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Leveraging on Blockchain Technology for the Sustainability of Real Estate Practice: A Systematic Review

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Abstract
Blockchain technology (BCTech) in real estate is innovative and full of potential, although it is not widely accepted and scarcely applied. To establish the potential of BCTech in the real estate sector, this study used a systematic review of the literature found in Researchgate, ScienceDirect, Semantic Scholar, IEEE Xplore, and Google Search. This was done with a view to ascertain the current challenges in real estate practice and the potential benefits of applying BCTech to mitigate or eliminate these challenges. A total of 99 publications from 2016 to 2022 were examined, and their contents were assessed using descriptive statistical tools and presented in charts and tables. Based on the review, BCTech can provide platforms for tokenised ownership, smart contracts, quick transactions and cost reduction.

Moreover, the outcome also showed that some countries have applied BCTech to land registration, with a few others to record-keeping and real estate tokenisation. In addition, the majority of the research efforts (55%) are from journal outlets published between 2020 and 2022. Finally, BCTech offers secure and transparent platforms for real estate stakeholders; hence, they have much to gain by encouraging and embracing its adoption. The study concluded that though BCTech is not yet widely used, it has a lot of potential to offer in terms of the sustainability of the real estate industry.

Keywords: *BCTech, challenges, potentials, real estate,* sustainability

1. Introduction

Cutting-edge technologies are advancing to new heights nowadays at a rapid rate. Blockchain technology (BCTech) has emerged as a popular topic of discourse in social and professional settings as yet another development in technology. In the quick-paced digital world of today, this technology has brought about revolutionary change (Walter, 2022). A blockchain – also known as "blocks" that hold data sets – gathers relevant information and groups it together. A specified storage restriction applies to each block. A block is linked to the preceding, filled block after it has reached capacity. As a result, a data-block chain is produced. Thus, "blockchain" was coined. The data is immutable and irreproducible because of the chain around the blocks. The chain also establishes a verifiable ledger of transactions that anybody may access without being able to change because this data is subsequently disseminated throughout a network of computers (Jacob, 2020; Classicattorneys, 2022;

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Venugopal, 2022). In other words, blockchain is a method of preserving records that makes it hard for third parties to modify stored data illegally. The process of documenting transactions and tracking assets is made more accessible by a blockchain, specifically a digital ledger of transactions (Venugopal, 2022; Walter, 2022).

BCTech in real estate is innovative and full of potential, even though it is still in its early stages of adoption (Classicattorneys, 2022). Transactions on a blockchain are tamper-proof and transparent. They are, therefore, perfect for real estate transactions, which are frequently quite complicated and include numerous stakeholders. Blockchain eliminates the possibility of error or fraud that is prevalent in conventional real estate practices by allowing all parties to know the transaction's status at all times (Malonson, 2022). Unlike typical traditional real estate transactions, which can take weeks or even months to complete (Shabbir, 2021), blockchain transactions are quick and effective. They can be completed in a matter of minutes. Generally, BCTech has the power to transform the workings of the real estate sector completely. It will improve transaction safety, openness, and effectiveness (Casino et al., 2019; Voigt and Rosen, 2022; Malonson, 2022).

Based on the foregoing, a large number of studies have proposed the application of BCTech to tackle the challenges of traditional real estate practice (Yarlagadda and Gampala, 2020; Ameyaw and De Vries, 2021; Saari et al., 2022; Ali and Gupta, 2022; Podshivalov, 2022; Akpokona, 2022). Some of these articles discuss the benefits of BCTech adoption in the context of land administration, documentation, registration, and management. Despite the volume of studies on BCTech's application in the real estate sector, Konashevych (2020a) emphasised that further technical analysis and empirical investigation are required to comprehend the potential of the technology. This assertion is supported by Ebekozien et al. (2022), who stressed that research efforts on utilising BCTech in Nigeria's built environment space are sparse. Moreover, Miah (2022) suggested that further research should consider BCTech's impact on real estate stakeholders (such as investors, real estate professionals, sellers, buyers and renters). This is crucial, considering that some stakeholders are sceptical about whether they will benefit from it. This may be because the subject (benefits to stakeholders) has gotten minimal attention in scholarly publications. This is evident because earlier works were on the general application of BCTech (Xu, Chen and Kou, 2019; Sharma and Bhuriya, 2019; Meiriño et al., 2019); application of BCTech to financial services (Javid et al., 2022); application to rural development (Kaur and Parashar, 2022); security application (Harbi et al., 2023); application of BCTech in manufacturing industry (Guo, Zhang and Zhang, 2023), even application to real estate (Thota, 2019; Pankratov, Grigoryev and Pankratov, 2020; Jules, 2021; Santana, Da Silva and Da Cunha, 2021; Saari, Vimpari and Junnila, 2022). However, none of the earlier reviews considered the impact of BCTech on real estate stakeholders.

