solution or platform to enhance the accessibility, productivity and deployment of different blockchain applications (Lu et al., 2019; Prewett et al., 2020) which eliminates the need for huge capital investment in the technology (Bhatia et al., 2020). Some leading BaaS providers are IBM, Microsoft Azure, Oracle and Amazon.

ACA3 states, "If you are an organization and you are implementing blockchain, there has to be a change in your business model. Are you going to get rid of certain entities that you deal with or intermediaries?" This fear is attributed to the perceived disintermediation of some businesses which include accounting and auditing roles.

ACA3 provided an example to illustrate her/his point, “For example, some organisations that built blockchain to process their bills that means that they are [gonna] get rid of some people and some processes within their organisation because the billing is going to be automated through smart contracts or whatever.” Users must have complete trust in a BCT ecosystem to lessen the effect of resistance to its adoption (Saadatmand & Daim, 2019).

Guo and Liang (2016) point out that complete disintermediation is impossible in practice because there is still the need to have some control over BCT, particularly in the financial sector. Also, this study earlier found that BCT cannot disintermediate the roles of auditors, and it can be argued that Bitcoin and other cryptocurrencies' operations are not completely decentralised as originally claimed. There are various actors (miners, crypto exchanges, and brokers) who act as gatekeepers in crypto operations. ACA5 confirmed this argument, “You can go to a company like Microsoft or IBM or Oracle, and they will not only install the BaaS, but they'll run it for you. In other words, IBM will take on the role of being the gatekeeper and the guardian of the data.” Recently, KPMG in partnership with Microsoft offered the Microsoft Azure BaaS solution to provide different technical services to their clients (KPMG, 2017).

ACA6’s view corresponds with Oreg's (2003) position on why people resist change. ACA6 notes “You've also got an inherent reluctance for people to change to something that they don't know about. So that's just an emotion. And people say our current systems work okay, but they don't really work okay.”

8.4.2.2 Fear or Resistance to Change – Audit and Assurance Firms’ (AAF) Views

Supporting the view of the academics group, some participants from the accounting and auditing practitioners had this to say:

> People. I say that because right now if you want to implement a system by yourself at your company you only have to convince many bosses within your own company. If you want to implement a blockchain and you have counterparties they all have to get on the blockchain too. Blockchain is a team sport, people are 100% the number one reason why more companies and people aren't using blockchain. (AAF7)

> Barriers, I think one is in new technology, there's always resistance to adopting a new process or new system functionality, change in general, and how you take people on the journey and get them to accept that this would become a new norm. (AAF3)

Corroborating the view of AAF3, Vovchenko et al. (2017) posit that employees are always unwilling to accept changes arising from the introduction of new technologies. Similarly, AAF8 thinks the human barrier is the obstacle to BCT adoption because it will be difficult to harmonise and implement a single protocol for all clients with different accounting systems. S/He concludes, “It just difficult, difficult in a sense of a barrier from human because they may not want to join this BCT for any reason. But what AAF8 did not consider is that where BCT is a regulatory requirement, it will be easier to get the cooperation of all clients.

8.4.2.3 Fear or Resistance to Change – Accountants and Auditors’ (AAD) View

From the AAD group perspective, AAD1 asserts that

> … in terms of actually moving forward with the change considering that the existing processes have been in place for a very long time, we all know a lot of times it is very difficult to change some things that are not broken. In this case, in the accounting profession, there have been so many accounting software in the market, auditors are doing a great job and all that. So, beginning to make a proposition to use a system that will change everything and probably make auditors to retrain and acquire new skills will receive pushback and resistance from some quarters in many organisations. (AAD1)

However, AAD4 suggests that the entire change management could be managed where the users are happy with the technology and they can see the value added to their job. Davis et al. (1989) posited that “Computer systems cannot improve organizational performance if they aren't used. Unfortunately, resistance to end-user systems by managers and professionals is a widespread problem (p.882).” In practice, it is not as easy as AAD4 claimed because individuals resist innovation for different reasons. Nonetheless, from the perspective of the accounting practitioners and academics, this study found that fear or resistance to change is one of the great barriers to BCT adoption.

Overall, despite the issue of resistance to change being a common phenomenon in the adoption of any innovation, most participants from academia, and accounting practitioners from both Big 4 and non-Big 4 firms considered it a major barrier to the adoption of BCT.

8.4.3 External Environmental Context

The external environment influences the adoption and non-adoption of innovation. Studies by (Daluwathumullagamage & Sims, 2020; Saheb & Mamaghani, 2021; Ullah et al., 2020; Volberda et al., 2013) have suggested that environmental elements such as government regulations, competition and infrastructure support can encourage or discourage innovation adoption. Participants from this study highlighted the absence of regulatory guidance or accounting standards, high investment cost and its use in the underground economy as barriers to BCT adoption.

8.4.3.1 High Cost of Investment – Accountants and Auditors (AAD) and Audit and Assurance Firms’ (AAF) Views

Participants from the AAD and AAF groups state that the high cost of investment is a barrier to the adoption of BCT. The participants considered switching costs, cost of training, and incidental expenses make the technology expensive and can hinder its adoption. BCT is also regarded as a high-risk investment. AAF2 notes, “Technically, they're expensive and they’re slow. …If you're treating a blockchain as a distributed database, then you don't really get any functional benefit, but you get more costs.” Other accounting practitioners also expressed their concern about cost as a barrier to the adoption of BCT:

> I think a lot of big corporations even governments may not want to fully adopt blockchain, you need to train a lot of manpower and hire more consultants. The cost is another obstacle. Currently, in the middle of the pandemic, a lot of companies and governments are losing money, it may be a lot difficult to implement blockchain in this environment. (AAD5)

> I think blockchain at the moment is very much viewed as rightly or wrongly as almost, I want to say gambling and gambling is probably not the right word for it, but it's the same as the perception as it's a high-risk investment or it's a high-risk asset to hold. (AAF3)

The view of AAF3 describing BCT as a high-risk investment or asset to hold may be based on the market volatility of Bitcoin and cryptocurrency operations. Pirrong (2019) notes that many of the proposed BCT non-crypto currency applications are quite expensive, and that cost will play a major role in determining the feasibility of BCT non-crypto currency applications against the existing legacy technologies and ERPs. Similarly, high sustainability cost is among the barriers to BCT adoption (Biswas & Gupta, 2019). Contrarily, the adoption of BCT will lead to cost reduction especially cost associated with intermediation (Guo & Liang, 2016; Saheb & Mamaghani, 2021).

Nonetheless, organisations will incur substantive costs to switch their current system to BCT which certainly will impact their decision. Some organisations are currently offering BaaS which can eliminate huge investments in hardware and infrastructure (Bhatia et al., 2020). Perhaps, those who claimed BCT adoption will involve a huge capital outlay did not consider that some IT vendors now offer BaaS. It could be argued that cost becomes a barrier where huge capital is required for investment in the adoption of BCT.

8.4.3.2 High Cost of Investment – Academics (ACA) and Blockchain Start-ups and IT Experts'(BSIT) Views

The participants from academia and blockchain start-ups also thought the cost is a barrier to the adoption of BCT. They expressed concern about the cost associated with BCT deployment and post-implementation maintenance. ACA3 suggests cost will make any organisation think of options of whether to build BCT in-house, hire experts to build it or acquire a blockchain-based company. S/He notes, "We'll also look into how much would it cost to build a blockchain solution, there is uncertainty on the maintenance, expansion, and post-implementation costs that I think [it] is not clear yet."

Similarly, ACA5 point out, "I think because of the switching costs…. I can recognize also that the costs of getting from here to there are really pretty high." S/He went on to say that the process will be gradual, and the movement would be led by start-up companies because well-established companies with many accounting systems would be reluctant to disrupt existing systems and pay the costs of migration.

The BSIT group also supported this argument. BSIT5 thinks the cost of adopting BCT is high and outweighs its benefits. S/He notes:

> The costs are prohibitive and then we've just got too [much] other things going

> on. …Cost is a big part of it for me; the cost of [xxxx] at this point outweighs the benefits. It matters for me, there are no benefits by the time we pay versus the likes of [xxxx] which is free. Free to the export order anyway, the carrier pays but there's no cost to our company. (BSIT5)

Kshetri (2017) claimed that the application of BCT will lead to significant cost reduction and backed this claim with examples of the BCT supply chain activities of Maersk, Everledger and Modum. Previous studies that supported Ksheri's position include (Clohessy & Acton, 2019; Ullah et al., 2020). The hands-on experience of BSIT5 contradicted this claim. There is a cost associated with using this BCT platform for supply chain and shipping documentation which the vendors are often silent about.

BSIT6 shared his/her experience about the cost of building BCT as a start-up firm:

> Another barrier is the industry is changing so quickly that it takes a lot of money to build something in the industry. Here's the example that I give. I started [xxx] as a start-up before this Blockchain as a Service. We built [xxx] and everything was decentralized, so we created a decentralized blockchain. This idea of permissioned blockchain came along, and we realized that that was a better fit. I had already built out something decentralised, and I had to pivot to execute permissioned blockchain. That was a good decision, but it wasn't a straight line, I was going this way and then had to do a pivot. They were going along here and realizing that now the industry has Blockchain as a Service. So instead of having all these programmers maintaining our blockchain and not always knowing what they were doing, I could just pay a small fee and have this big company do it. I pivot it again. Each pivot is expensive. (BSIT6)

The participants believed that a prohibitive cost will be a deterrent to BCT adoption because organisations need to weigh the benefits against the cost. It could be argued that BCT has to be cost-effective to the users to enhance its adoption, but it is also relevant to point out that cost may not be important where BCT is a regulatory requirement. As highlighted by BSIT6, the issue of cost, particularly building an in-house BCT, can be mitigated by subscribing to BaaS. Ullah et al. (2020) further asserted that BCT has created cost reductions in different business sectors and reduced transaction costs. However, relying on the participants' practical experience, the study found that the high cost of implementing BCT is an obstacle to its adoption, thus contradicts the assertions by Kshetri (2017); Ullah et al. (2020)

but agrees with the view of Biswas and Gupta (2019).

8.4.3.3 Absence of Regulatory Guidance and Accounting Standards – Blockchain Start-ups and IT Experts' (BSIT) and Financial Analysts and Other Experts' (FAE) Views

The lack of a regulatory framework for the adoption of BCT has been identified as one of the obstacles to its adoption in different studies (Bag et al., 2021; Karuppiah et al., 2021; Lohmer & Lasch, 2020; Mathivathanan et al., 2021; Saheb & Mamaghani, 2021). This study found that the absence of regulatory guidance and accounting standards has constituted a major barrier to BCT adoption. The participants noted that a lack of clear guidelines has reduced their appetite for investment in BCT because such a regulatory framework would guide the classification/treatment of investment in cryptocurrencies and related investments.

These are some of the views expressed by the participants from the BSIT group:

> It's the governance challenge, who defines those rules, who advises or how do regulators come up with proper rules, and those are conversations that happen all the time right now. (BSIT10

> I reckon one of the big ones is the regulatory framework, which is something I think every country is challenged with right now. How do we regulate it? Even, how do we audit it? That's one of the big challenges, right now. There is very little governance or authoritative guidance on how to audit things that comes from blockchain technology. Right now, organisations have to kind of make that up if you will. You can have crypto-assets in an exchange, in your own wallet and there're different definitions of you really own that or not. So, firms or auditors have to make the decision if they are using an exchange, does the information from the exchange actually provide evidence of ownership or do they have to be in a wallet to be considered a crypto-asset. I think one of the primary challenges for an organisation in adopting blockchain technology is understanding what the governances around it and rapidly changing regulatory landscapes when it comes to blockchain technology. Again, some of the challenges are due to the lack of authoritative guidance when it comes to auditing digital assets or any transaction that comes from the blockchain. (BSIT3)

Similarly, FAE5 observed that the change is not only the absence of a regulatory framework but also a lack of technical expertise of the regulators. S/He explains:

> A combination of regulatory caution, fear, and a lack of technical know-how on the regulatory side. I think it's a very different context to something like mobile money in East Africa, where the Kenyan central bank was prepared to stand back and let it play. I think because of the global systemic risk of watching something like crypto that's never going to be allowed to happen. (FAE5)

Mbunge et al. (2021) note that a lack of regulatory and standard framework by WHO on the integration of BCT in health care management is a barrier to technology adoption. The regulatory requirement is important but should not be seen as a blanket barrier to BCT adoption. It can be argued that the area that this regulatory pronouncement is important but should not be a condition to stifle the development of BCT and other emerging technologies because some areas require more regulations than others. It is unlikely any regulator will worry whether a company uses BCT for tracking of goods, shipping or record keeping, but people will be concerned for finance and health purposes.

The position of FAE5 that the operation of blockchain Bitcoin is not the same as mobile money in Kenya is valid because that system has a regulatory framework and target population, unlike decentralised BCT crypto operations. Similarly, it is difficult to contest the narrative of BSIT3 about the negative impact a lack of authoritative guidance on digital assets is having on auditing and accounting.

8.4.3.4 Absence of Regulatory Guidance and Accounting Standards – Academics (ACA) View

Academics participants in this study also believed that lack of regulation and auditing standards are barriers to BCT adoption. ACA6 points out, “One of the things will be like auditing standards because I know that the last round of changes in auditing standards took years.” ACA1 explains:

> In my understanding, the first one would be the regulations. Because since the technology is not mature we don't have very established regulations right now. It's a global matter not only about the big countries like the United States or countries in Europe or Asia countries like China. It’s a global issue I'm seeing in different papers, talking with a couple of people that are saying, okay, we need this technology for the future. But we need to bring some frameworks or the infrastructure to put it in the right place to be able to actually take advantage of that technology, that is I think the first one. (ACA1)

Likewise, ACA3 thinks the challenges are legal and regulation uncertainties because governments want to have control over the financial system and there is no single person or entity that controls the BCT cryptocurrency system. S/He notes that there are arbitrary signals from governments and regulators because some countries allow cryptocurrencies while some others outlawed them. Mathivathanan et al. (2021) also identified regulatory uncertainty as an obstacle to harnessing BCT potential opportunities and the likely undesirable consequences. This is further regarded as a deterrence to potential adopters (Choi et al., 2020). It could be argued that investment in BCT is being stifled because of the blanket ban on cryptocurrencies by some countries, which may affect the overall adoption of BCT.

8.4.3.5 Absence of Regulatory Guidance and Accounting Standards – Accounting Regulatory Bodies' (ARB) and Accountants and Auditors' (AAD) Views

The ARF and AAD groups also note the absence of regulatory requirements for accounting and auditing of BCT as a barrier to its adoption.