As a result of the foregoing, more academic papers are needed, particularly in the Nigerian context, that can enhance stakeholders' understanding of the adoption of BCTech to combat real estate challenges and the benefits of BCTech adoption to real estate stakeholders. Hence, this study further strengthens the existing discourse on how blockchain can minimise or eradicate the challenges in real estate practice. Against this background, this study reviewed research efforts on the challenges threatening the sustainability of real estate practice and the potential of BCTech in solving these challenges. The outcome of this study will help real estate professionals better comprehend the value of BCTech. Additionally, this study is crucial for fulfilling goal 9 of the United Nations' SDGs, which centres on industry, innovation, and infrastructure. BCTech's application in real estate is an innovative way of curbing the challenges of real estate practice and thereby ensuring its sustainability.

To better situate the review, the following research questions served as the guide:

1. What are the challenges in real estate practice threatening its sustainability?
2. What are the ways BCTech can minimise or eradicate these challenges to ensure the

sustainability of real estate practice?
3. How can BCTech enhance real estate processes?
4. Does BCTech offer any benefits to real estate stakeholders?
5. What are the authors' contributions to BCTech's potential in real estate practice?

2. Materials and Methods

Concerning the research questions, the researcher used a systematic review to provide answers. The same five-step methodology used in earlier studies (Khan et al., 2003; Green, 2005; Babalola et al., 2019) was followed to conduct the review. The steps are (i) formulating research questions, (ii) identifying relevant published studies, (iii) evaluating the studies, (iv) summarising the significant findings, and (v) interpreting the findings. The first phase involved developing research questions to direct the review. The next step was to find publications to be included in the review. A literature search was conducted using databases like Researchgate, ScienceDirect, Semantic Scholar, IEEE Xplore, and Google Search. These databases were selected because they are known to be leading online research tools and databases (Turner, 2010; Joannah, 2022). The online searches were in two stages. The first stage focused on challenges in real estate. The search was conducted using phrases like "challenges in real estate", "challenges in real estate practice", "hindrances to real estate practice", "real estate challenges", and "fraud in real estate practice". The second search focused on the usefulness of BCTech in real estate. The researcher used search terms like "blockchain and real estate", "blockchain in real estate", "benefits of blockchain in real estate practice", "potentials of blockchain in real estate practice", and "BCTech for real estate sustainability" for the search.

The materials were then screened to identify papers with titles, abstracts, or keywords related to the previously mentioned terms. To ensure currency of the publications, the review was limited to 7 years (i.e. 2016–2022). The search for "real estate challenges" produced 15 pertinent publications (comprising 4 online papers and 11 journal articles). In comparison, 84 publications were found for the "blockchain" search (composed of 20 online papers, 40 journal articles, 16 conference papers, 7 theses and 1 book chapter). In all, a total of 99 documents (i.e. 15 on real estate challenges and 84 on blockchain) are included in this review. The identified publications were next subjected to screening and classification. The researcher read and reviewed the chosen papers to determine their relevance to the study. The information used in this study is entirely secondary. After subjecting them to frequency and percentage analysis, tables and charts are used to present the review's findings.

3. Challenges in Real Estate Practice Threatening its Sustainability

Real estate investment is the most significant global wealth reserve and a vital component of the worldwide economy (Saull et al. 2020). Real estate and property rights transactions are intricate and drawn-out processes requiring the approval of numerous agencies, including appraisers, lenders, attorneys, and agents (Liu et al., 2020). As a result, real estate practice and the purchase process are marked by numerous challenges. Table 1 summarises some of these challenges as identified by various researchers.

Table 1: Challenges in Real Estate Practice

S/N	Authors	Challenges
1	Wouda and Opdenakker (2019)	Fragmented market data and lack of transparency
2	Yarlagadda and Gampala (2020)	Cumbersome title management, fraud/scams and illiquidity
3	Liu et al. (2020)	High cost of land, expensive transactions (resulting from legal, brokerage, title registration, and banking fees)
4	Jane (2020)	Documentation issues, presence of brokers or middlemen, Title Management, illiquidity and fraud/scams
5	Ngwu (2020)	Fraud potential, cumbersome transaction processes, human

		errors in 'manual' land registries, involvement of numerous intermediaries, high transaction costs and corruption arising from undue bureaucracy
6	Konashevych (2020a)	Abuse of power, third-party actions, corruption, and centralisation expose data to the risk of loss
7	Mashatan et al. (2021)	Professional misconduct and fraud
8	Jules (2021)	A high number of middlemen (e.g. banks, lawyers, notaries and brokers), transaction cost, fraud and illiquidity
9	Shabbir (2021)	Onerous paperwork, high transaction cost, lack of transparency, fraud risk, slow pace of transactions and presence of middlemen
10	Ameyaw and De Vries (2021)	Lack of transparency, high cost, fragmented institutional arrangements, intrusion of unqualified middlemen, fraud and unnecessary bureaucracy
11	Zahuruddin et al. (2021)	Onerous paperwork, time-consuming registration and documentation issues, middlemen/brokers and fraud
12	Chirag (2022)	Higher risk of fraud, lack of transparency, expensive investment, tedious paperwork, a large number of intermediaries and poor transaction speed
13	Saari et al. (2022)	Trust issues, corruption, non-transparency, fraud, high costs and inefficiencies
14	Kislitsyna (2022)	Difficulty obtaining accurate property information, the possibility of fraud, a large number of intermediaries, tedious paperwork, high entrance barriers to property investing
15	Mann et al. (2022)	Space restrictions, fraud, complex process of verifying titles, lack of standardisation, and poorly maintained land records

Source: Author's Compilation (2023)

Judging from the review in Table 1, several researchers have highlighted the challenges associated with real estate practice. Thankfully, most of them are surmountable with the application of BCTech, which has prospects of transforming the real estate industry.