AAD2 suggests that the biggest barriers include clarity about compliance, the requirements for accounting and auditing, and the classification of BCT on a balance sheet. Is it cash, an investment vehicle, or a commodity? S/He notes that cryptocurrency has been classified, except in Japan, as a long-lived intangible asset such as a patent or goodwill or license. Similarly, AAD6 states that the barrier facing the accounting and auditing profession regarding BCT is the absence of auditing standards. S/He observes that audit and assurance firms that audit BCT are currently using their professional judgements because there are no standards to adjudge the risks and rewards. AAD2 concludes:

> There's no guidance on that, no one says you have to do it that way but that's what a lot of the accounting firms are coming out and saying, and unfortunately that's not a faithful representation of the economic phenomena. So, the lack of guidance is certainly a hindrance. AAD2

ARB6 also argues that regulation is a barrier because BCT is expected to be used across international borders. S/He explains:

> The other thing is the regulatory dimension, there's a big piece around governments and regulators because this is an ecosystem technology and a lot of the use cases which I was explaining to you are cross border use cases. If

> you have countries in different parts of the world or an international supply chain where they're following different regulations and jurisdictions laws. There's going to be a problem there because they all need to agree on a common way of dealing with blockchain-based backend. A lot of these back-end technologies so that also is going to be definitely an issue, I think it's going to be a big consideration to deal with. (ARB6)

The existing financial regulations are inadequate for BCT operations (Yeoh, 2017) and this has led to different approaches to BCT by different regulatory authorities in many countries. Some adopted proactive measures while others are reactionary in their approaches. Uncertainty exists about the regulatory requirements in many jurisdictions regarding BCT operation, particularly the cryptocurrency operation. There are mixed signals across the globe. Countries like Nigeria, Turkey, China, India, Thailand, and a few others have made trading in cryptocurrencies illegal within their territorial spaces. In December 2020, the Economic Times reported that the Reserve Bank of India has requested a total ban on cryptocurrencies in India.[27] However, some of these countries particularly Nigeria and China, have issued BCT-enabled digital currencies known as eNaira and eRMB[28] in addition to their fiat currencies which are Naira and Yuan respectively. Despite these mixed positions by some countries, many countries have shown great interest in the applications of BCT for service delivery; UAE, Honduras, Estonia, New Zealand, Ghana, and Japan (see Chapter 2.8). The UK, EU, US and Australia have introduced some financial regulatory guidelines for BCT-enable financial operations (Daluwathumullagamage & Sims, 2020; Paech, 2017; Yeoh, 2017) and New Zealand was the first country in the world to legalise cryptocurrencies for salary and wages. These examples indicate that the regulatory framework is evolving as BCT matures.

However, there is no unified accounting standard concerning the classification of Bitcoins and other cryptocurrencies. "Blockchain-held assets differ markedly from assets held in more traditional, account-based structures" (Paech, 2017, p. 1097). The author further suggests that it may be difficult to formulate tailor-made legal and regulatory frameworks for multiple BCT networks, but a set of global standards

[27] https://economictimes.indiatimes.com/news/economy/policy/in-favour-of-complete-ban-on-cryptos-rbi-to-central-board/articleshow/88350099.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

[28] http://fintech.xinhua08.com/a/20210618/1990883.shtml

are required (Paech, 2017). The absence of accounting standards remains a barrier, but this may be receiving attention from bodies responsible for formulating accounting and auditing standards. As rightly pointed out by (Wall Street Blockchain Alliance, 2020) "Accounting and financial professionals are not the final say on regulations but have an important role to play in how these regulations are ultimately crafted (p.15)."

Thus, the need for accounting and auditing standards governing BCT cannot be over-emphasised to help with the accounting classification and auditing of BCT. However, Yeoh (2017) suggests that unintended consequences of BCT could spur the regulatory authorities to establish a governance framework for the technology. Overall, the study found from the practitioners and academics interviewed that the absence of regulatory guidance and accounting standards is a major barrier to BCT adoption. The next section examines the unintended consequences of BCT adoption.

8.5 Unintended Consequences of BCT as a FinTech

Previous studies (Akter et al., 2021; Choi et al., 2020; Clohessy & Acton, 2019; Orji et al., 2020; Saheb & Mamaghani, 2021; Seshadrinathan & Chandra, 2021) have used TOE to analyse the opportunities for and barriers to the adoption of BCT in different industries but none has empirically examined the unintended consequences of adopting the technology. Rogers (2003) pointed out that despite the importance of innovation consequences, researchers have paid little or no attention to outcomes of innovation adoption. The author further acknowledged the difficulty and uncertainty associated with predicting and generalising the likely consequences of adopting a technology (Rogers, 2003), but emphasised the need for pro-innovators to highlight both the merits and demerits of an innovation. Supporting Roger's position, Bai and Sarkis (2020) note that it is difficult to predict BCT performance outcomes before implementation, but suggest the need for decision-makers to consider both the possible gains and losses associated with BCT before adopting it.

This study is different from many of the existing studies because it attempted empirically, from the experience of the participants, to examine the known unintended consequences of adopting BCT as a FinTech in addition to the technology's incentives and barriers. The study of consequences is complicated because the outcomes of innovation should be observed over an extended period and a short survey method will not yield rich data for generalisation (Rogers, 2003). This study is mindful of these limitations as it was based on perceptions of the interviewees from a small sample size, in addition to BCT being an evolving technology, barely over 10 years old, which has not been fully implemented outside cryptocurrency operations. Nonetheless, the study predicts some unintended consequences of adopting BCT as a FinTech which could be useful as more industries embrace BCT innovations.

Consequences can be desirable or undesirable. Desirable consequences are regarded as functional effects of innovation on an individual or a system while undesirable consequences are dysfunctional effects (Rogers, 2003). The emphasis of this study is on the later, unintended consequences of BCT using TOE as an analysis tool (see ***Figure 24***).

This thesis found that the majority of participants acknowledge that it is hard to know the real undesirable consequences of adopting the technology because the technology is immature and subject to social changes. Nonetheless, the participants highlighted breaching of privacy, killing of sovereign currency and irreversibility of errors as unintended consequences of BCT. The researcher categorised these under a technological context. Additionally, participants suggested that another unintended consequence is where organisations did not derive the potential benefits of BCT due to a mismatch of its application to the business needs, thereby leading to waste of resources and mass adoption of private blockchain. This is categorised under the organisational context. Other unintended consequences mentioned include BCT becoming a regulatory tool of governments, conflict due to non-unification of accounting concepts, and loss of jobs. These were categorised under an external environmental context. The emerged main themes and subthemes are discussed below:

8.5.1 Technological Context

Judgement regarding innovation consequences is often subjective and value-laden irrespective of the study's participants (Rogers, 2003). Predicting the adoption and diffusion trends of BCT is difficult in light of the challenges facing the technology (Pennington, 2020). The other areas that the study's participants mentioned as the unintended consequences within the technological concept include the advent of quantum computing, use for criminal activities, flawed coding, high transaction costs and limited life-span of Bitcoin application.

8.5.1.1 Hard to Know – Blockchain Start-ups and IT Experts (BSIT) and Academics' (ACA) Views

The study found that many of the participants believe that it is hard to know the undesirable consequences of adopting BCT now since the technology is still evolving and at various pilot stages. The BSIT and ACA groups expressed their views about the unintended consequences of adopting BCT as follows.

> That is a little bit of a tricky one. The reason why I say that is because I don't have a crystal ball so I can't see a future, I mean, unintended consequences. I think that there are many, and they are good and bad. I think this is a difficult question, unintended consequences. (BSIT1)

> I can say the main one is that since the technology is still evolving nobody knows the right answer about the technology. We are just learning more about the features, advantages and disadvantages, but we don't know how it's going to impact [in] the big picture systematically. (ACA1)

> It's actually hard to know because if we thought of them in advance, they wouldn't be unintended, that almost by definition, you're talking about things that surprise people after their onboarding. (ACA5)

ACA5 supported this argument by pointing out that Nakamoto, the founder of Bitcoin thought he created an anonymous system and the early users of the currency thought so, particularly those using it for criminal activities. However, the reality is that those criminals using Bitcoin were caught because it is relatively easy to match cryptocurrency wallets with the identities of their owners in the real world. Many scholars (Bashir, 2018; Chen et al., 2020; Ferrag et al., 2019) have argued that the Bitcoin blockchain is not fully anonymous because it is possible to identify and link accounts to the real owners.

8.5.1.2 Hard to Know – Accountants and Auditors' (AAD) and Audit and Assurance Firms' (AAF) Views

Some practitioners from the accounting and auditing firms also held the view that it is hard to tell in advance what the unintended consequences of BCT as a FinTech will be. AAD1 believes it is not easy to know what the consequences of BCT will be but compares its emergence to the Internet and mobile phones. S/He states:

> To be honest, we simply can't know yet because just like you said when the Internet came up, it was all joy, this is changing our lives. When the mobile phone came, I mean everyone just wanted to get one because it is going to change our lives. (AAD1)

AAD1 further argued that there are downsides to using the Internet and mobile phones which were never envisaged but these came to light after the adoption. Similarly, AAF2 thinks it is hard and difficult to know the negative consequences of BCT because it is hard to know where the technology is going to end up. S/He explains:

> It's kind of really hard because we're talking about something that's going to be socially determined and you don't know until you get there… It's like radium. The reason we had radium girls and people licking radium is because we thought radium was for healthy people, that it made you healthy. "It cures, cancer, it must be good for you!" Well, not so much…(AAF2)

A common view amongst this study's interviewees was that until BCT becomes mainstream technology in non-cryptocurrency applications, the unintended consequences of its adoption as FinTech remain hazy.

8.5.1.3 Harmful to Privacy and Irreversibility of Errors –Accountants and Auditor' (AAD) and Audit and Assurance Firms' (AAF) Views

As previously pointed out in Chapter 2, Section 2.6, the user privacy has been a major concern to all stakeholders in a BCT-enabled environment. Some studies (Banerjee et al., 2018; Casino et al., 2019; X. Xu et al., 2019) have identified it as a limitation to the adoption of technology especially the public blockchain where all participants may have access to records on a BCT ledger. The privacy concern is less of an issue in a private blockchain because there are access restrictions and control governance over data management (Bhatia et al., 2020).

The immutability of records on BCT is described as both a benefit and disadvantage. The BCT immutable record of transactions has been described as a feature that could help with fraud detection since no user can amend validated transactions (Yermack, 2017). The permanence of records has made some scholars like (Coyne & McMickle, 2017) assume that the BCT ledger is not suitable for the accounting recording system because of the impossibility associated with the correction of genuine mistakes. Further, government and regulators are not favourably disposed to BCT tamper-resistant quality (De Filippi & Wright, 2018). However, it has been commonly assumed that BCT ledgers could not be tampered with or modified. According to a recent report, (see Brandom, 2019), hackers disrupted Ethereum Classic blockchain, stole the coins, rewrote the BCT ledgers and double-spent. This is arguably something considered unlikely in a BCT transaction system

Some of the practitioners from accounting, audit and assurance firms in this study see harm or breach to users' privacy and irreversibility of errors as the unintended consequences of adopting BCT as a FinTech. AAD5 and AAF1 could be taken as the representative views of these groups.

> I think making things public, you don't want to expose someone's privacy, but it may have privacy concerns, eventually. Imagine you have invested in a few companies and all those companies started using the blockchain and now your wealth is a public thing. You may have some right to privacy, you do have some right to privacy of information, but that may be harmed. (AAD5)

> Privacy laws are probably going to be really key so that information that was designed to be private is kept private. I think decryption, I know you can have different levels of visibility or different levels of decryption for different blockchains depending on what you want the users to see. Sometimes you can have transaction parties have full visibility, sometimes regulators can have partial and in the public and of course no visibility. So, you might just have to administer that privacy or have a look and see that people don't get the information they shouldn't get. (AAF1)

It is important to reiterate that the privacy concern noted by the participants about the use of public blockchain cannot be empirically established because there are no public non-cryptocurrency blockchain applications yet. Most of the existing piloted and launched BCT programmes are permissioned blockchains. Even in the blockchain cryptocurrency world, the idea of having access to the BCT public ledger could be described as illusionary because only technically savvy individuals or miners understand the codes behind such a ledger.

Regarding the irreversibility of records, AAF5 notes that:

> I think the two biggest unintended consequences are. One, we move from a trusted environment where mistakes can be rectified by human beings to the

> one where inevitable mistake are encoded in computer codes and are potentially uncorrectable. That's number one. (AAF5)

The irreversibility of entry into BCT is a double-edged sword. It depends on which side of the argument the writers' favour. The general position is that updating added data and transaction history on BCT is impossible once completed (Bhatia et al., 2020; CAANZ, 2017; Galvez et al., 2018; Gao et al., 2018). However, Bhatia et al. (2020) claimed that data could be erased on BCT using irreversible encryption because it is possible for the BCT programmers to use smart contracts to make transactional records or data cryptographically inaccessible on a blockchain. The authors further acknowledged that there is uncertainty about whether cryptographically inaccessible data on BCT is permanently removed or just inaccessible from the network (Bhatia et al., 2020). Through collusion from malicious miners with over 51% computing power, scholars (Alketbi et al., 2018; Alkhudary et al., 2020; Coyne & McMickle, 2017) think that records on BCT can be modified.

Biswas and Gupta (2019) refer to the irreversibility of mistakes in a BCT system as one of the barriers to its adoption. Contrarily, Chang et al. (2019) believe that the immutability of records will help in validating contractual agreements and reduction in trade disputes since no one can tamper with them. In practice, there is a provision for lawful destruction of data or right to be forgotten or granting of pardon to convicts, the management of things like these in an immutable BCT ledger system calls for caution. This feature like the right to be forgotten is said to be missing in the original conception of BCT developers (Bhatia et al., 2020). This inflexibility in modification of genuine mistakes or errors made the participants in this study believe it is an unintended consequence since BCT leaves no room for correction of errors.

Consistent with the literature, this study found that participants believed that the privacy of users could be harmed and immutability of records was among the unintended consequences of adopting BCT as a FinTech.