4. Overview of Blockchain Technology (BCTech)

In a hypothetical sense, there is no genuine definition of blockchain that the average person can easily comprehend (Ravikiran, 2022). Venugopal (2022) believes a blockchain is a set of chronologically ordered, publicly accessible records known as "blocks." The information is encrypted to ensure that the user's privacy is not violated and that the data cannot be changed. In contrast to existing financial organisations, a centralised authority does not have control over the information on a blockchain network. The data is maintained by network users, who also retain the ability to democratically approve every transaction that takes place on a blockchain network. A typical blockchain network is, therefore, a public blockchain. A digital ledger, a peer-to-peer network, and cryptographic keys are combined to form the blockchain (Venugopal, 2022; Ravikiran, 2022; Hayes, 2022).

The two varieties of cryptography keys are public and private keys. Every individual or node possesses both keys, which are used to create digital signatures. The most essential component of BCTech is this digital signature, which acts as a precise and secure point of reference for a digital identity. Each transaction must have the owner's digital signature to be valid. In a peer-to-peer blockchain network, a mathematical verification authorises a transaction. Many people work together in this peer-to-peer network to decide on transactions and other matters (Venugopal, 2022). The digital ledger is a system that houses all of these transactions. The digital ledger functions like a spreadsheet that contains every single node in a network and records every single transaction that node has ever

made. The digital signature protects the data in the ledger from being tampered with and ensures that it is exceptionally secure. The most intriguing feature of this ledger is that any user can view the data, but nobody can tamper with it (Venugopal, 2022; Ravikiran, 2022; Hayes, 2022).

4.1 Potential Uses of BCTech in Sustaining Real Estate Practice

The real estate sector stands to benefit significantly from BCTech. For example, transactions might be streamlined using platforms built on the blockchain. Such platforms provide a secure, transparent environment for all parties to follow the progress of a transaction (Casino et al., 2019; Malonson, 2022; Voigt and Rosen, 2022). In the future, blockchain-based systems will enable broader participation in real estate through fractional property ownership. As a result, the real estate market can become more democratic and present new investment options (Malonson, 2022). In the opinion of Wouda and Openakker (2019) and Walter (2022), BCTech has the prospect of reducing the need for middlemen in real estate transactions, resulting in cost and time savings, as well as increased security over traditional transaction methods and even a reduction in fraud. Soetan (as cited by Gbonegun, 2019) added that blockchain is a cutting-edge technology that adds some valuable elements to the real estate industry. These include the immutability of records and smart contracts, which shield property owners and buyers from fraud since cryptographic hash algorithms prevent data inside the blockchain from being altered.

According to a report by Gbonegun (2019), using BCTech would help mitigate several problems, including a severe lack of transparency, high taxes and fees, a lack of liquidity in the market, sluggish transaction speeds, and problems with pricing commitments. Through BCTech, there will be greater access to the market for more people, and transactions will be safer and more transparent (Liebkind, 2020). Table 2 gives an overview of some of the potential uses of BCTech in real estate.

Table 2: Potential Uses of BCTech in Sustaining Real Estate Practice

S/N	Potentials	Description	Source
1	Tokenised ownership	With BCTech, tokens can protect property against fraud or theft via verifiable ownership. By purchasing tokens for a property, numerous people can jointly own it. Tokenisation enables partial or fractional ownership of an asset. It also makes real estate a more liquid asset, enabling owners to acquire and sell their shares more quickly and easily. Consequently, tokenisation opens up the real estate market to more participants	Liebkind (2020); Pankratov et al. (2020); Yarlagadda and Gampala (2020); Shabbir (2021); Jules (2021); Walter (2022); Kumar (2022); Kurtzer-Meyers (2022); Pritchard (2022); Kim (2022)
2	Smart contract	Smart contracts automate transactions. For real estate transactions, they execute legal agreements once the stated requirements are met. This makes the transaction process transparent and certain	Liebkind (2020); Pankratov et al. (2020); Yarlagadda and Gampala (2020); Shabbir (2021); Jules (2021); Walter (2022); Kurtzer-Meyers (2022); Kim (2022)
3	Crowdfunding investment	Real estate projects can raise money from sundry investors using crowdfunding. Crowdfunding provides a platform where investors and entrepreneurs may interact and conduct secure transactions. Property	Perzhanovskiy (2021); Kurtzer-Meyers (2022)

		developers can exhibit their project scope, potential, financial needs, and profit sharing to draw investors. In a similar vein, investors might spot openings to make wise investments. Both parties can satisfy each other's needs more quickly and easily using such a platform.	
4	Decentralisation	The decentralised nature of BCTech encourages security and trust. Since all peers on the network have access to the data recorded in the blockchain, it is transparent and immutable. The system of a decentralised exchange is predicated on trust. Knowing that peers can independently verify information gives buyers and sellers more confidence when making deals. Fraudulent acts would also decrease	Liebkind (2020); Konashevych (2020a); Shabbir (2021); Kurtzer-Meyers (2022)
5	Transparency of transactions	Data is made accessible to everyone since BCTech virtually prohibits tampering with stored data. Moreover, it helps all participants keep track of every detail of transactions, so the transactions are transparent. As lots of money is involved in exchanging the rights to and ownership of property, there is a great interest in secure, quick, and straight-forward transactions; BCTech enables such transactions	Liu et al. (2020); Yarlagadda and Gampala (2020); Shabbir (2021); Walter (2022): Kumar (2022); Kurtzer-Meyers (2022); Pritchard (2022); Kim (2022); Saari et al. (2022)
6	Reduced cost	BCTech facilitates cost-efficient processing of transactions by eliminating the involvement of third parties. Due to the transparency a decentralised network provides, transaction costs (e.g., taxes, registration fees and inspection fees) can be reduced. Additionally, money is saved by cutting out the fees and commissions of middlemen. BCTech allows for the automation of various processes, thereby minimising costs	Liebkind (2020); Liu et al. (2020); Yarlagadda and Gampala (2020); Walter (2022); Pritchard (2022)
7	Reliable and accurate data	Buyers can have complete confidence in the information they receive since the data stored on a blockchain are more accurate and dependable	Liu et al. (2020); Kim (2022)

Source: Author's Compilation (2023)

4.2 Real Estate Processes BCTech Can Enhance

Several processes in the real estate space can benefit from the use of BCTech. A few of these processes that are being revitalised with blockchain implementation are:

1. ***Property management***: Property management is quite complicated, particularly when numerous players are involved. This is why it is crucial to use blockchain's data-sharing capabilities. BCTech has the potential to expedite rental payments to owners, offer top-notch due diligence across portfolios, and streamline rental collection processes when used correctly. Time and money can be saved while operational efficiency increases (Ferranti, 2021; Chirag, 2022).

2. ***Property search***: Platforms that require hefty fees and are subscription-based are commonly used by brokers, owners, tenants, and buyers. Their property information is frequently unreliable, out-of-date, or partially distorted. All of this may be avoided by utilising a real estate search engine built on the Blockchain (Chirag, 2022). A blockchain-based application can decentralise data storage and make it possible for everyone in a network to share data. It also gives brokers more data monitoring alternatives, ultimately lowering associated expenses (Chirag, 2022; Classicattorneys, 2022; Kislitsyna, 2022).

3. ***Due diligence and financial evaluation***: Extensive effort is spent on due diligence before purchasing or renting any property. To avoid legal, technical, or financial problems, many middlemen are engaged to check relevant documents. In most jurisdictions, property information is stored on paper, which anyone may alter (Chirag, 2022; Kislitsyna, 2022). However, with BCTech, all property-related documents can be digitised and kept on a blockchain for easy and secure access. This will speed up and improve the accuracy of the due diligence process (Ferranti, 2021; Chirag, 2022; Kislitsyna, 2022).

4. ***Documentation and payments***: The current process of filing property documents is time-consuming, complex, and expensive due to middlemen's extensive documentation and involvement. This becomes more pronounced in mortgage administration or overseas transactions. Blockchain can now streamline and innovate the filing process by offering verifiable digital identities for properties. Also, the advent of cryptocurrencies may make the payment procedure more efficient, e.g., making

5. It is easier to complete multi-currency transactions (Chirag, 2022).

6. ***Title/Deed management***: The majority of property titles are paper-based. As a result, there is a greater possibility of mistakes and fraud. Any fault renders the deed management procedure illegal to continue with until the problem has been fixed. Property owners must pay expensive legal fees to ensure the accuracy and legitimacy of their property titles. By using BCTech to create immutable digital records, this problem may be readily solved while also providing transparency of the entire process (Ferranti, 2021; Chirag, 2022).

4.3 Benefits of BCTech's Adoption to Real Estate Stakeholders

Blockchain is a new technology that can change how the real estate sector and its stakeholders conduct business. Real estate stakeholders, in particular, should pay close attention to this new trend because it will drastically alter real estate transactions and tremendously benefit them (i.e. stakeholders). Table 3 provides an overview of how BCTech benefits real estate stakeholders.