8.5.1.4 Use for Criminality – Blockchain Start-ups and IT Experts (BSIT) and Academics (ACA) Views

One of the assumed public perceptions about BCT is that it would be used for criminal purposes (see Chapter 2, Section 2.6.5). This kind of perception may not be unconnected with the use of Bitcoins and other crypto assets on the dark web. Thus, it is unsurprising for this study to find that many of the participants believed that the use of BCT has given rise to cyber-security concerns and led to an increase in money laundering, tax evasion and transactions on the dark web. These activities are tagged as unintended consequences of the technology. BSIT10 and ACA4 capture the position of these groups:

> I think there are a couple of very specific unintended consequences. One is the evolution or the expansion of cyber-security concerns. What I mean by that is many people have this image in their mind that blockchain is totally secure and will always offer a more secure way to manage transactions which it does at its core, but it also changes what we call the risk surface or the risk vectors for cybersecurity and you mentioned that earlier, the public and private key management. The potential unintended consequences of not properly managing private keys are part of the challenge as well and I think the unintended consequence. (BSIT10)

> Facilitation of bad actors and their transactions, the idea of anonymity which is not real anonymity but it’s actually a pseudo-anonymity, those are unintended consequences of it. (ACA4)

BSIT1 assumed that the way the Internet and cash have been used for illegality and illicit transactions, cryptocurrency could facilitate illicit online transactions. Despite this, BSIT1 believed that many of the people who have used BCT for dishonest purposes were eventually found out, thus the public ledger outlook of BCT will facilitate detection of such bad actors. It could be argued that the facilitation of illegal trading is not a phenomenon associated with Bitcoin blockchain only, the Internet, cash and other technologies have been used for different illicit transactions. New Zealand Cryptopia Exchange (currently under liquidation) was reported to have suffered multiple hacking attacks since the initial hack in 2019.[29] However, considering the security architecture of the BCT distributed ledger, the originator of BCT Bitcoin never envisaged frequent hacking of blockchain cryptocurrency applications and the use of the platform as a tool for criminal activities. Nonetheless, the view of some participants that BCT has become a tool for criminal activities could be said to be valid.

[29] https://www.coindesk.com/policy/2021/02/20/cryptopia-exchange-currently-in-liquidation-gets-hacked-again-report/

8.5.1.5 Use Quantum Computing to Break BCT Encryption – Academics (ACA) and Accounting Regulatory Bodies' (ARB) Views

The previous chapter (see Section 2.6.3) highlighted how the security architecture of BCT is likely to be threatened by the advent of quantum computing. Some scholars (Eddy, 2016; Fedorov et al., 2018; Pawczuk et al., 2020) postulated that quantum computing is capable of breaking the encryption codes behind BCT. The study found that some academics participants consider that the use of a quantum computer to decrypt BCT encryption code is an unintended consequence. ACA4's view can be taken as a representative view.

> Another unintended consequence, Bitcoin built on the encryption protocol SHA256. Security people love to throw this on the face of Crypto people. They keep saying when will finish working on quantum computers, all your security is going to be completely meaningless, and we'll be able to get easy access to your coins because a quantum computer ought to be able to crack SHA256 hashes within minutes or seconds. So, advances in computing technology may render all these security protocols meaningless which opens up a whole lot of people's wallets to theft. (ACA4)

The position of ACA4 is in line with the postulations of some studies (Eddy, 2016; Fedorov et al., 2018; Pawczuk et al., 2020; Prewett et al., 2020; Reyna et al., 2018) that the advent of quantum computing will render the cryptographic security of BCT ineffective. However, the accounting regulators hold contrary views and ARB3 captures this:

> Some are people are talking about quantum computing that these computers are so advanced that they'll be able to break the code that is protecting the blockchain, that's cryptography. I don't think so. From the literature I am reading, it says that that's not going to be the case because as quantum becomes more sophisticated, cryptography will become more sophisticated. (ARB3)

BCT and quantum computing are emerging technologies and it is hard to conclude whether the advent of the latter will enhance the decryption of BCT applications. Rohde et al. (2021) acknowledged what they described as cryptographic primitives of the blockchain (digital signatures, hashing and PoW) as vulnerable to the deployment of quantum technologies, but expressed caution that a quantum hacker may not be motivated where the cost outweighs the gain of attacking BCT cryptographic assets. One could argue that, like any other hacking incident in the IT environment, hackers are motivated by the financial incentives or gain and the deployment of quantum computing to attack BCT encryption may fall within the same scope.

The doubt expressed by ARB3 about the possibility of using quantum computing for the decryption of BCT security codes sounds logical because as technologies evolve a lot of new features emerge with them. Theoretically, there is a possibility that with quantum computing anyone can crack the irreversible Bitcoin hash SHA256, and the same technology could be used to enhance BCT encryption. These scenarios are yet to be seen in practice, but it could be a valid argument to assume that one of the unintended consequences of BCT adoption is the use of quantum computing to break its encryption.

8.5.2 Organisational Context

Within the organisational context, some participants see the mismatched firm's need with BCT and the mass adoption of private (permissioned) blockchain as unintended consequences. Ben Rejeb et al. (2011) note that uncertainty, complexity, and risk are associated with assessing innovation, and the absence of required knowledge at the beginning of the innovation process makes things more difficult for organisations. Evidence from previous studies (Appelbaum & Smith, 2018; Walch, 2015) has shown that many of the ongoing BCT pilot schemes are favourably disposed to the adoption of private blockchain systems which is against the main idea of open and distributed blockchain systems.

8.5.2.1 Mismatch of BCT Application to Firm's Need – Audit and Assurance Firms' (AAF) View

The AAF group termed the outcome of organisations mismatch of their needs with the BCT applications as an unintended consequence of adopting the technology. The views of AAF2 and AAF7 explain the group's position:

> There could be unintended consequences if we use blockchain where it's not appropriate and we end up with systems that don't have the benefits we thought. (AAF2)

> As far as unintended consequences, if you didn't do proper scoping and you picked blockchain, it wasn't the actual solution to your problem, so maybe you wasted a bunch of money. … Unintended consequences are virtually always

> the result of poor needs analysis. (AAF7)

Glaser (2017) observes that practitioners and researchers are yet to grapple with the understanding of BCT development, particularly on how the technology will be integrated with existing infrastructures because it is still at its infancy stage. The classification of mismatched BCT applications to firms' needs by the accounting practitioners is possibly premised on the assumption that the BCT adoption decision is made by the business sector focusing on the likely economic incentives associated with the technology. The AAF group, perhaps, did not give priority to where the adoption of BCT is a regulatory requirement that organisations have no choice but to adopt.

Undoubtedly, organisations need to undertake a business need assessment before adopting any innovation to avoid waste of resources, but where innovation is pushed by the external environment such as the ongoing CBDC, there is little or nothing any organisation can do. It is not out of place to say that the outcome of inadequate need analysis by an organisation will be an unintended consequence to them.

8.5.2.2 Mass adoption of Private (Permissioned) Blockchain – Academics' (ACA) View

The ACA group believe that the mass adoption of private (permissioned) blockchain is a major unintended consequence of adopting BCT. The proponent of BCT wants an open, transparent, and decentralised financial system where all middlemen are disintermediated (Ali et al., 2020; Kosmarski, 2020; Yadav et al., 2020). The academic participants consider that there is an uptick in private blockchains which is against the spirit and letter of the founder of the Bitcoin blockchain and the BCT-enthusiasts. ACA5 elucidates:

> I think the model that has really emerged in industry with great speed is the permissioned model, where you have the powerful gatekeeper, and the whole mission of Nakamoto was to get rid of the trusted third party, but as far as I can tell you are just reintroducing that third party, maybe even making them more powerful than they were before. And I don't know if this is an unintended consequence or maybe I would just call it an ironic outcome that the wide adoption of this is to reinforce the power of the third party rather than to undermine it, which is the opposite of what Nakamoto was trying to achieve. (ACA5)

Going by the main proposition behind BCT, the use of private blockchain as a FinTech is an aberration and indeed an unintended consequence. Although, cryptocurrency operations claim to be open and decentralised, it is rare to come across any public BCT in practice that is truly decentralised, including those in pilot programmes by governments and regulatory agencies. The permissioned model of BCT is considered more appropriate for enterprise applications (Bonsón & Bednárová, 2019), has a higher chance of adoption in supply chain management (Kshetri, 2018) and is suitable for supply chain and accounting transactions (O' Leary, 2017).

8.5.3 External Environmental Context

The study found that participants believed that BCT becoming a regulatory tool in the hands of governments, and possible disruption or loss of jobs are unintended consequences of its adoption as FinTech. Despite the BCT's potential to bring disruption to business processes, the technology still needs to overcome some barriers like throughput, privacy and security, and block size (Chang et al., 2019; Walport, 2016).

8.5.3.1 Control Tool by Government and Regulatory Agencies – Blockchain Start-ups and IT Experts' (BSIT) View

The view of some participants in the BSIT group is that some aspects of BCT adoption will result in centralisation, especially with the advent of CBDC. This is simply captured by the view of BSIT9:

> There is also a systemic risk. The banking world right now is decentralized, each bank has its own database, and your account is kept in that database under lock and key. We're actually becoming more centralized if you move to a central bank digital currency with a shared ledger. The nodes are decentralized, but the system itself is centralised. If any bank office isattacked, one exploit can take the whole thing down, whereas that can't happen today. The other big risk is systemic in moving to a more centralised system in my mind. (BSIT9)

BSIT9 argues that the adoption of CBDC will lead to the direct connection from the central banks to individual citizens which may affect the credit flow and the money supply since this arrangement may empower the banking regulator at the expense of the commercial banks. This view contradicts Cai (2018) who claimed that, "Bitcoin, for example, has eliminated the classic intermediary of central banks (p.984)". The fear of BSIT9 that CBDC will move the banking system to a centralised system, though a valid proposition, is yet to be seen in the practice. The operation of CBCD will still be through the commercial banks who could perform the similar roles of gatekeepers, opening of digital accounts and KYC. For instance, the guidelines issued by the Central Bank of Nigeria on the CBDC still exclusively preserve the role of financial institutions as intermediaries, thus, citizens are expected to operate their eNaira accounts via commercial banks.[30] Also, in 2021, China launched ATMs for their digital currency through commercial banks.[31]

Nonetheless, this does not remove the substance of the view of the BSIT group that with CBDC, the banking sector is moving towards a centralised system which is against the original idea of blockchain. It is also likely going to put more power in the hands of governments and central banks.

8.5.3.2 Control Tool by Government and Regulatory Agencies – Academics' (ACA) Views

Similarly, the ACA group believe that the unintended consequence of adopting BTC as a FinTech is the concentration of more power in the hands of governments. This view challenges the assertion by Bhatia et al. (2020) that BCT will affect the roles of governments through the decentralisation of authority. ACA5 explains:

> You may have seen the story last weekend that the Chinese seized $4 billion of crypto that was used in that big Ponzi scheme. And that's something they really wouldn't have been able to do in the old days. So, I think the concentration of power especially in the hands of the government has been one unintended consequence, and it's 180 degrees opposite. Now, I will say this [that] when I got interested in this, I remember very well was in 2013. Bitcoin was first getting attention from the regulators in the US and the Governor of the Federal Reserve who at the time was Bernanke, was very favourable, he testified in the US Congress, he said this technology has a role to play in the financial system. And for a day or two, I was completely baffled, I thought why would the Chairman of the Federal Reserve endorse this, but then I realized it's the audit trail. This gives the central bank the ability to collect every dollar of tax, to know about every money laundering, it's their fantasy to have this kind of a universal ledger. And I realized right then in there that this was the opposite of what the creators had intended, and that the end-user, in the long run, was probably going to be the government. And to me, that's the

[30] https://www.cbn.gov.ng/Out/2021/FPRD/eNairaCircularAndGuidelines%20FINAL.pdf
[31] https://boxmining.com/dcep/

> most massive of all the unintended consequences, but there are many others that have turned out more or less opposite of what the entrepreneurs had been trying to do when they first launched it. (ACA5)

The view of ACA5 that BCT is being positioned as a powerful tool in the hands of third-party and regulatory authorities is corroborated by Kosmarski (2020) who asserts that BCT is a platform that governments and private firms are using for strengthening their power. Contrarily, Yadav et al. (2020) claim that the support from governments and related agencies is for the benefit of the masses.

It is possible that among the chief reasons the reserve bank and other regulatory agencies are interested in BCT is the ability to use the universal ledger to monitor the financial activities of all citizens and for tax purposes. O' Leary (2017) notes that some features of BCT, particularly immutability and append-only, make it a useful tool for government. The argument that it is an unintended consequence appears genuine where BCT is deployed for a role that is against the inventor's idea of transparency, P2P, and decentralisation.

8.5.3.3 Disruption or Loss of Jobs – Blockchain Start-ups and IT Experts' (BSIT) & Academics' (ACA) Views

Some participants from the BSIT and ACA groups believe that disruption and the loss of jobs that may accompany the adoption of BCT is an unintended consequence. BSIT1 thinks that every corporation that exists today is at the risk of being disrupted top-down by BCT. S/He believes BCT is disrupting business hierarchies through disintermediation of roles thereby leading to job loss. Following are some of the ways the participants from BSIT and ACA groups expressed their views concerning adopting BCT as a job disruptor:

> I also think that the disruption of many different industries that it's going to force a lot of financial industries or financial businesses into bankruptcy. I believe that we're not going to have a lot of the financial institutions that we have today in the future, some of them will be utilising blockchain, but they are going to struggle. In terms of disruption, the disruption is going to be enormous in the financial markets or the legacy financial markets. Also, lots of tech businesses are going to struggle with blockchains. I think it's going to impact businesses such as Google, Facebook, TradeMe, Amazon, Uber, Airbnb, Twitter. Some of the largest tech firms in the world are going to struggle with technology as the technology provides new solutions which have

> replacement essentially. (BSIT1)
>
> So many firms that were doing business the same way they've been doing it for a very long time. They absolutely need to be innovative, the unintended consequence of not trying to keep up is that they will lose business over time. They will lose the ability to service clients in a more and more sophisticated world because of blockchain technology. (BSIT10)
>
> Maybe according to my knowledge, sometimes it will decrease or maybe some people will lose their job as we are talking about removing the intermediary. It will save costs, but the process will replace the intermediary. When we are talking about technologies everything is possible. So, the human element may be lost. So, this is one of the many drawbacks, I think there are consequences that it will affect also maybe organization will close down and not only people will lose their job. Now, the digital currency, if it becomes the main way, so there will be no need for Western Union and other companies that are sending money for customers, and banking and many other things. The technology will change that. (ACA2)

The participants' view that BCT is likely to bring disruption and loss of jobs to different business models is not far from the position of some scholars. For instance, BCT has been hyped to disrupt many business landscapes with possible loss of jobs when adopted (Andoni et al., 2019). BCT is capable of disintermediating some financial related jobs and also can create a new set of jobs (Cai, 2018) and eliminate intermediaries like auditors (Kshetri, 2018). Contrarily, BCT is said to have the potential to create new business models without disintermediation (Carson et al., 2018).

The fear that the adoption of BCT will lead to a massive loss of jobs is a debatable theoretical proposition because the adoption of technology also can lead to the creation of more job opportunities. The suggested roles that some participants have claimed that the use of BCT has the potential to disintermediate them require evidential proof. The next section considers whether COVID-19 has enhanced BCT adoption or not.