Table 3: Benefits of BCTech's Adoption to Real Estate Stakeholders

S/N	Stakeholder	Benefit	Source
1	Property developers	When numerous parties can invest, developers raise the capital required to launch a project more quickly and efficiently. Although fractional real estate	Kim (2022); Classicattorneys (2022)

		ownership is not new, BCTech simplifies the procedure and expands the pool of possible investors. Project financiers will not need to worry about screening investors or dealing with a ton of paperwork when asking for capital contributions from investors outside their network. Blockchain keeps track of every piece of information, makes it possible to sign smart contracts, and provides updates and briefings to all stakeholders. The information is easily accessible to investors, regulators or any other participating party. As a result, transaction time and expenses are drastically decreased, allowing developers to concentrate on the actual development of the project	
2	Property owners and investors	Prospective owners and investors might feel secure when purchasing real estate because BCTech makes misrepresenting or manipulating data impossible. They can readily invest in a property knowing its price and validity are open and honest. Additionally, tokenisation enhances the liquidity of the property market. The entry barrier for prospective buyers or investors is made lower through tokenisation. As a result, a seller does not have to wait for a purchaser who can afford the entire property before making a sale	Shabbir (2021); Jules (2021); Kim (2022); Classicattorneys (2022)
3	Residents and tenants	Renters benefit from a better leasing and living experience using blockchain, which allows them to do everything from taking virtual tours and signing leases with smart contracts to making payments or submitting maintenance requests. These features are protected by BCTech, ensuring that all parties are aware of the legitimacy of the property listing, the veracity of identities, and the encryption of personal data. International transactions may now be simpler than ever using blockchain. Given that blockchain removes geographical restrictions, conducting negotiations and leasing property in a particular country may be feasible without leaving one's home country.	Yarlagadda and Gampala (2020); Shabbir (2021); Kim (2022); Saari et al. (2022); Classicattorneys (2022)
4	Property managers	Property management today entails processing much paperwork. A blockchain-based property management system transforms all that documentation into virtually error-proof smart contracts. Payment, tenant and property history, contractor agreements, etc., are all transparently available in such a system.	Kim (2022); Kurtzer-Meyers (2022); Classicattorneys (2022)
5	Real estate professionals	Although blockchain is helpful in assuring quick and safe transactions and data-sharing, it does not displace real estate specialists, unlike other intermediaries, e.g., lawyers. Home buyers, sellers and investors will still need assistance locating the ideal property, negotiating prices, and handling	Patno (2018); Jacob (2020)

		contingencies. Real estate professionals offer clients trustworthy information, counsel, and emotional support. Thus, they will undoubtedly become more valuable.	

Source: Author's Compilation (2023)

4.4 Authors' Contributions to BCTech's Potential in the Real Estate Sector

To position this review well, it is pertinent to look into the contributions of authors on BCTech's potential in the real estate sphere. Table 4 is a detailed summary of earlier works on blockchain applications.

Table 4: Summary of Authors' Contributions to BCTech's Potential in the Real Estate Sector

S/N	Country	Author/Year	Main Research Focus/Areas of Blockchain Application	Publication Outlet
1	US	Spielman (2016)	Land registration	Thesis
2	Tanzania	Kombe et al. (2017)	Land administration and title registration	Journal
3	Sweden	Corluka and Lindh (2017)	General application	Thesis
4	Pakistan	Uzair et al. (2018)	Record keeping	Journal
5	New York	Castellanos and Benbunan-Fich (2018)	Land records	Conference
6	South Africa	Tilbury (2019)	Real estate transaction	Thesis
7	Netherlands	Nijland and Veuger (2019)	General application	Journal
8	Netherlands	Wouda and Opdenakker (2019)	Real estate transaction	Journal
9	Poland	Kaczorowska (2019)	Land registration	Journal
10	Georgia	Lazuashvili (2019)	Land registration	Thesis
11	Georgia	Lazuashvili et al. (2019)	Land registration	Conference
12	Germany	Muller and Seifert (2019)	Land administration	Conference
13	India	Shinde et al. (2019)	Land registration	Conference
14	UK	Jyotsna and Gampala (2020)	General application	Journal
15	UK	Schubert (2020)	Land records	Thesis
16	Bangladesh	Jahan et al. (2020)	Land documentation and registration	Journal
17	Russia	Pankratov et al. (2020)	Real estate transaction	Conference
18	UK	Reddy (2020)	Real estate transaction	Journal
19	India	Singh (2020)	Land records	Conference
20	India	Krishnapriya and Greeshma (2020)	Land registration	Conference
21	Switzerland	Daniel and Speranza (2020)	Land documentation and administration	Journal
22	Italy	Morena et al. (2020)	Project application	Journal
23	Italy	Konashevych (2020a)	General application	Journal
24	Italy	Konashevych (2020b)	Real estate tokenisation	Journal
25	Italy	Konashevych (2020c)	Land registration	Journal
26	Turkey	Mendi et al. (2020)	Land registration	Conference
27	Pakistan	Ali and Tahir (2020)	Land registration	Journal
28	India	Nandi et al. (2020)	Land registration	Conference

29	Malaysia	Shuaib et al. (2020)	Land registration	Journal
30	India	Madhurya et al. (2020)	Land registration	Journal
31	India	Zahuruddin et al. (2021)	Land registration	Journal
32	Germany	Schmidt and Elferich (2021)	Real estate market	Conference
33	India	Yadav and Kushwaha (2021)	Land transaction	Journal
34	Ghana	Ameyaw and De Vries (2021)	Land registration	Journal
35	Nigeria	Ibrahim et al. (2021)	Land administration	Journal
36	UK	Jules (2021)	General application	Journal
37	Australia	Perera et al. (2021)	Property transaction records	Journal
38	Bangladesh	Shithy et al. (2021)	Land registration and ownership management	Conference
39	India	Suganthe et al. (2021)	Land registration	Conference
40	India	Naikwadi et al. (2021)	General application	Conference
41	Australia	Bennett et al. (2021)	Land administration	Journal
42	Malaysia	Humdullah et al. (2021)	Land registration	Conference
43	Malaysia	Razali et al. (2021)	Land registration	Conference
44	Australia	Ullah and Al-Turjman (2021)	Real estate transaction	Journal
45	Saudi Arabia	Shuaib et al. (2021)	Land registration	Conference
46	China	Lu (2022)	Land tokenisation	Thesis
47	Finland	Saari et al. (2022)	General application	Journal
48	Singapore	Ooi et al. (2022)	Land transfer	Journal
49	India	Ali and Gupta (2022)	Land tokenisation	Book Chapter
50	Nigeria	Ebekozien et al. (2022)	General application	Journal
51	Nigeria	Akpokona (2022)	Fractionalisation of property	Thesis
52	India	Gaikwad et al. (2022)	General application	Journal
53	Croatia	Racetin et al. (2022)	General application	Journal
54	Pakistan	Khalid et al. (2022)	Land registration	Journal
55	Russia	Podshivalov (2022)	Real estate registration	Journal
56	Malaysia	Shuaib et al. (2022a)	Land registration	Journal
57	Malaysia	Shuaib et al. (2022b)	Land registration	Journal
58	Bangladesh	Alam et al. (2022)	Land title management	Journal
59	India	Mann et al. (2022)	Landholding system	Journal
60	Saudi Arabia	Shuaib et al. (2022c)	Land registration	Journal
61	India	Umrao et al. (2022)	Land registration	Journal
62	US	Miah (2022)	General application	Journal
63	India	Chatterjee et al. (2022)	Land administration and title registration	Journal
64	Malaysia	Jasimin and Nordin (2022)	General application	Journal

Source: Author's Compilation (2023)

5. Summary of Major Findings

5.1 Challenges in Real Estate Practice

Table 1 shows that the efforts of different researchers to pinpoint the challenges in real estate practice have produced non-uniform results; hence, it is necessary to have a common perspective. This will

make it simple to identify the problems and to suggest remedies. From the review, the researcher has identified eleven key challenges in real estate practice, namely: lack of transparency; fraud; corruption; expensive transactions; onerous paperwork; slow pace of transactions; the presence of middlemen; fragmented real estate market data; title management issues; illiquidity; and professional misconduct. Using this outcome, the author proposed a conceptual framework (see Figure 1) to illustrate the leading real estate practice challenges requiring intervention. From this outcome, it can be concluded that stakeholders must focus on offering solutions to the eleven key challenges identified in this study to ensure the industry's sustainability.