8.6 Impact of COVID-19 on the Adoption of BCT

Although some studies (Akter et al., 2021; Choi et al., 2020; Clohessy & Acton, 2019; Orji et al., 2020; Seshadrinathan & Chandra, 2021) have evaluated barriers to the adoption of BCT using the TOE framework, only Akter et al (2021 briefly mentioned the impact of COVID-19 on the adoption of this disruptive technology. This study views this as an important external environmental context considering how the pandemic has disrupted the entire global working system coupled with the craving for new technologies that can enhance intra and inter borders economic activities. The participants were asked, “How has COVID-19 enhanced the adoption of emerging technology like BCT?” This research question was aimed at understanding whether COVID-19 has enhanced BCT or not in the light of different claims made by some scholars that COVID-19 has accelerated the adoption of many technologies.

Some studies (Abd El-Aziz et al., 2021; Joel & Mijes, 2020) have suggested that the outbreak of COVID-19 has enhanced the adoption of many emerging technologies including BCT, and other scholars (Chamola et al., 2020; Khubrani & Alam, 2021; Marbouh et al., 2020) believe that BCT applications will be useful in COVID-19 healthcare management in areas such as clinical trials, contact tracing, record management, prevention, and early detection of vulnerable people. It has been reported that during the COVID-19 pandemic, the UAE government implemented a BCT driven digital distribution system to authenticate official documents and certificates, the Chinese Zhejiang Provincial Commission deployed BCT for medical supplies management, and the US Department of Homeland Security listed a BCT-based platform for food and agricultural distribution purposes (Erazo, 2020a). Similarly, Helperbit, an Italian blockchain start-up, provided a BCT enabled platform for donations of Bitcoins and other cryptocurrencies to the Italian Red Cross, and the Colli Albani Committee for construction of pre-triage medical posts (Erazo, 2020a).

Furthermore, Sharma et al. (2021) designed a BCT enabled food supply chain framework which is capable of mitigating disruption of the COVID-19 pandemic. Similarly, Khurshid (2020) suggested that BCT could be a platform to resolve trust issues associated with COVID-19 health management. However, Abd-alrazaq et al. (2021) acknowledged that BCT applications can play significant roles in mitigating the impact of the COVID-19 pandemic, but a concrete conclusion cannot be drawn because the technology is still in its infancy. Moreover, there is inadequate evidence to support the implementation of BCT in the fight against COVID-19 (Mbunge et al., 2021). This reason, perhaps, prompted (Abd El-Aziz et al., 2021; Khurshid, 2020; Tsikala et al., 2020) to advise governments, health providers, academics and other experts to collaborate in tapping the potential of BCT to resolve the COVID-19 health crisis and quicken BCT adoption in health care.

This study found that the majority of the participants believe that the outbreak of COVID-19 has not accelerated the adoption of BCT. The main reasons provided are that there were no major investments in innovation due to financial constraints facing many businesses and the discussion during the pandemic was mainly about cryptocurrencies as hedge investment. The participants also stated that there are a few cases of successful trials of BCT outside Bitcoins. Mbunge et al. (2021) acknowledge that there is limited evidence on the implementation of BCT during COVID-19. Furthermore, a few of the participants held a contrary view that COVID-19 has enhanced the adoption of the technology particularly Bitcoin and other cryptocurrencies. The participants' views are discussed in each group in the following sub-sections.

8.6.1 COVID-19 Enhances BCT Adoption – Blockchain Start-ups and IT Experts' (BSIT) View

Most participants in the BSIT group believe that COVID-19 has enhanced the adoption of BCT. They claimed that the COVID-19 pandemic has contributed to the surge in the adoption of BCT applications with huge investment in Bitcoins and other cryptocurrencies and digitalisation by corporate investors.

BSIT6 notes that COVID-19 has enhanced the BCT adoption because it has opened people's minds to electronic trade solutions, creating both opportunity and momentum to automate some business processes and significantly reduce reliance on the paper-based environment. Similarly, BSIT5 also believes that COVID-19 has enhanced the adoption of BCT, especially regarding Bitcoin and other cryptocurrencies.

> I think it's helped. It is very much helped because people are realizing how much of a constraint, physical paper-based processes are in the COVID-19 world, where you couldn't we couldn't create stuff, because you couldn't get the carriers, everybody was in lockdown. (BSIT6)

> Yeah, it definitely sped it up. obviously with everybody going remote everything's more digital now. So, you're seeing a lot more people kind of

> participate in online activity. So, the same way that the internet kind of democratised information, access to information for the world. Bitcoin and blockchain [is] democratizing the transfer of value, so anybody can send money to anybody in the world, and you do it online instantaneously. So, as we've kind of been forced to this like digital future through COVID-19 definitely sped up the adoption, as you've seen in the news with some of these large businesses taking huge positions on Bitcoin. (BSIT5)

The BSIT6 view is premised on the recent deployment of BCT-enabled electronic trade solutions for shipping documentation in their company. The argument that large investors invested heavily in Bitcoins as a hedge fund is apt. COVID-19 has caused the expansion of the money supply by the Federal Reserve and other central banks. Supporting this view is BSIT1.

> Oh yes, I mean it certainly accelerated it. We've seen a huge uptick in the users and customers if we're looking at the financial side and investing in assets on various blockchains as a hedge against systemic risks: money printing, all these stimulus packages, geopolitical issues between things like the US dollar, the Chinese Yuan and so. (BSIT1)

Similarly, BSIT3 believe that because COVID-19 has rapidly increased the adoption of many emerging technologies such as virtual reality and 5G, it could also facilitate the adoption of BCT. S/He notes, “I think that people are becoming more comfortable with some of these emerging technologies in the new world of COVID-19, which I think [it] will also help open people's minds to blockchain adoption.”

It is safe to argue that the COVID-19 pandemic has enhanced the digitalisation of many landscapes and BCT applications have been implemented in some fields (see Khubrani & Alam, 2021). Worthy of note are some successes that were reportedly recorded in health management using BCT-enabled platforms such *MiPasa* built on top of Hyperledger Fabric and *Civita*s app built by a Canadian BCT start-up (Chamola et al., 2020; Marbouh et al., 2020). However, some of these BCT-enabled implementations during COVID-19 are operated as piece-meals and standalone platforms which require time and large scale adoption to prove their cost efficiency and long-term impact. Kumar et al. (2020) conclude that despite the enormous potential of using modern technologies to resolve COVID-19 issues, there is little or no evidentiary proof for their operational effectiveness.

8.6.2 COVID-19 has not Enhanced BCT Adoption – Audit and Assurance Firms' (AAF) View

The view most of the participants from the Big 4 firms (AAF group) is contrary to the position of the BSIT group, which is possibly expected. The AAF group believe that COVID-19 has not enhanced the adoption of BCT. The reason given is that the economic hardship brought by COVID-19 has limited many organisations' appetite for investment in innovation or emerging technologies such as BCT.

AAF7 says for their clients, "For enterprise adoption, it's actually decreased substantially because people aren't spending money on innovation." AAF8 thinks that there definitely was a surge in digitalisation and a craving for technologies to ease the COVID-19 lockdown and restrictions on movement, but this was achieved with the use of existing applications such as Zoom, and not with the adoption of BCT. AAF4 further supports this point:

> I don't think that it really enhances it. It rather, at least in Europe, it reduces the willingness of companies to invest into blockchain technology at the moment because they have to save money and so I wouldn't say that it enhanced the adoption of blockchain technology. (AAF4)

AAF2 further contests the idea that BCT will help solve old provenance problems, and COVID-19 tracking and tracing. Her/his view contradicts some studies (Chamola et al., 2020; Marbouh et al., 2020) which assert that the use of BCT will help with COVID-19 supply chain and health management. AAF2 posits:

> So, there's been no big wave of adoption. There's been a few people saying it's going to solve some COVID thing about testing stuff but that's the old provenance problem which ultimately will fall away. And they'll probably quote that diamond tracking thing (Everledger) which people forget that the reason that the diamond tracking blockchain solution worked is De Beers had already engraved ID numbers on the diamonds. They'd already solved the identification problem for them, so there was no need for the database. (AAF2)

However, some participants in the AAF group acknowledged that for Bitcoin and cryptocurrency companies, there is a huge investment and more adoption because people and organisations took money out of the existing financial markets and invest in the crypto market.

> There's lots more adoption because people are taking money out of traditional

> financial markets due to quantitative easing and huge amounts of money being printed and put into circulation so they're moving their money into Bitcoin because it is a deflationary currency versus inflationary. Crypto definitely has grown a lot because of the COVID. (AAF7)

8.6.3 COVID-19 has not Enhanced BCT Adoption – Accountants and Auditors' (AAD) View

There were divergent views among the interviewees in the AAD group. Some believe that COVID-19 has enhanced the adoption of BCT and other emerging technologies because some BCT applications were developed in response to the COVID-19 pandemic. Others think that the pandemic has not accelerated BCT adoption.

AAD2 and AAD3 believe the adoption of the technology has been enhanced by COVID-19.

> I think I know there have been applications related to COVID-19. By the way,
>
> there's a lot of benevolent applications to the like of the World Health Organizations for distribution of food to refugee camps and stuff like that. What they do is they digitize people so that if you're getting a couple of meals a day from a refugee camp, they can use your fingerprint on a blockchain and biometrics to make sure that you're the one getting the food and not some drug lords or warlord or something that's stealing food from people. (AAD2)

> I think COVID-19 has accelerated the acceptance of a lot of technologies. Just like our remote meeting today, we probably wouldn't have done the same thing without COVID. And I think the overall crypto market this year has entertained more interest in blockchain. (AAD3)

AAD3 suggests that COVID-19 has enhanced the adoption of many technologies and the cryptocurrency market is the major beneficiary among the BCT applications. S/He believes that low return on equity investment and the huge government debt from COVID-19 palliatives as factors responsible for investors to moving to Bitcoin as an alternative investment.

AAD2 acknowledges that despite some BCT applications being developed to help with COVID-19, s/he is uncertain about the success rate of these use cases. "I think with COVID-19 the fact that I don't know all the details, but I know there were some blockchain applications that were spun up…. How many of them became anything bigger I don't know? However, it appears there are a few successful use cases. The WHO has acknowledged the usefulness of *MiPasa*, a BCT app that enables health professionals to access verifiable data (Chamola et al., 2020; Marbouh et al., 2020).

In contrast, these are some of the participants' contrary views.

> I have not seen that it has thus far. People are thinking about how it could be in the future, but I'm not seeing any real-life use cases, so right now it's probably in the theoretical literature and so forth. (AAD6)

> COVID-19 has pushed people to move into a digital environment…. One thing I can think of is companies losing a lot of money and running into financial difficulties which will actually hurt the adoption of blockchain just like any other new technology. Once we even come out of the pandemic a lot of companies will take time to recover and investing in the new technology would not be a priority. (AAD5)

The argument about the lack of use cases to prove whether the pandemic has enhanced the adoption of BCT or not depends on the school of thought. To the BCT enthusiasts, there are uses cases, and to the sceptics, the technology is yet to have real-life uses cases or applications beyond Bitcoins. The position of AAD that the financial constraints experienced during COVID-19 have limited the adoption of new technologies is incontestable because, in practice, surplus funds are what most companies will use for expansion and innovation.

8.6.4 COVID-19 has not Enhanced BCT Adoption – Academics' (ACA) View

All the participants in the academic group believe COVID-19 has not in any way enhanced the adoption of BCT because there are no use cases to support its successful deployment.

ACA3 notes, "I haven't talked to anybody that said, well, I'm adopting blockchain because I believe there's so much value due to COVID-19, that I'm seeing the value. I haven't honestly talked to somebody that said that." Additionally, AAD4 notes that COVID-19 has given people an opportunity to increase their awareness of technologies, but it has not increased the number of successful deployments of BCT. Despite this awareness, ACA5 claims there is no proof of mass adoption of BCT due to COVID-19, instead, there is still apathy toward BCT adoption due to privacy concerns.

> The reality is there're relatively few successful technological adoptions of blockchains in the world. There is a lot of hype, there are a lot of research papers, but there's not a lot that are actually being successfully adopted in a commercial world which is quite normal. Because we are still quite in the early stage of the technological development cycle; we are 10 or 11 years on to the cycle. A technological cycle can take about 20 or 30 years to go through its complete process of adoption. (ACA4)

> But as far as I've seen there's been great reluctance to adopt these systems because of the privacy issues and I have not seen them widely used in any country, but I don't really think the COVID pandemic affects this much one way or the other. The opportunity is more or less the same, the technology isn't really affected by it. COVID has been great for the farming industry, it's been great for computer networking things like this Zoom, they can attribute their growth very directly to COVID, but I can't say that the blockchain one way or the other has much do with it. (ACA5)

Reluctance to adopting BCT due to privacy concerns as observed by ACA5 is in tandem with the finding of (Mbunge et al., 2021) that adoption is low because people are still worried about the ultimate security and privacy of their medical and health records. BCT is still an evolving technology, and it is understood that its mass adoption may take time, but there are a few successful BCT applications such as *MiPasa*, *Civitia* that have been implemented. It could be argued that the awareness created by COVID-19 could help to see more development in BCT applications in the future.

8.6.5 COVID-19 has not Enhanced BCT Adoption – Accounting Regulatory Bodies' (ARB) View

Most participants in the ARB group consider BCT is not among the emerging technologies whose adoption has accelerated due to COVID-19.

> I don't think it has, if anything it slowed it down because people have just been too busy dealing with pandemic issues to think about these longer-term kinds of projects, I think if anything it slowed it down. (ARB4)

> It enhances the adoption of emerging technologies in general, Yes, because we have heard from many CPA members that have started to adopt AI and machine learning tools as well as data analytics, data visualisation tools, robotic process automation, cloud computing and so on, but none of them has referred to blockchain technology. So, in other words, none of them has

> adopted blockchain technology or has come across a client that uses blockchain technology. … it has enhanced the adoption of certain emerging technologies, but certainly not blockchain technology in the accounting space. (ARB2)

Deductively, the ARB4 thinks people prioritise their survival from the pandemic ahead of adopting new technology. It could be argued that adopting innovation that could help to lessen the impact of COVID-19 could be a part of the strategic thinking or a tool for government and people. The idea that CPA members are not having in-depth discussions about BCT may be an indication that the technology has not gained much attention from their clients.

8.6.6 COVID-19 has not Enhanced BCT adoption – Financial Analysts and Other Experts' (FAE) View

The FAE group believe that COVID-19 may have slowed down the adoption of BCT. Some of the financial experts acknowledge that COVID-19 has increased conversations about many emerging technologies, but the use cases are still at the experimental stages. FAE5 clarifies:

> I think in a lot of organizations pandemic has been a springboard into even serious thought about what the future of work and commerce looks like. What are the implications of doing more and more work digitally and then dispersed teams? What that's going to look like? That tends to accelerate the conversations about stuff like blockchain and its various use cases even if on paper. On a practical level, it's maybe slowed down some of the implementations. (FAE5)

Despite the slowness caused by the pandemic to the adoption of BCT as highlighted by FAE5, FAE3 thinks that, in the US, the COVID-19 pandemic has pushed at least the accounting profession forward at least five years in terms of developing technology and going digital due to working in a remote environment. Additionally, FAE2 suggests that since COVID-19 highlights many issues with health data coupled with misinformation and disinformation around vaccinations and lack of trust in government, BCT will be a good fit in health fields particularly to enhance trust issues.

The entire world is still grappling with the disruption by the COVID-19 and there is a craving to explore emerging technologies to ameliorate and prepare for the prevention of similar disruption in the future (Chamola et al., 2020). This study has examined whether COVID-19 has enhanced the adoption of BCT, or not. Despite some modest BCT applications for health and supply chains, this study found that COVID-19 has not enhanced the adoption of BCT. Most of the participants asserted that COVID-19 has possibly slowed down rate of BCT and other emerging technologies due to the global financial and economic crises brought about by the pandemic.

8.7 Summary

This chapter examined the incentives, barriers, and perceived unintended consequences as well as the impact of COVID-19 on the adoption of BCT as a FinTech using the TOE framework. The chapter addressed the research questions: "What are the incentives, barriers, and unintended consequences of adopting BCT as a FinTech solution? and "How has COVID-19 enhanced the adoption of BCT?" A few previous studies have used TOE to analyse the factors that promote and hinder the adoption of BCT, but none of the existing studies have looked at the unintended consequences of adopting BCT as a FinTech. This study attempts to use TOE to discuss the likely unintended consequences of BCT adoption, in addition to exploring whether COVID-19 has enhanced the adoption of the technology or not. Filling this identified existing gap stands this study apart from the previous studies. It is important to note that forecasting unintended consequences of a young technology like BCT is an uphill task, but this study has provided an insight into this area which could aid future research.

Using TOE as a theoretical lens, this study found that the major incentives identified under the technological context include the ease of integration with other technologies, understanding, and user-friendliness. It was found that business need, cost-benefit and top management support are the chief incentives in the organisational context. The external environment factors are wide adoption by the industry, regulators, and the availability of reliable and proven use cases.

The barriers found by the study under the technological context include poor education, lack of knowledge about BCT, and few use cases. The high cost of investment in BCT infrastructure and the absence of a regulatory framework are seen as external environmental barriers, while the participants further suggested that fear and resistance to change as the major organisation barriers.

Concerning the known unintended consequences, the study's findings show that the participants acknowledged that it is hard or difficult to forecast the unintended consequences of BCT adoption at this developmental stage of the technology. Nevertheless, the study identified harm to privacy, irreversibility of errors, use for criminal activities, and breaking BCT encryption with the use of quantum computing as unintended technological contexts. The study further found under the organisational context that mismatched BCT applications to firms' needs and adoption of private (permissioned) blockchain as undesirable consequences. The interviewed participants affirmed that the deployment of BCT as a centralisation platform by governments and regulatory authorities, and loss or disruption of jobs as external environmental unintended consequences.

The COVID-19 pandemic took the entire world by surprise. The pandemic has been credited as a contributor to the accelerated adoption of some emerging technologies, including BCT. However, most participants from the practitioners and academic groups suggested that COVID-19 has not enhanced the adoption of BCT but it has, instead, slowed it down. This view is premised on the assumption that organisations are facing economic hardship which makes investment in innovation an unlikely priority. However, some blockchain start-ups and IT experts believe COVID-19 has enhanced the adoption of BCT because some BCT health and supply chain management applications were launched during the pandemic, coupled with huge institutional investment in Bitcoin and other cryptocurrencies.

The COVID-19 pandemic has driven unprecedented growth in the adoption of different technologies including BCT. Despite this, the study found that BCT has not accelerated its adoption. Technology innovations involve different developmental cycles before they reach adoption and are sometimes shrouded in secrecy because of the commercial sensitivity attached to them. In this study, the commercial sensibility of BCT innovation was highlighted and this could have affected the disclosure of the ongoing technology experiment. It is too early to have a full picture of whether Covid19 had accelerated the adoption of BCT.

Taken together the TOE framework (see ***Figure 12*** and ***Figure 20***) and the summary of findings in ***Table 7***, the study has provided empirical evidence regarding incentives, barriers and unintended consequences of adopting BCT as a FinTech.

The three contexts of TOE: technological, organisational, and environmental have been used to analyse and provide empirical answers to the research objectives and questions. This study's exploration of unintended consequences of BCT adoption could be said to be a novel addition to the use of the TOE framework in the study of the adoption innovation. Additionally, in the external environmental context, the COVID-19 pandemic was extensively evaluated to understand whether it has contributed to the accelerated adoption of BCT or not. The final chapter contains the summary and recommendations for future research.

Table 7. *Summary of Major Findings - Incentives, Barriers, Unintended Consequences and Impact of COVID-19 on BCT Adoption*

TOE	Incentives	Barriers	Unintended Consequences	COVID-19
Technological Context	*Ease of integration with other systems * Simple to understand and user-friendliness	*Poor education and lack of knowledge *Untested technology	*Hard to know *Harmful to privacy and irreversibility of errors *Use for criminality *Use of a quantum computer to break BCT encryption codes	
Organisational Context	*Business need *Benefits outweigh the cost *Top management support	*Fear or resistance to change	*Mismatch of BCT application to firm's need *Mass adoption of private BCT	
External Environmental Context	*Industry or market adoption *Availability of reliable use cases	*Huge cost of investment *Absence of regulatory framework and accounting standards	*Control tools by government and regulatory agencies *Disruption or loss of jobs	*COVID-19 pandemic has not enhanced BCT adoption

Note. Source: Author

Chapter 9
Conclusion and Recommendations

9.1 Introduction

BCT is an emerging technology that has attracted a lot of attention from academics, practitioners, governments, and different institutions, particularly with the crypto-assets revolution. BCT’s features P2P, cryptographic signature, append-only, and immutable records position it as a disruptive innovation capable of changing many business landscapes (Tapscott & Tapscott, 2017). Studies have suggested that the adoption of BCT disrupts auditing (Lombardi et al., 2021), could lead to the demise of auditors (Arrowsmith, 2018; Tapscott & Tapscott, 2017), redundancy in the accounting profession, and cause significant changes to the double-entry accounting system, and tax management, as well as facilitating triple-entry paradigm (Karajovic et al., 2019). Furthermore, accountants and auditors will require a high level of specialised skillsets and understanding of programming codes to function efficiently in a BCT environment (Bible et al., 2017, p. 12). This technology is said to have built-in mechanisms to prevent and detect fraud or anomalies (Alboaie et al., 2018; Baron, 2017) and that BCT is suitable for accounting and record-keeping because the technology will guarantee the traceability and authenticity of recorded transactions, and ensure the immutability of records (Faber & Jonker, 2019). Most pro-BCT innovation stakeholders make these assertions based on the unique features of the technology, however empirical evidence from practitioners does not appear to validate these claims.

Similarly, there are counter-arguments among scholars who are sceptical that BCT will not disrupt the accounting and auditing field. For instance, Coyne and McMickle (2017) argue that the unique features of BCT such as immutability, and append-only make it unsuitable for accounting record-keeping and a replacement for traditional double-entry accounting. Equally, Brazina and Ugras (2018) suggest that game-changing technologies such as BCT and AI will not replace the roles of CPAs. Further, fraud is still possible in a BCT environment because the technology is not 100 per cent flawless (Oladejo & Jack, 2020). It was further argued that the technology will not disintermediate auditors (Tan & Low, 2019) but will be a tool for accountants and auditors, and that CPAs will not be required to learn programming codes to be able to use it (ICAEW 2018). In addition, Shankar (2008) notes that acceptance by customers, a high rate of adoption, and the creation of large markets are the major factors that underpin the success or failure of any innovation. These could be major reasons why BCT has not enjoyed the perceived success that accompanied the introduction of Bitcoin and other crypto-assets. Outside of cryptocurrency operations, the acceptance and diffusion rate of BCT appears to be very low. However, there is a gap in how BCT disrupts or enhances the field of accounting and audit and the factors influencing the adoption of this technology. This could be due to the little or no engagement with practitioners regarding the real effects of BCT on accounting professionals.

Relying on TOE framework and through engagement with practitioners and academics and exploration of the existing literature, the overarching objective of this study was to understand whether BCT disrupts or enhances the accounting and audit field. To realise this objective, this study set five sub-research objectives and 11 research questions were posed (see **Table *1***, p.10).

1. Explore how accounting practices will change in a BCT-based environment (RQ1-RQ3).
2. Examine the extent of the relevance of auditors and what auditors are expected to audit in a BCT system (RQ4-RQ5).
3. Understand the effectiveness of BCT in the prevention and detection of fraud and the impact of garbage in, garbage out (RQ6-RQ7).
4. Examine the technical skillsets required by accountants and auditors in a BCT environment and the relevance of understanding BCT programming codes (RQ8-RQ9).
5. Explore incentives, barriers, and unintended consequences of the adoption of BCT in the accounting and auditing professions and whether COVID-19 has enhanced the adoption of BCT or not (RQ10-RQ11).

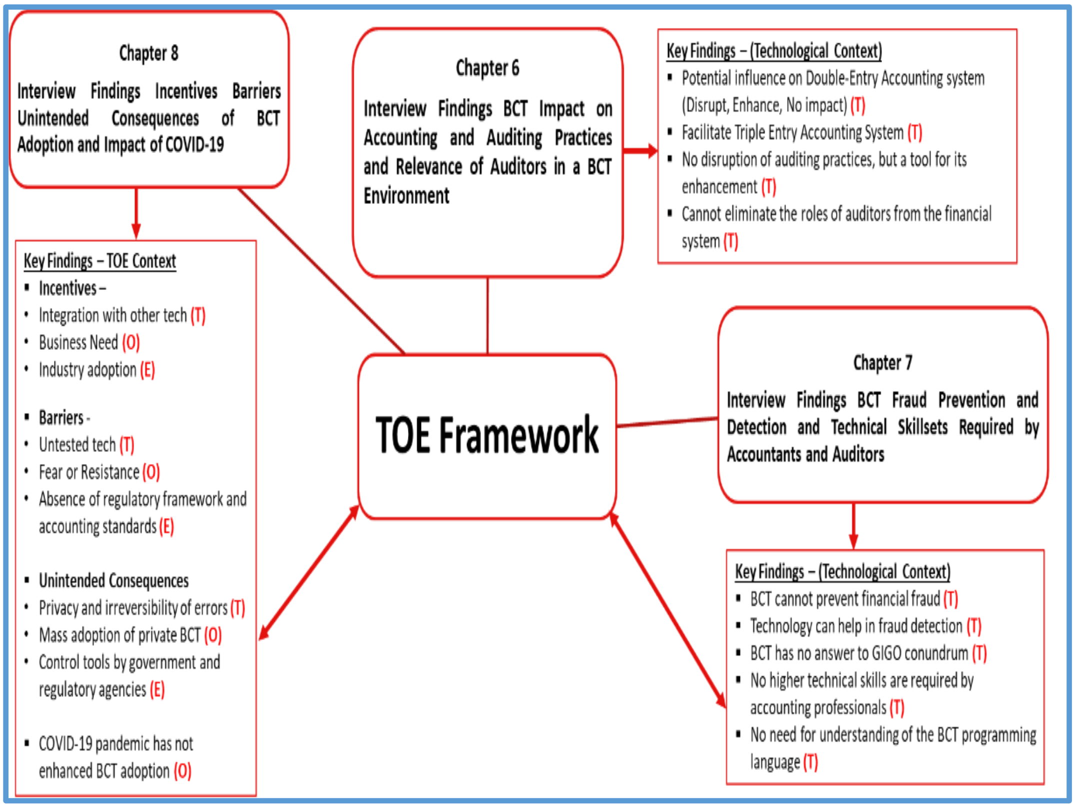
The study adopted a qualitative exploratory research method using semi-structured interviews to answer the research objectives and questions. A social constructivism-interpretivism paradigm underpinned this research. Forty-four participants representing blockchain start-ups, IT and financial experts, professional accountants, accounting regulatory bodies and organizational leaders as well as academic scholars from 13 countries were interviewed. Thematic analysis was employed with the aid of NVIVO for data coding and analyses.

This final chapter presents the major findings of the study using an expanded TOE framework, the contributions of the research to knowledge, implications for policy and practice, and the limitations of the study. The limitations provide the basis for recommendations of areas for future research.

9.2 Key Findings of the Study

Drawing on the research questions (see **Table 1**), the main findings are summarised below. ***Figure 25*** provides diagrammatically the key findings through the application of the TOE Framework.

Figure 26. TOE Framework and Key Findings



Note. Source: Author

9.2.1 Changes to Accounting and Auditing Practices

The double-entry system is as old as the accounting profession, and the advent of BCT has led some scholars to suggest that BCT could facilitate long-awaited changes to this traditional record-keeping system. However, like existing studies, there are different perspectives on the disruption of double-entry accounting by BCT. This study finds that BCT will disrupt double-entry accounting principles.

Participants further believe that the technology, as a new concept in accounting, will enhance the double-entry system by adding multiparty visibility to transactions and help to evolve triple-entry accounting. These findings corroborate studies by Baliga et al. (2018); Cai (2021), and Hildebrand (2020) who believe that BCT will change the traditional double-entry accounting system. In contrast, this study also finds that BCT may not add any value to the traditional double-entry accounting system, but neither can it change the configuration of the existing accounting system. These divergent views could be due to the technology being in its infancy coupled with limited practical experience of BCT in the industry.

Despite the common use of the term 'triple-entry accounting system' in several studies, this study found that the term BCT triple-entry accounting system is seen as jargon and confusing terminology that has nothing to do with the accounting system. The use of the term 'triple-entry system' is not an acceptable nomenclature among the participants. However, the interviewees indicate that the BCT algorithm can be a third layer of the double-entry system in real-time, thus facilitating the proposed BCT triple-entry accounting. This study did not delve into the technicalities of how this algorithm will be used in practice. The merit of this proposition could only be accessed if BCT triple-entry accounting system becomes the norm.

Concerning the tax management system, the findings indicate that BCT, where it is widely adopted, could be useful in the administration of GST, VAT, WHT and company income taxes, but not for income tax due to computational complexities and regulations, especially in some jurisdictions. The participants further believe that BCT could reduce collusion and tax fraud. The study established that these changes could be feasible only when a BCT-driven accounting record system has been established.