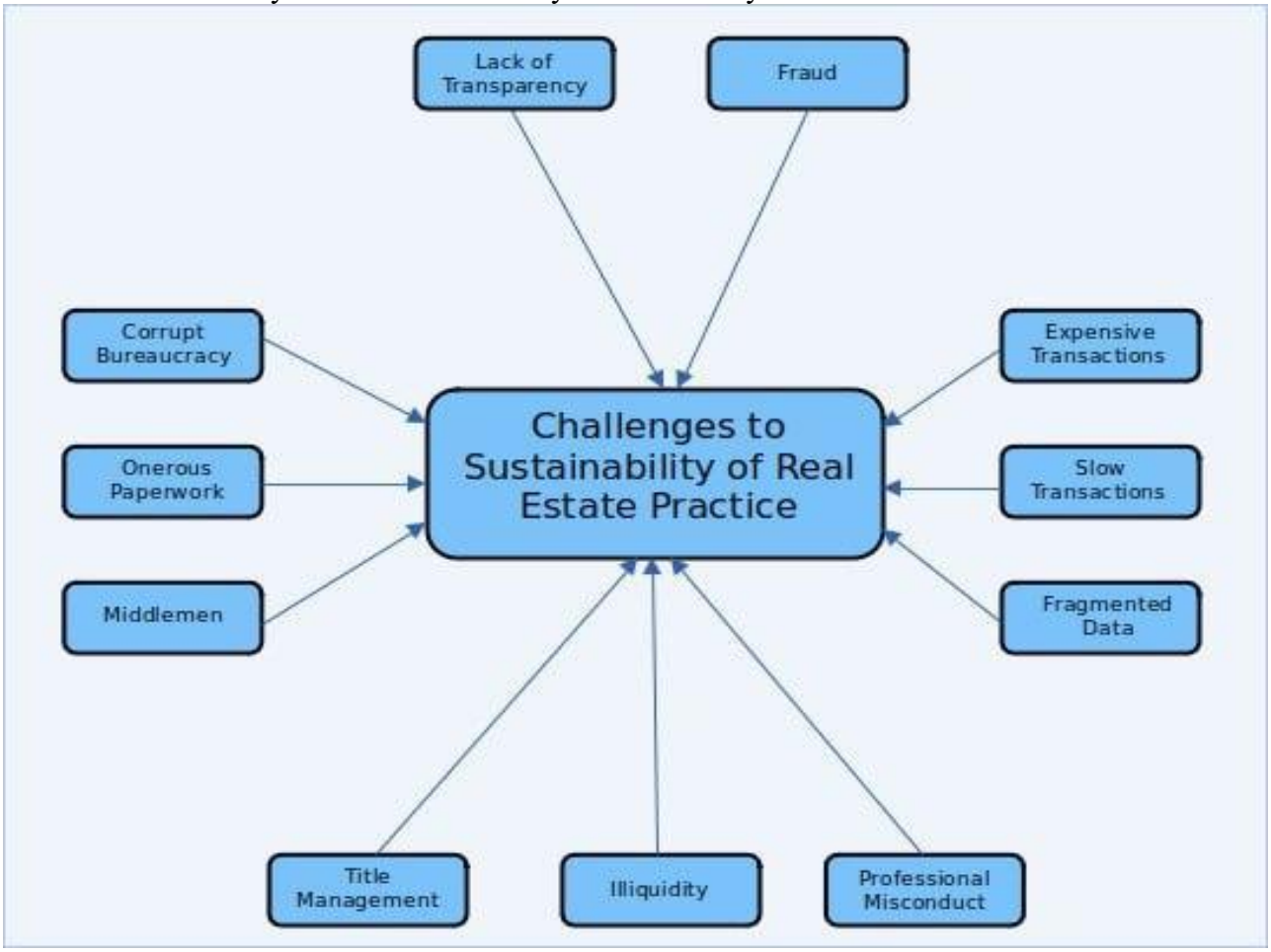

Figure 1: Challenges to Sustainability of Real Estate Practice

5.2 Potential of BCTech to Eradicate the Challenges in Real Estate Practice

Previously unresolvable issues in real estate (like those identified in Figure 1) now have BCTech-powered solutions, as indicated in Tables 2 and 6. Though the real estate industry is one of the most traditional industries, which might make accepting technological change difficult (Pritchard, 2022), BCTech should be seriously considered for adoption due to its enormous potential.

Table 5: BCTech Solutions to Real Estate Challenges

S/N	Challenges	Blockchain Solutions
1	Lack of transparency	◆ Immutable, tamper-proof transaction history
2	Fraud	◆ Tamper-proof records ◆ Smart contracts
3	Corrupt bureaucracy	◆ Elimination of middlemen ◆ Ready access to records ◆ Quick completion of transactions ◆ Smart contracts

4	Onerous paperwork	◆ Digital and complete history of ownership of assets
5	Presence of middlemen	◆ Immutability of records ◆ Smart Contracts
6	Professional misconduct	◆ Smart Contracts
7	The slow pace of transactions	◆ By design, blockchain networks enable fast completion of transactions
8	Expensive transactions	◆ Elimination of middlemen ◆ Low transaction fees are an in-built feature of blockchain networks
9	Fragmented market data	◆ Provision of complete transaction history of assets
10	Title management issues	◆ Provision of comprehensive digital records that are updated automatically every time a transaction occurs
11	Illiquidity	◆ Tokenisation

5.3 Real Estate Processes BCTech Can Enhance

The review of the processes in the real estate industry that BCTech can enhance identified property management, property search, due diligence and financial evaluation, documentation and payments, and title/deed management. This implies that if stakeholders leverage the opportunities BCTech has to offer, streamlined transactions will be common.

5.4 Benefits of the Adoption of BCTech to Real Estate Stakeholders

The review of the potential benefits of BCTech to stakeholders shows that there is a lot to gain in terms of documentation, archiving, identity management, cost reduction, and time reduction, among others. In addition, it is evident from Table 4 that BCTech offers a secure and transparent platform to real estate stakeholders. These imply that stakeholders should encourage its adoption since they stand to benefit significantly from it. Finally, from the review, non-academic papers make up the majority of the cited publications. This fact implies that there are limited scholarly articles on how BCTech benefits real estate stakeholders. This further buttresses the suggestion of Miah (2022), who advocated for more studies on how BCTech may impact real estate stakeholders. This study will, therefore, contribute to the body of knowledge found in scholarly publications.

5.5 Authors' Contributions to the Potential of BCTech in Real Estate Practice

The discussion in this section looks at the authors' contributions to the potential of BCTech in real estate practice**.**

5.5.1 Year of Publication

The evaluation of the year of publication of reviewed materials indicates that 80% (51 papers) were published from 2020 to 2022. Of this figure, 30% (19) were published in 2022. In light of this, it may be concluded that the bulk (80%) of the research work was published from 2020 to 2022. It can thus be inferred that the potential of BCTech has recently caught the attention of researchers.

5.5.2 Publication Outlets

From findings on publication outlets, out of the 64 papers reviewed, 63% (40) are journals, 25% (16) are conferences, 11% (7) are theses, and 1% (1) is from a book chapter. Moreover, the review also showed that the highest number of journals (35) were published in 2020 (11 journals), 2021 (8 journals), and 2022 (16 journals). Figure 2 depicts the results.