9.2.2 Areas BCT Disrupted or Enhanced Accounting and Auditing Fields

The areas that BCT are expected to disrupt or enhance in accounting and auditing functions are similar. The technology is expected to disrupt some manual accounting processes: reconciliation, bookkeeping, checking, and verifications of transactions as well as inventory management. This study found that BCT can facilitate real-time accounting, inter-entity transactions, and access to information, and reduce the cost of maintaining and sustaining accounting ledgers. The possible elimination of manual bookkeeping tasks led a handful of participants to assert that BCT could eliminate the functions of accountants. This relates to the potential features of the technology and falls under the technological context of the study's theoretical framework.

Despite the potential revolution attributable to BCT, the findings show that BCT will not disrupt auditing practices but will be a tool for their enhancement. There is no empirical evidence from the participants to support the assertion that BCT has so far disrupted accounting and auditing, as stated by Lombardi et al. (2021). The technology has not had a significant disruption in the audit profession beyond a change in audit sampling, reconciliation, and confirmation processes. The participants believed that the professional judgment of auditors is required to determine the true financial position of organisations. The findings further indicate that there is no consensus among participants on whether an external auditor becoming a node in a BCT environment will eliminate the function of the internal audit department. The implications of external auditors becoming a node in a BCT network and the likely impact on the internal auditors' responsibility requires further study as the proponents of this idea appear not to have thought of the wider implications of such a proposal.

9.2.3 Adoption of BCT for Financial Reporting and Accounting Purposes

There are many ongoing BCT experiments and pilot projects by governments, financial institutions, and top global accounting firms. However, this study establishes that participants do not know any organisations that use BCT for their financial reporting and accounting systems. This is situated within the organisational context of the TOE framework because there is yet to be any industry adoption for this accounting activity. Despite the significance of this finding, given the ongoing efforts to harness BCT for different applications, there may well be a handful of firms with BCT-enabled accounting systems that are not publicly known.

9.2.4 Relevance of Auditors and what Auditors Need to Audit in a BCT Environment

The relevance of auditors in a financial system has been a subject of debate since the collapse of many multinational companies. The emergence of BCT resulted in some studies assuming that auditors are not relevant in a BCT environment

(Arrowsmith, 2018; Faber & Jonker, 2019; Yermack, 2017). On the contrary, the study's participants believed that auditors will still be relevant in a BCT environment, but with a change in focus or roles. The findings further show that there is a low possibility that BCT will eliminate auditors from financial systems. This may be because BCT is not the right solution for everything as claimed by its proponents. It should be noted that some participants viewed BCT as a labour-reducing technology that can eliminate the roles of auditors.

The justifications by the participants for the continued relevance of external auditors include the high risks associated with BCT and the need for an independent auditor to ascertain if transactions in BCT are genuine and reliable. It was also believed that investors may prefer companies that use BCT and can withstand the rigorous scrutiny and the regulatory requirements associated with auditing public companies by registered accounting, audit and assurance firms. It could be argued that these justifications are rhetoric to support audit relevance by most participants and the available literature. Consequently, it may be too early to ascertain the full extent of audit relevance in a BCT environment because, in practice, BCT has not been fully adopted for financial reporting and accounting systems on any commercial scale.

9.2.5 Audit of BCT - Chains or Transactions

Since most participants acknowledge the importance of audit in a BCT environment, this thesis further investigates whether auditors need to examine the chains or transactions, or both in a BCT network. The finding shows that auditors are expected to audit both the chains and transactions in a BCT network. The participants note that IT systems are composed of many layers that the audit team is expected to review. This significant finding has provided an answer to the question by Karajovic et al. (2019, p. 322) that, "Would auditors still be responsible for confirming the authenticity of transactions, or would their role change to audit the system itself?" The study's participants affirmed that BCT is unlikely to have a significant change in the principles and fundamentals of audit procedures.

9.2.6 BCT Fraud Prevention and Detection

There are diverse opinions on the effectiveness of the BCT security system for the prevention and detection of fraud. Most of the participants suggested BCT can detect some fraud or anomalies. They claimed that the unique features of this technology such as shared database, transparency, cryptographic security, and immutable records will make the identification of fraud or anomalies much easier. Contrarily, some participants argued that BCT can neither prevent nor detect fraudulent activities. A possible explanation for the diverse views may be the lack of many use cases of BCT and differences in knowledge of how the technology actually works.

Nonetheless, the study finds that blockchain as a technology can neither prevent nor detect fraud or anomalies on its own because it takes the combination of human and technology efforts to reduce, prevent, or detect anomalies in a BCT environment. This study also notes that BCT is not suitable for complex operations, which makes it difficult to prevent and detect. A possible explanation for this might be that BCT would be integrated with other technologies that could expose the vulnerability of the network to fraud.

The findings of this study show that BCT cannot eliminate financial fraud. The participants note that BCT cannot prevent or detect fraud arising from the falsification of reports, manipulation of internal controls, collusion, deceit, and related party transactions. This view is corroborated by Bradbury (2015), who believed BCT cannot detect deceit and Yeoh (2017), who stated that blockchain cannot prevent fraud executed by collusion orchestrated by the majority of nodes in the network. According to the study's participants, other financial frauds or anomalies that could occur in a BCT environment include re-entrancy, race conditions, malware embedded in wallets, forks, front running, and wash trading. This study also found that the human element would be the weakest link in a BCT system. This finding is similar to the assertion of Alboaie et al. (2018) that the data accuracy on BCT depends on human management since transactions are validated by miners.

9.2.7 Impact of Garbage In Garbage Out (GIGO) on BCT Fraud Prevention and Detection Mechanism

The findings of this study further reveal that BCT mechanisms have no solution to the issue of GIGO in financial transactions. This finding is in tandem with that of Ferris (2018) and Frederik (2020) regarding their views on the implication of GIGO in BCT. BCT is like any other technology, bad input will result in bad output.

However, a small number of those interviewed suggested that the BCT configuration would not allow inaccurate data into the network.

Overall, it is difficult to predict how effective the BCT security system is because, outside its major applications in crypto-assets and a few companies in logistics management, there is no large-scale adoption of BCT for financial reporting and accounting systems. Consequently, a better understanding of how reliable the inbuilt fraud prevention and detection mechanism of the technology could only be determined when it is adopted on a commercial scale.

9.2.8 Specialised Skillsets for Accountants and Auditors in a BCT Environment

The debate on the appropriate specialised IT skillsets required by accountants and auditors in the digital age is unending. As new technologies emerge, accounting professionals are expected to upgrade their skills to keep up with the increase in technological innovation.

The findings from this study indicate that accountants and auditors do not require any high-level technical skills to use the BCT-enabled accounting system or any DLT. The participants believe that professional accountants do not require any specialised technical skills to use BCT. The study notes that audit firms usually rely on in-house experts for the audit of specialised entities; therefore, accountants should not become IT specialists because of BCT adoption. It was further suggested that accounting professionals will only interact with BCT at the user interface level and no higher-level skillset is required for that.

9.2.9 Understanding the BCT programming language

Understanding BCT programming languages is considered a necessary technical skillset for CPA (Appelbaum & Smith, 2018; Bible et al., 2017). The findings from practitioners and academics in this study indicated that accountants and auditors do not require an understanding of the BCT programming language. This finding contradicts the position of studies by Bible et al. (2017); Brender et al. (2019) but aligns with the view of the ICAEW (2018) that accountants do not require this knowledge. Most of the study's participants agreed that understanding the BCT programming language is desirable but not important for accounting professionals, while a small number of interviewees held contrary views.

Understanding BCT programming codes could be said to be a requisite knowledge where auditors are expected to certify BCT, associated transactions, the underlying technology, and other controls within the BCT network including the smart contracts built atop it. It could be argued further that a basic understanding of a BCT may not be enough for auditors who are expected to examine both the chains and transactions. However, some participants claimed that they have audited the Bitcoin blockchain and used other BCT applications without understanding any programming languages.

It was also found that many of the participants emphasised that BCT requires hybridisation of talent; thus, accounting professionals could collaborate with other technical experts in examining BCT because the technology involves multidisciplinary fields and unique skills. However, one of the participants strongly believed that leaving everything to technical experts is considered risky because a rogue IT expert may use the opportunity to manipulate the system and perpetrate fraud in a BCT environment. Nevertheless, overall, the study’s findings reveal that it is not important for accountants and auditors to become BCT programmers, cryptographers, or database experts, and what these professionals require is a basic understanding of the technology's impact on their profession and their clients.

9.2.10 Incentives, Barriers, Unintended Consequences and COVID-19 for the Adoption of BCT

In exploring the factors that influence the adoption of BCT, the study takes a holistic approach by highlighting the incentives, barriers and unintended consequences of its adoption as a FinTech as well as the effect of the COVID-19 pandemic. The attributes that could encourage interviewees to adopt BCT for their operations include ease of integration with existing technologies, ease of understanding and user-friendliness, business needs and problems to be solved, cost-benefit, top management support, industry or market adoption, and availability of more use cases.

This study finds that barriers to the adoption of BCT include poor education and lack of knowledge, technology is untested, fear and resistance to change, high cost of investment, and lack of regulatory guidance and accounting standards. The participants considered poor education and lack of knowledge of what BCT could be used for as the main barriers. It was pointed out that there were many unsubstantiated applications anticipated for BCT. The Dunning-Kruger effects (see Chapter 1, Section 1.2) could be said to be visible in claims and counterclaims in many studies concerning how BCT will disrupt and revolutionise many business models without any concrete empirical evidence, including among the interviewees in this study.

As the findings show, practitioners and academics agree that it is hard to know what the unintended consequences of adopting BCT as a FinTech are since the technology is still evolving and at various experimental stages. Roger (2003) acknowledged this fact but still recommended the need for innovation researchers to consider the consequences of innovation adoption. However, there is no forthcoming research on this critical issue of the consequences of innovation. The study's participants mentioned unintended consequences such as harm to privacy, irreversibility of errors, use for criminality, use of quantum computers to break BCT encryptions, mismatch of BCT applications with firm's need and mass adoption of private or permissioned blockchain, control tools by governments and regulatory agencies, and job losses among the unintended consequences of BCT adoption. These findings highlight the need to view together incentives, barriers, and possible consequences of the adoption of BCT. This study realises that these factors are interwoven and taking them together could aid the comprehensive understanding of what influences BCT adoption in practice. Additionally, these findings suggest that further research in these areas is important to provide greater insights and a comprehensive understanding of factors that influence BCT adoption.

The COVID-19 pandemic is an environmental factor that could influence the faster adoption of BCT. However, this study's finding reveals that the outbreak of COVID-19 has not enhanced the adoption of BCT. Participants believed that the pandemic has slowed the adoption of many innovations, including BCT because many companies were financially restricted and access to investment capital was limited.

9.3 Contributions of the Study

This study contributes methodological, theoretical, and practical knowledge about an emerging BCT innovation and has implications for the accounting and auditing profession. The study contributes to literature, practice, and policy.

9.3.1 Methodological Contribution

This study makes a methodological contribution in the emerging area relating to BCT, accounting, auditing, and fraud analysis through its adoption of the social constructivist-interpretivism paradigm and exploratory qualitative exploratory method approach to understand the BCT disruptive innovation phenomenon in the accounting and auditing profession. The adoption of the constructivist-interpretivism paradigm enabled the researcher to co-construct the participants' multiple meanings, interpretations and understanding of BCT and its implications for accountants and auditors. Forty-four semi-structured interviews were analysed using NVivo qualitative analysis software. This study is the first of its kind to explore and engage a wide group of participants from five continents and 13 countries. Additionally, the study sought the perspectives of both academics and practitioners from blockchain start-ups, IT and financial experts, global accounting regulatory bodies, senior editors, accounting professionals from Big 4 and non-Big 4 firms and other organisational leaders, all of whom had at least a basic understanding of BCT. Previous studies on BCT’s implications for the accounting industry have mainly relied on participants within a geographical locality or at best two countries, or have only focused on the participants from Big 4 accounting firms.

9.3.2 Theoretical Contribution

The thesis has resulted in some findings that, on one hand, contribute to theory and, on the other hand, present a challenge for further research. At the theoretical level, the findings contribute to the literature by offering an integrated conceptual TOE framework. The framework offers a reference for practitioners, academics and policymakers seeking to appraise comprehensive factors influencing BCT adoption and its likely unintended consequences. The study addresses the expanded scope and potential disruptive BCT innovation, as well as the novel use of the TOE framework for the investigation of the unintended consequences of adopting the technology. This integrated theoretical perspective could be a persuasive way for similar studies on the potential impact of BCT and other emerging innovations. Innovation researchers should investigate the consequences of the adoption of any innovation. Ideas concerning disruptive BCT innovation are still in the embryo stages of development. Many governments, investors, and software companies including the leading accounting firms are still exploring what practical changes can BCT bring to their businesses. However, the constructivist-interpretivist use of the social paradigm and qualitative exploratory methodology for the construction of multiple meanings and interpretations of practitioners from accounting and blockchain start-ups and other experts, including academics has lent credence to the methodological contribution of this study.

Furthermore, the study contributes to the theory by expanding the TOE framework contexts (technological, organizational, and environmental) with unintended consequences for the analysis and explanation of the perceptions of the participants about the factors that influence the adoption of BCT. The study developed a conceptual framework (see Figure 12) that explains incentives, barriers, and unintended consequences of BCT adoption. This conceptual framework offers a reference for practitioners and policymakers seeking to appraise comprehensive factors influencing BCT adoption and its consequences for their firms. It also offers insights for professional accountants and firms into potential opportunities in emerging technology such as BCT. Equally important, this thesis has addressed the research gap identified by Schmidt and Wagner (2019) on "How do technological, organization, and environmental factors influence blockchain adoption?"

This study expands existing knowledge on areas BCT can disrupt or enhance in the field of accounting and auditing. Studies in this regard are lacking on whether BCT will disintermediate functions of accountants and auditors, and if accounting professionals need specialised skillsets and understanding of programming codes to use BCT. This study also attempted to find out whether there are organisations that have adopted BCT for financial reporting and accounting systems. There is no empirical evidence on this; prior studies have focused on investments and exploration of BCT applications. Interestingly, the thesis found that there are no organisations that are using BCT for financial reporting and accounting. By way of a new finding, this study further enhances the research literature by revealing participants' views on fraud or anomalies that the BCT security architecture is unlikely to prevent or detect. The study expands the knowledge of the factors that influence the adoption of BCT by considering its unintended consequences as a FinTech.

The research brought to light some practical reasons why BCT is yet to be fully incorporated into commercial activities despite the optimistic view that BCT has the potential to change many business operations. On one hand, the barriers to the BCT adoption as suggested by the study's participants include a lack of education, knowledge and understanding as well as complexity associated with BCT. On the other hand, the participants think the likely incentives to consider when adopting BCT are the ease of understanding and integration with existing applications, the availability of many use cases, and the adoption by the market or industry.

Every innovation has consequences, desirable and undesirable. This study has expanded the TOE framework to include the consequences of innovation adoption in an emerging BCT phenomenon. The participants acknowledged that it is difficult to tell in advance the unintended consequences of adopting BCT as a FinTech. However, 'peeping into the future', the participants remarked that the unintended consequences of adoption could include: being harmful to privacy, used for criminal activities, quantum computer could break BCT encryption codes, the technology becoming a regulatory tool for government and regulatory authority. BCT is advocated to have the potential opportunities to enable a triple-entry system, facilitate reconciliation of ledgers and accounts, and eliminate audit circularisation and manual accounting practices. Undoubtedly, many of the potential consequences attributed to the technology are still at different experimental or pilot stages, and it may be too early to accurately forecast their future implications.

9.3.3 Practical Contribution

Treiblmaier (2020) posits the attention of academia has been on the development of frameworks and theories, however, industry is in search of concrete and practical solutions. The analysis and findings of this study have some concrete and practical implications for the blockchain, accounting and auditing industry, and the financial industry in general. This thesis contributes to the practice and understanding of practitioners, academics, and the public by highlighting the deviations between initial expectations and practical applications of what BCT can do in the accounting industry.

The public expectation is that BCT will disrupt the accounting and auditing fields, and possibly disintermediate the role of third-party auditors. The technology is also viewed as capable of preventing and detecting fraud and anomalies, and accounting professionals require higher-level specialised skillsets and an understanding of BCT programming codes to function in a BCT environment. Some of these assertions were based mainly on the literature about the unique features of BCT particularly using crypto-assets applications, there were no actual engagements with practitioners from blockchain start-ups, IT experts and the financial industry, professional auditors, accountants, organisational leaders, nor academics to validate these assertions.

This study reveals that there is not enough evidence to support the assertion that BCT disrupts auditing or will eliminate the roles of auditors in a financial system. What the participants suggested is that BCT, if adopted, is likely to be a new tool to enhance the audit process. The study's finding shows that auditors are to audit both the chains and transactions including the associated controls. Most participants believed that auditors should scrutinise both the BCT and associated technologies because BCT cannot change the fundamental principles of audit procedures. This finding has addressed one of the study's research objectives and further answered the question raised by Karajovic et al. (2019, p. 322) that "Would auditors still be responsible for confirming the authenticity of transactions, or would their role change to audit the system itself?" The implication of this for professional accountants, accounting regulatory bodies, academics, and the public is that the technology could not audit itself and that auditors would still be relevant in a BCT environment.

This study also highlights how strong the BCT mechanisms are for fraud detection and prevention, which could be said to be one of the attributes that endeared the technology to the financial industry. This thesis highlights that BCT on its own cannot prevent or detect fraud and anomalies, as the technology will be integrated with other software. BCT cannot prevent financial fraud arising from collusion, manipulation of internal control, and deceit. The human element is regarded by several participants as the weakest link in any innovation, including BCT. These findings have shown that organisations need to ensure there are adequate controls to safeguard their operations in a BCT environment. The study further contributed to practice by pointing out that the BCT security system has no solution to the GIGO conundrum. Where the entries into the BCT are faulty, the outputs from the technology will be wrong.

Significantly, concerning skills and knowledge, accountants and auditors do not need to acquire higher-level skillsets and an understanding of BCT programming languages to be able to provide blockchain-based services to their clients. This finding has, on one hand, bridged the research gap regarding skillsets and knowledge required by accounting professionals. On the other hand, it has provided an answer to a suggested future research area by Schmitz and Leoni (2019) regarding the skillsets and extent of the technical understanding required by accountants and auditors. The participants highlight that collaboration with other professionals and a basic understanding of the features of BCT is what accountants and auditors require. This finding could be useful to accounting accreditation institutions, academic, and professional bodies on the relevance of including BCT in their curriculum for students. This is in the light of suggestions by some studies for the inclusion of blockchain into the academic and professional accounting curriculum. It has also contributed to the re-evaluation of the training requirements for accounting graduates and professionals because the study reveals that accountants and auditors are not required to become IT specialists, programmers, or cryptographers to use BCT.

9.4 Implications for Policy and Practice

The practical and policy implications of this study span several industries. The findings of this study could be relevant to the government, blockchain start-ups, the accounting and auditing profession, accounting regulatory and professional bodies, academics, and the general public.

This study contributes to policy development by highlighting the potential unintended consequences of adopting BCT. Understanding incentives, obstacles, and unintended consequences will enable policymakers, regulators, and technology users to understand the associated risks with using BCT. The framework of analysis (see **Figure *13***) will enable practitioners, academics, and the general public to understand the influence of technological, organisational and environmental context on BCT adoption.

This study helps uncover critical areas in BCT that were not explored earlier and also highlights the skills accountants and auditors require in a BCT environment. The study has contributed to the awareness of professional accounting bodies, accounting educators, the government, accountants, auditors, and academics about the training requirements for accounting graduates and professionals. Inclusion of emerging innovations such as BCT in the accounting curriculum is desirable, but the overall effect of this technology on the functions of accountants and auditors should not be based on hypothetical conjecture from the generic features of what this emerging innovation is projected to bring to the accounting industry. The floodgates of emerging technological innovations are opened and coupled with the craving for digitalisation by many sectors. The impact of the digital technologies cut across all layers of business operations (Bharadwaj et al., 2013). However, accountants need not flood a curriculum with all emerging technologies. Explicitly, this study affirms that a basic understanding of BCT is sufficient for accountants and auditors, as these professionals are not required to learn BCT programming languages or have any higher-level skillsets to use BCT. Therefore, this awareness could be useful in practice and to policymakers.

The findings indicated that tax accounting management could be affected by the adoption of the BCT application. BCT is expected to enhance tax administration regarding GST, VAT, WHT and company income taxes, but it may not be effective for personal income tax in jurisdictions with multi-tax regulations. In the long run, if the technology is used as the underlying accounting system, it could reduce collusion and tax fraud. The tax authority and the government can leverage BCT to reduce the incidence of tax fraud.

In practice, from this study, it was noted that no organisations have adopted BCT for financial reporting and accounting purposes. Practitioners, academics, and the general public need to be aware of organisations using BCT for this purpose, considering the disruption that BCT is expected to bring to the accounting and auditing profession. This shows that BCT is yet to have any significant impact on financial accounting and reporting systems. The examples of BCT applications that many of the participants have seen include for transport documentation, tracking of supply chain items, and health applications. Based on the knowledge of the participants, no organisation has integrated its full financial operations into BCT. This position is in contrast with the claims of some scholars that the software will eliminate the need for many management functions (Tapscott & Tapscott, 2017), stakeholders can prepare financial statements independently on the blockchain, thus reducing accountants' roles (Yermack, 2017). The reason could be that the technology is still in the early stage of development and adoption (CAANZ, 2017) and has not been proven on a commercial scale. It is also possible that different pilot programmes may be ongoing to harness BCT potential for accounting and auditing purposes which are yet to be made public due to their commercial nature. The researcher is unaware of them at the time of this research.

The outbreak of the COVID-19 pandemic has opened up opportunities that have accelerated the adoption of some emerging technologies such as BCT, AI and so on that have allowed people to work from home. The pandemic also presented challenges not only for the organisation's financial reporting system but also for auditing. The study has contributed to our understanding that the COVID-19 pandemic has not enhanced the adoption of BCT, but it has rather slowed down its adoption due to financial constraints experienced by many organisations during the pandemic. This finding would possibly help the government, practitioners, academics, and society to understand that the extent of BCT adoption in the industry is still only in the early stages. ARB3 succinctly captured this when he stated that "The world needs more education and material to dispel all misunderstanding" about areas where BCT could be useful and relevant.

For accounting, audit and assurance firms, financial regulators, and accounting professionals, the perception of the participants is that, in practice, auditors are expected to audit both the chains and transactions, as well as the associated controls in a BCT network. The implication of this is that financial audits will not be disrupted, and auditors are still regarded as relevant in a BCT environment.

There are divergent views as to the disruption of the double-entry accounting system by BCT, which is expected in light of the proposed BCT-enabled triple-entry accounting. The 'triple-entry accounting system' is regarded by the participants as jargon and a confusing term that has no place in accounting. Despite being frequently used in different studies, the practitioners and academics interviewed unanimously agreed that this term was used in a way that could make the understanding of BCT complex and difficult.

It is evident that, in the judgement of the interviewees, this study has a significant practical contribution not only to the literature and theory but also to the accounting and auditing profession and the public in general. During the interview, some participants have this to say about the importance of this research.

Accounting Regulatory Bodies

> This is a game-changer; the sooner accountants learn about this technology, the better. I'm glad you are doing your PhD on this. The world needs more education and material to dispel all misunderstandings. (ARB3)

> I think your questions cover everything that is out there in the blockchain space considering accounting and auditing issues. I think you did a really good job putting these questions together because they're really, really comprehensive. And I must confess that it is definitely difficult to write a PhD about a very new topic. (ARB2)

Accounting and Audit Firms

> It’s very important what you’re doing because, in the accounting environment, I would say that there's still a lot of research and work to do for using the blockchain technology, so I really liked it, that you contribute to this because, at least in Germany, we don't have a lot of stuff about it yet. (AAF4)

> I think that the research you are doing is incredibly important as we have to find value in the investment the world has made in blockchain rather than simply “blockwash” other technologies to make it look like predictions of blockchain came true! (AAF5)

Blockchain Start-ups and IT Experts

> I am so happy to hear that students of accounting are really focusing on blockchain technology. (BSIT3)

> That's why we think next year (2021) is going to be a good year, so you've picked a good topic, you pick a great topic. (BSIT4)

Accountants and Auditors

> I'm still trying to learn. I haven't got blockchain for everything I do, and probably won't in my lifetime, but there are going to be aspects of this that I think will definitely move over. It's easy to find a lot of opinions and I think those of us that are learning about this would say, the more you know, maybe, the less strong your opinion is. And I found that with technology throughout my career is that the less people know the stronger their opinions are, they're more emotional about it. I think you're the future, the younger generation and if you can pick up a few things you probably understand this better than I do. But if you can pick up a few things, you're the ones that are going to have to make this happen. (AAD3)

9.5 Limitations of the Study

Despite the global reach of the study, the study findings have some limitations. Qualitative research is considered to have a generalisation issue. This inherent challenge affects this study because it is a qualitative exploratory study using semi-structured interviews. The study's approach enabled the researcher to explore and understand the disruption associated with the adoption of BCT for accountants and auditors. As earlier noted by some participants, it is difficult to undertake research in an emerging innovation like BCT because it is in its infancy and there are a lot of arguments about the potential of blockchain. Likewise, it is important to note that it was difficult to find participants in the accounting and auditing industry with a basic understanding of BCT. The study relies on a sample size of 44 participants from 13 countries (New Zealand, Australia, South Africa, USA, UK, Ireland, Canada, Germany, Italy, Hong Kong, UAE, Pakistan and India)(see Figure 15. Distribution of Participants) with some basic knowledge of BCT. With a small sample size, caution must be applied, as the findings might not be able to be generalised. However, the researcher believes that the global spread of 44 participants across five continents and 13 countries is fair representation for a study of this nature. Although there were participants from 13 countries, a limitation of this study was that it was not possible to conduct the analysis by geographical differences. The study did not analyse whether responses and views had significance because of their geographies of where they lived and worked or in the economics in which they operated.

In this study, conclusions are drawn based on the perceptions of the participants and the documents reviewed. It is important to bear in mind the possible bias from the interviewed participants. Nonetheless, the researcher was conscious of the Dunning-Kruger effect on the participants’ perception. Rapid change and uncertainty are issues that characterise emerging innovations such as BCT. It could be argued that the technology’s drivers and future realities could affect some of the conclusions drawn. Nonetheless, the findings of the study are based on the current realities of the extent of BCT's disruptive impact on the accounting and audit fields from the experience and viewpoints of the interviewed practitioners and academics. The analysis from this study has provided some significant insights and empirical evidence that could be used for future discussion and decision making for potential users of BCT.

Researchers can improve the meaningfulness and understanding of their studies by formulating questions that challenge existing propositions (Levitt et al. (2017). The study’s research questions were formulated to challenge current perceptions of BCT regarding its potential impact on accounting and auditing practices (p156). Also, Popay et al. (1998) notes that provision of in-depth description is one major hallmark of a qualitative study. In the researcher’s view, this study has provided in-depth and detailed descriptions of the participants’ views, and follows some of the fundamental assumptions of a qualitative study which include: understanding the processes by which events and actions take place, developing contextual understanding, facilitating interactivity between researcher and participants, adopting an interpretive stance, and maintaining design flexibility (Bloomberg & Volpe, 2019, p. 217). Similarly, underlying the intersectionality of research is the research category's diversity and participants' membership (Cole, 2009). The intersection of participants across disciplines and geographical boundaries ensures that the study sample is not only broad but a good representative of the study population.

Another issue is the commercial sensitivity of BCT among the study population. Given that BCT has a commercial connotation, being asked about it evoked uneasiness in some respondents. Some respondents declined to comment on the names of organisations or their clients that are experimenting with BCT due to confidentiality. Perhaps, it could be that non-disclosure is a way of upholding the client’s duty of care, privacy, and protection of intellectual property. Perhaps, the disclosure of those names could have helped the researcher to get additional information from such organisations. Notwithstanding, the researcher still succeeded in getting some referrals for interviewing purposes from both participating and non-participating contacts. The next section examines future research areas.

9.6 Recommendations for Future Research

With BCT being such a new phenomenon, there are many things to develop as technology evolves. Some interesting theoretical problems should be very central to research in accounting going forward. Given the theoretical assumption that an audit and assurance firm or external auditor should become a node in a BCT network, becoming a node is expected to enable external auditors' 24/7 real-time monitoring of their client’s financial transactions. It would be interesting to know the implications of this on the roles of internal auditors. Future research would examine the roles of internal auditors if an external auditor or audit firm becomes a node in a BCT network.

Future empirical research could consider looking at whether the accounting educators, professional accounting bodies and curriculum developers are required to include the studies of all known emerging technologies such as BCT, AI, Data Analytics, Robotics, and Remote Sensing in the accounting curriculum to keep up with technological innovation. This becomes relevant because innovation has a life cycle and increasing pressure from academics, employers, and the accounting industry to add technological innovation to the accounting curriculum may become endless. In addition, the study should examine whether accounting graduates are expected to learn programming codes or become cryptographers to remain relevant in the digital age.