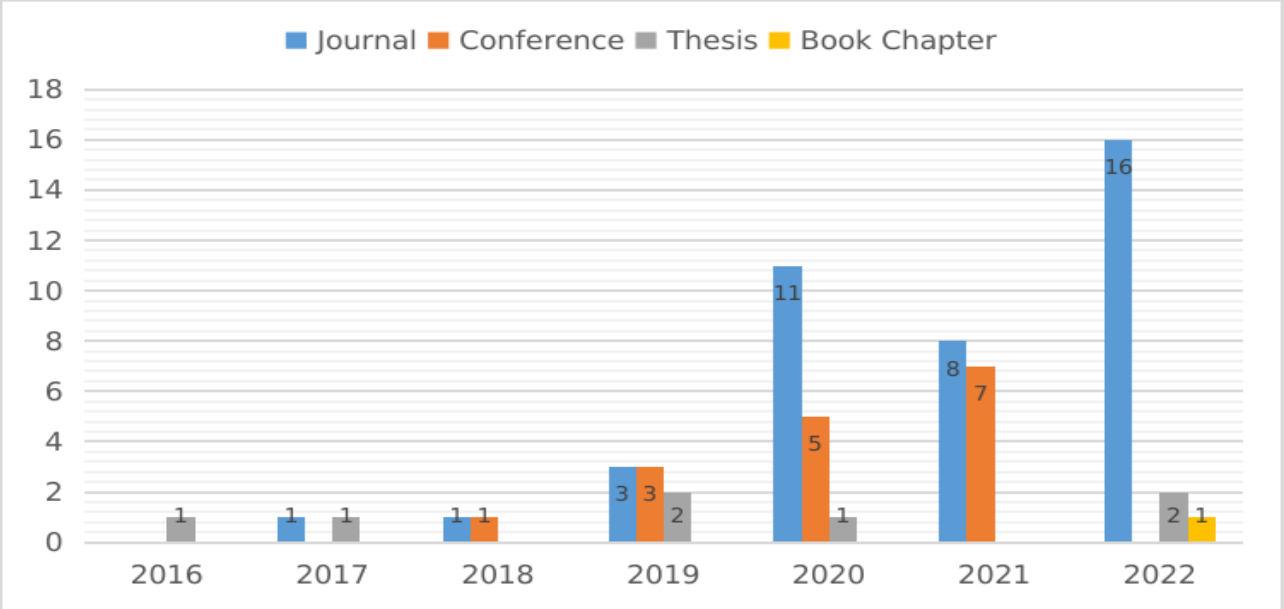

Figure 2: Publication Outlets

5.5.3 Main Research Focus/Areas of Blockchain Application

From the review, it is evident that most of the academic publications are on applying BCTech to land registration. This implies that some countries (Sweden, the UK, Estonia, Georgia, etc) have been applying BCTech to ease challenges in land registration (McKerrell, 2020). Although a few of the articles also focused on other areas, such as record keeping and tokenisation, there is a need for further academic research on other areas where BCTech may be useful, such as property search, due diligence, and financial evaluation.

6. Conclusion

BCTech will guarantee the integrity of transactions in the real estate industry because tampering with data stored on the network is impossible. Additionally, the real estate market's transparency will boost transaction dependability, increase database confidence, and drastically reduce fraud risk. BCTech will facilitate the development of a system that will enable optimised real estate transactions. This technology will make Real estate transactions quicker, safer, and less expensive.

Moreover, several authors (Li et al., 2019; Ngwu, 2020; Demestichas and Daskalakis, 2020; Lu, 2020; Brown, 2021; Kouhizadeh et al., 2021; Saheb et al., 2021; Saif et al., 2022) have identified technological, governance, organisational, knowledge, financial barriers as well as human errors (in coding and data entry) as some of the challenges confronting its adoption. To tackle these barriers, some workable solutions have been proffered (Yadav et al., 2020; Ngwu, 2020; Brown, 2021; Saif et al., 2022).

One of the topics of debates and discussions about leveraging BCTech is possible implementation challenges. Blockchain technology can be accessed on a software-as-a-service basis to ease implementation challenges. Another way of avoiding implementation challenges is by hiring consultants to lead the effort. The latter is the option utilised by the government of Ghana, which has blockchain-enabled its land registry.

There is little doubt about the advantages of BCTech (Miah, 2022). This is evident considering the number of developed and developing nations (Estonia, Sweden, Georgia, the UK, the Netherlands, Ghana, Dubai, etc) that have created blockchain-based applications to make real estate transactions more cost-effective and seamless (McKerrell, 2020). Also, in May 2023, the government of Nigeria launched a National Blockchain Policy (Adepetun, 2023; Usigbe, 2023). If so many nations are taking

the adoption of BCTech seriously, others should at least evaluate it for possible adoption.

6.1 Implications of Findings and Limitations to the Study

This study offers insight into the relevance of BCTech in sustaining real estate practice. Also, this study will contribute towards stirring stakeholders in the built environment to establish a robust framework and guidelines to adopt BCTech. This study has a few limitations. First, to ensure the currency of literature, this study was limited to 7 years, and only 99 articles were included. A further review can cover more years and articles. Finally, this paper did not elaborate on the barriers to the adoption of BCTech for real estate sustainability; hence, a follow-up study can look into this.

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