There has been much academic debate as to the appropriateness and workability of a triple-entry accounting system This study has adopted a social-constructivist-interpretivism approach and generalist view from the participants’ understanding, future research could include the building of a BCT triple-entry accounting model to examine the technical feasibility of the proposed third entry to the double-entry accounting system. This exploration could assist in determining the practicability of the BCT triple-entry system to users. Furthermore, future research could investigate the adoption of BCT for financial accounting and reporting within a geographical location. This is likely going to shed light on the extent of BCT adoption within a chosen country.

Consequently, this study recommends that future studies consider research on the assumption of completeness regarding the issue of audit completeness in a BCT environment. For instance, completeness of all transactions when there is no cut-off, and there is no closing date on a BCT network. Additionally, organisations, investors, regulators, and the general public would like to know if BCT software and applications are doing what they are supposed to do or are performing the functions they are programmed to undertake. It may be important to know if BCT software will lose relevancy overtime in a financial system.

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Appendix 1 Profile of Participants

Group	Coding	Country	Profile	BCT Knowledge over 10
Accountants & Auditors	AAD1	Ireland	Banker & IT Auditor	6
	AAD2	USA	Audit & IT & Academia	9
	AAD3	USA	CEO/ Consultant Financial Svcs	6
	AAD4	UK	Director of Finance	7
	AAD5	Pakistan	Assistant Manager Telecom	5
	AAD6	USA	CEO/ Consultant Financial Svcs	7
Audit & Assurance Firms	AAF1	NZ	Associate Director Audit	7
	AAF2	Australia	Fellow IT Expert	9
	AAF3	NZ	Associate Director Audit	4
	AAF4	Germany	Advisor BCT Application	7
	AAF5	Australia	Managing Partner Audit/CTO	8
	AAF6	NZ	Associate Director Audit	5
	AAF7	Canada	Senior Manager/Digital Leader	10
	AAF8	Hong-Kong	Director	7
Academics	ACA1	USA	Financial Analytics	6.5
	ACA2	UK	Cybersecurity	7
	ACA3	USA	Engineering & Technology	7
	ACA4	NZ	System Tech & Database Design	8
	ACA5	USA	Finance	10
	ACA6	NZ	Law & Blockchain Tech	6
	ACA7	India	IT	6.5
	ACA8	UK	Accounting & Finance	7
Blockchain Startup & Information Technology Experts	BSIT1	NZ	CEO BST	7
	BSIT2	USA	MD IT Firm	5
	BSIT3	USA	Consultant & IT Expert	8
	BSIT4	NZ	GM Strategic Planning	6
	BSIT5	USA	CO-Founder of BST/CFO	9
	BSIT6	NZ	Manager Logistics	6
	BSIT7	USA	Senior Manager BCT & Digital Assets	7
	BSIT8	USA	CEO BST	8
	BSIT9	USA	Director Innovation - BCT & Machine Learning	6
	BSIT10	USA	CEO & Chairman BST Alliance	10
	BSIT11	NZ	CEO of IT Firm	7
Accounting Regualtory Bodies	ARB1	UAE	Director *	7
	ARB2	Australia	Director *	8.5
	ARB3	South Africa	Director *	10
	ARB4	UK	Director *	8
	ARB5	NZ	Director *	6
	ARB6	UK	Director *[32]	8
Financial Analyst & Other Experts	FAE1	Italy	Senior Analyst	10
	FAE2	NZ	Practice Lead Audit of AI	7
	FAE3	USA	Senior Editor	7
	FAE4	UK	Consultant Food Safety	5
	FAE5	UK	Manager Operations/Editor	7

[32] Director was allocated to participants from the Accounting Regulatory Bodies to further protect the identity and privacy of this group because they could be easily matched if their real titles are used.

Appendix 2: Interview Guides

Research Question	Interview Question
1. General Questions. It enables the researcher to understand the background of the participants and their involvement with BCT.	* Are you familiar with the word blockchain technology (which is hereafter referred to as BCT)? Could you briefly explain what BCT is? * On a scale of 1 to 10 (with 10 being the highest), how do you rate your knowledge/understanding of BCT? * Do you undertake BCT activities or operations or research in your organisation? What BCT activities or operations are you currently undertaking in your organisation? * Are you aware of any organisations or clients that are using BCT for their operations? * Would you like to provide any further information?
2. What accounting practices will change in a BCT-based environment?	*Double entry is the foundation of accounting transactions, what will BCT add to the double-entry accounting system? *Are you aware of the triple entry accounting system? How do you think BCT could facilitate this system in accounting practices? *What impacts is BCT have on tax management? *What areas in the traditional accountant's functions BCT will disrupt?
a. What areas will BCT disrupt or enhance in the accounting and auditing practices?	*In your judgement, what areas of accountant's functions BCT will enhance? *What areas have BCT enhanced in the audit? *What are the areas BCT has disrupted in the audit? * What effects would BCT have on accounting and auditing without the digitalisation of financial records and processes?
3. What are the organisations currently using BCT or have adopted BCT for financial accounting and reporting purposes?	*From your experience, are there organisations currently using BCT or have adopted it for financial accounting and reporting purposes? Please, mention them.
4. To what extent are auditors relevant in BCT-based financial records and reporting system	* What effects is BCT having on audit processes? *Are auditors relevant in the BCT financial system? *How likely is BCT to eliminate a third-party auditor? Could you explain, please? *How will auditors benefit from using BCT? *Are there new roles for auditors in a BCT environment? *How does the ability of BCT to record transactions in real-time affect auditing processes?
5. What are auditors expected to audit in a BCT accounting system?	*What are auditors expected to audit in a BCT accounting system? Is it the chains or transactions or both? * To what extent can auditors rely on the record generated by BCT as audit evidence?
6. How effective are blockchains in the prevention and detection of fraud or anomalies?	*What mechanisms are in place in BCT for fraud prevention and detection? *How effective are BCT security systems in preventing and detecting anomalies or fraudulent transactions? *Can blockchain reduce or eliminate financial fraud? If so, how? *How possible are fraudulent transactions or entries in a BCT system? *What weaknesses are there in BCT's fraud prevention and detection mechanism? *What types of fraud or anomalies can take place in a BCT environment

Research Question	Interview Question
7. What effect does garbage in and garbage out have on the effectiveness of BCT fraud prevention and detection mechanisms?	*What impact does garbage in, garbage out have on the effectiveness of BCT fraud prevention and detection mechanisms? *How will GIGO impact BCT security architecture?
8. What are technical skillsets required by accountants and auditors in a BCT environment? 9. How relevant is the understanding of BCT programming languages for accountants and auditors?	*What technical skillsets do accountants and auditors require in a BCT-enabled environment? *To what extent does learning BCT programming languages relevant to accountants and auditors? *What is your view on "Auditors do not need to become IT specialists to use BCT"? * To what extent should accountants and auditors rely on IT staff in the operation of a BCT system?
10. What are the incentives, barriers and unintended consequences of adopting BCT as a FinTech solution?	*What are the characteristics/attributes/features you consider important for the adoption of BCT in any organisation? *Are there barriers to the adoption of BCT? What are these barriers or obstacles to the adoption of BCT in the accounting and auditing professions? *What makes BCT a disruptive technology? What are the parameters you used to classify it as a disruptive technology? *What are the undesirable consequences of adopting BCT as a FinTech?
11. How has COVID-19 enhanced the adoption of BCT?	*How has COVID-19 enhanced the adoption of emerging technology like BCT? *Which of the types of BCT (private or public) has a higher chance of adoption?
12. General views	* Could please share your general views on BCT and its implications for accounting professionals?

Appendix 3 Participant Profile Form

PARTICIPANT PROFILE FORM

Participant Name: (Represented with Codes)

Mode of Interview: F2F ☐ Phone ☐ Zoom ☐ Message Chat ☐

Contact Date: ……………… Interview Date ……….

Summary of Information for Each Research Question:

RQ1 :

RQ2:

RQ3:

RQ4:

Additional Information needed:

Possibility of further getting a contact: Yes …….. No …….. if yes, follow up

Reflection: on the positive or negative issues on overall impression, questions, concerns, pending items still to be addressed

Positive: …………	Negative:…………
……………………	……………………
……………………	……………………

Note. Source: Author (originally adapted from Bloomberg and Volpe (2019, "Participant Summary Form," p.390)

Appendix 4: Ethics Approval

WAIKATO MANAGEMENT SCHOOL
TE RAUPAPA

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Waikato Management School
The University of Waikato
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Amanda Sircombe
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Email amandas@waikato.ac.nz
www.management.ac.nz/research

I
Musbaudeen Oladejo
By email: mo163@students.waikato.ac.nz

12 July 2021

Dear Ola

Ethical Application WMS 20/96
Blockchain Technology: Disruptor or Enhancer to the Accounting and Auditing Profession

The above research project, as outlined in your submitted application, has been granted Ethics Approval for Research by the Waikato Management School Human Research Ethics Committee.

Please note: should you make any major changes to the project outlined in the approved ethics application, you may need to reapply for ethics approval.

Best wishes for your research.

Kind regards,

Amanda Sircombe

Amanda Sircombe
WMS Research and Postgraduate Manager

Appendix 5: Introductory Letter to Participant

Introductory letter to participants – Semi-Structured Interviews

Waikato Management School
Te Raupapa

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

School of Accounting, Finance and Economics
Waikato Management School
The University of Waikato

……….. 2020

This letter is to invite you to participate in a research project entitled:

Blockchain Technology: Disruptor or Enhancer to the Accounting and Auditing Profession

Dear Sir/Madam,

I am currently studying for a doctoral degree at the University of Waikato, New Zealand. My research is investigating the implications of blockchain technology (BCT) in the accounting and auditing profession.

Blockchain is described as a disruptive innovation with the potential to eliminate the key functions of accountants and the roles of auditors. The technology is poised to affect the entire record-keeping processes which includes transaction initiation, processing, authorisation, recording and financial reporting including tax preparation. Some writers assert that BCT's features such as distributed-shared ledger, audit trail, transparency, immutability and cryptographic security will eliminate the need for external auditors. Similarly, BCT is capable of preventing and detecting fraudulent transactions. The purpose of this study is to conduct empirical research to understand the practical implications of BCT in the accounting and auditing profession from the perspectives of the blockchain start-ups, accountants, auditors and members of academics. It is equally important to understand how accounting will change in a blockchain-based environment, what auditors are expected to audit in a blockchain system, how strong are blockchains for fraud prevention and detection as well as the rate of adoption of the technology.

I would like to invite you to participate in this semi-structured interview which is expected to take at least 60 minutes or thereabout of your time. This interview could be face-to-face, online, via telephone or text message depending on your preference. Participation is voluntary. I am fully aware of the importance of treating information given with a high degree of confidentiality. I will neither identify you nor attribute any comment made by you in my thesis without your express permission. The interview is strictly for academic purposes and it will form part of my PhD thesis and possible publications in academic journals. Please read the attached information sheet that contains further information regarding the research to enable you to decide your participation.

I appreciate your valued participation in this research and feel that the results will contribute significantly to better understating the practical implications of blockchain in the accounting and auditing profession as well as for other stakeholders. If you have any comments or queries, please contact me or any of my supervisors: Assoc Professor Mary Low, Dr Vida Botes and Professor Steve Reeves.

I look forward to your participation in this research. Thank you.

Yours truly,
Musbaudeen Oladejo
Email: mo163@students.waikato.ac.nz
Mobile: +64 22 361 9686

Appendix 6: Participant Information Sheet

Participant Information Sheet – Semi-Structured Interviews

Waikato Management School
Te Raupapa

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Blockchain Technology: Disruptor or Enhancer to the Accounting and Auditing Profession

I am a PhD research student at the University of Waikato. My research is investigating the implications of blockchain technology (BCT) in the accounting and auditing profession. This study aims to explore whether BCT will enhance or disrupt the accounting and auditing profession. The under-listed personalities are associated with this research:

Researcher's Name and contact information:

Musbaudeen Titilope Oladejo
School of Accounting, Finance & Economics
Waikato Management School
University of Waikato
mo163@students.waikato.ac.New Zealand

Supervisor's Name and contact information:

Chief Supervisor:

Assoc Professor Mary Low
Waikato Management School
University of Waikato
Hamilton New Zealand
mary.low@waikato.ac.nz
+64 7 837 9270

Supervisor:

Dr Vida Botes
Waikato Management School
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vidab@waikato.ac.nz
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Supervisor:

Professor Steve Reeves
Dept of Computer Science
University of Waikato
Hamilton New Zealand
stever@waikato.ac.nz
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What will my participation in the study involve?

You have been invited to participate in this study as someone who would be able to provide the researcher with valuable opinions about the issue under investigation. Participation involves providing your answers to the questions in the semi-structured interview. Your answer should express **your personal opinion concerning the questions**. Any **information provided is strictly for academic research purposes**, which explores and develops a better understanding of the practical implications of blockchain technology in the accounting and auditing profession. Particular of individuals will remain anonymous and data provided will be processed as non-attributable unless there is an explicit agreement to attribute the comment to a participant. Additionally, the interview transcripts will be stored securely, and upon completion of the research, sensitive data will be destroyed.

Participation in this research is voluntary. If you decide to participate in this study, you are at liberty to withdraw your participation or information provided in the interview up to the end of November 2020 or a month after the interview. You may also decline to answer any of the questions without offering a reason for doing so. **If you require more information or clarification on any aspect of this research, you can contact the researcher or the supervisors using the contact details provided above**. The results will be published as a doctoral thesis. Likely, the research results will also be published in peer-reviewed journal articles and presented at seminars, and academic conferences. As a participant, upon request, you will be provided with a copy of the data analysis findings.

Appendix 7 Consent Form for Participants

Consent Form for Participants

Waikato Management School
Te Raupapa

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Blockchain Technology: Disruptor or Enhancer to the Accounting and Auditing Profession

Consent Form for Participants

I have read the **Information Sheet for Participants** for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I also understand that I can decline to answer any particular set of questions, and free to withdraw from the study at any time up to the end of November 2020. I understand that my participation is voluntary. Any information provided to the researchers is under the conditions of confidentiality set out on the **Information Sheet**. I agree for this interview to be audio/video recorded. I agree with the use of anonymised quotes in the study's publication.

Signed: ____
Name:____
Date: ____

Researcher's Name and contact information:

Musbaudeen Titilope Oladejo
School of Accounting, Finance & Economics
Waikato Management School
University of Waikato
mo163@students.waikato.ac.nz

Supervisor's Name and contact information:

Chief Supervisor:

Assoc Professor Mary Low
Waikato Management School
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Hamilton New Zealand
mary.low@waikato.ac.nz
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Supervisor:

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Supervisor:

Professor Steve Reeves
Dept of Computer Science
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